

Cell Cycle and Cell Division

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Introduction

- All living organisms, including the largest and most complex, begin life as a **single cell**.
- This single cell eventually gives rise to a complete organism composed of **millions of cells**.

Key Characteristics of Cells

- **Growth** and **reproduction** are essential characteristics of all living cells.
- Cells reproduce by a process called **cell division**.

Process of Cell Division

1. Single parental cell divides to form **two daughter cells**.
2. Each daughter cell:
 - Grows,
 - Undergoes cell division again,
 - Produces more daughter cells.
3. This process continues in cycles, resulting in a growing **population of cells**.

Significance of the Cell Cycle

- Through successive cycles of growth and division, a single cell can:
 - Generate a large number of cells,
 - Form complex tissues and organs,
 - Ultimately develop into a **multicellular organism**.

Cell Cycle

- **Cell division** is a vital process for growth, development, and maintenance in all living organisms.
- During cell division, several processes occur in a **coordinated manner**:
 - DNA replication
 - Cell growth
 - Distribution of replicated DNA
- Coordination ensures the formation of progeny cells with intact genomes.

Definition:

- The **cell cycle** is the **series of events** through which a cell:
 - Duplicates its genome
 - Synthesizes other cellular components
 - Eventually divides to form **two daughter cells**

Key Points:

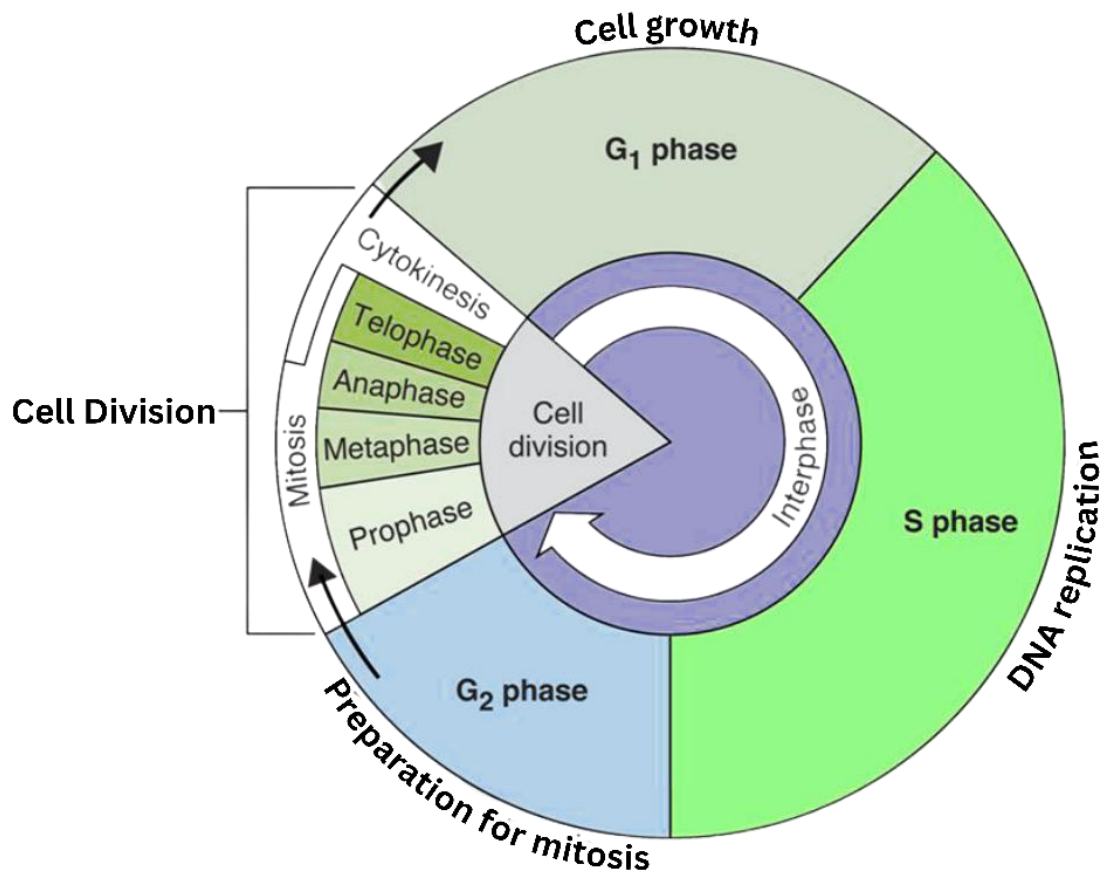
- **Cell growth** (cytoplasmic increase) is **continuous** throughout the cycle.
- **DNA synthesis** takes place only during a specific phase.
- Distribution of chromosomes to daughter nuclei occurs via a genetically regulated mechanism during mitosis.

Phases of the Cell Cycle

In **eukaryotic cells** (e.g., human cells in culture), the complete cell cycle takes approximately **24 hours**.

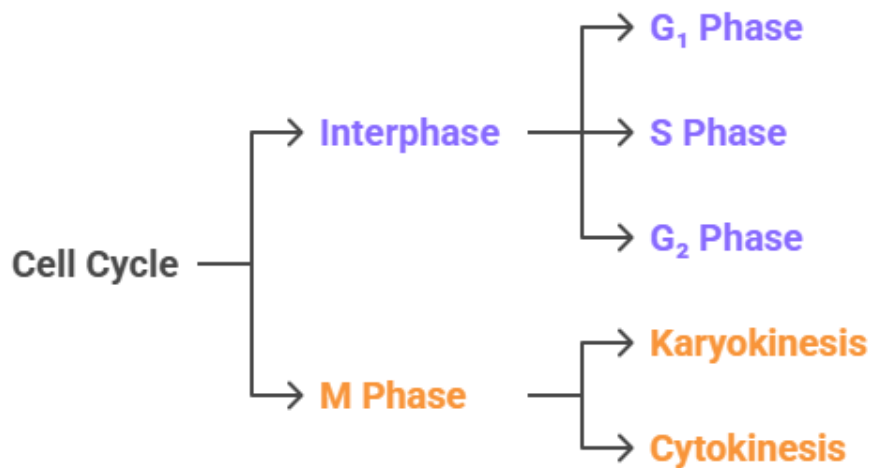
However, this duration:

- Varies across organisms (e.g., ~90 minutes in yeast)
- Varies between different cell types



A diagrammatic view of cell cycle indicating formation of two cells from one cell

The Cell Cycle is Divided into Two Major Phases:



1. Interphase (Preparation Phase)

- Longest phase of the cell cycle.
- Takes up **more than 95%** of the total cell cycle duration (e.g., ~23 out of 24 hours in human cells).
- The cell remains metabolically active.
- **Major Processes During Interphase:**
 - Cell growth
 - DNA replication
 - Synthesis of proteins and organelles required for cell division
- Interphase is divided into **three** Sub-Phases:

A. G₁ Phase (Gap 1)

Duration:

- First phase after mitosis.

Activities:

- Cell grows in size.
- Performs normal metabolic functions.
- Prepares for DNA replication.

Note:

- DNA is **not** replicated in this phase.

B. S Phase (Synthesis Phase)

Activities:

- **DNA replication** occurs.
- DNA content doubles (from **2C to 4C**).

- Chromosome number remains the same (e.g., $2n$ stays $2n$).

Additional Events in Animal Cells:

- **DNA synthesis** begins in the **nucleus**.
- Centriole duplication occurs in the **cytoplasm**.

C. G_2 Phase (Gap 2)

Activities:

- Further growth of the cell.
- **Synthesis of proteins** required for mitosis.

2. M Phase (Mitotic phase – actual division)

- **Shortest phase** of the cell cycle (~1 hour)
- Represents the **actual process of cell division**
- Divided into **two** main processes:

A. Karyokinesis

- Division of the **nucleus**
- Involves separation of daughter chromosomes

B. Cytokinesis

- Division of the **cytoplasm**
- Results in the formation of two **genetically identical daughter cells**

Quiescent Phase (G_0 Phase)

- Some cells exit G_1 and enter a non-dividing **quiescent stage**
- Called the **G_0 Phase**

Characteristics:

- Cells remain metabolically active
- Do **not divide** further unless required

Examples:

- **Heart cells** (do not divide)
- Liver or skin cells (divide only when needed)

Mitosis in Animals vs Plants

A. In animals:

- Mitosis occurs only in diploid somatic cells
- Exception: **Haploid male honey bees** can undergo mitosis

B. In plants:

- Mitosis can occur in both haploid and diploid cells
- Seen in various stages of alternation of generations

From your knowledge of plant life cycles (e.g., mosses and ferns), identify stages where **mitosis** occurs in **haploid cells**.

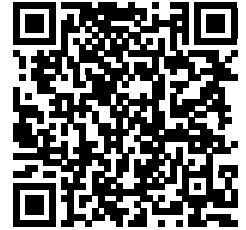


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