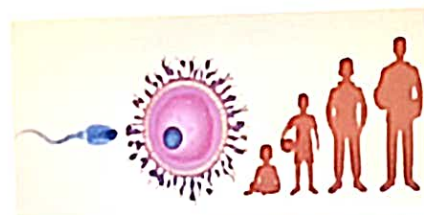


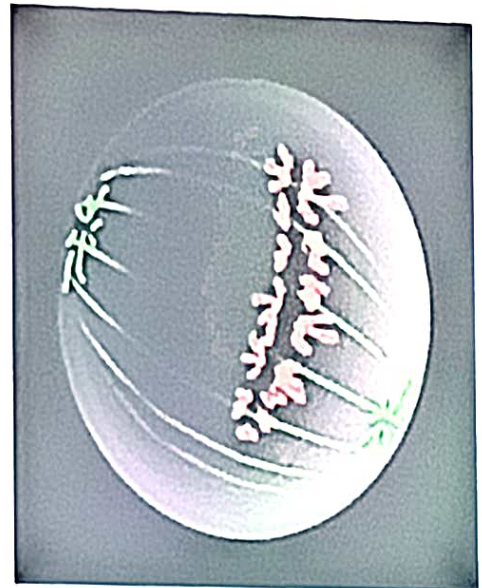
## Introduction: Cell division

- Cell Division: process by which a cell divides to form two new cells (daughter cells)
- Three types of cell division, or cell reproduction
  - Prokaryotes (bacteria)
    - Binary fission → divides forming two new identical cells
  - Eukaryotes
    - Mitosis
      - Cell or organism growth
      - Replacement or repair of damaged cells
    - Meiosis
      - Formation of sex cells, or gametes



## Why do we care about cell division?

- Cell division is a process of reproducing cells.
- This occurs during growth, repair and development of tissues.



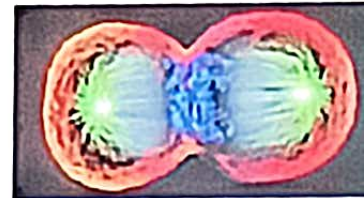


## Understanding the Cell Cycle

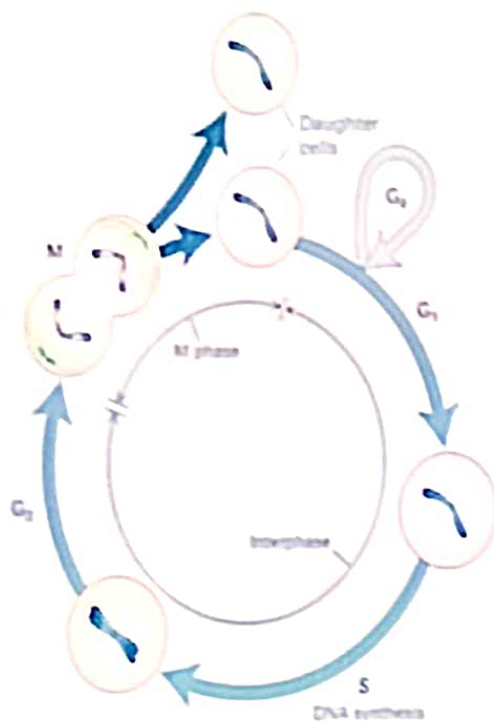
- There are three major stages to the cell cycle – Interphase, Mitosis and Cytokinesis.
- 1. Interphase encompasses the phases of G1 (Growth 1), S (DNA Synthesis) and G2 (Growth 2) phase.
- 2. Mitosis encompasses the phases of prophase, metaphase, anaphase and telophase.
- 3. Cytokinesis (cytoplasm divides)

# Understanding the Cell Cycle

- ▀ It is the life period of a cell during which a cell divides (synthesizes DNA, grows and divides into two daughter cells.
- ▀ Cell growth (increase in cytoplasm) is a continuous process.
- ▀ Duration of cell cycle varies in each organism and cell type.
- ▀ For a typical human cell: 24 Hours
- ▀ For yeast cells: 90 minutes



## What is the cell cycle?



- Repeating sequence of cellular growth and division throughout the life of an organism



## Phases of Interphase


- ▀ A) 1<sup>st</sup> Growth Phase = ( $G_1$ )

- ▀ 1. Cell grows rapidly and carries out routine functions
- ▀ 2. Phase takes most of the cell's life
- ▀ 3. Muscle and nerve cells never divide, so they remain in  $G_1$





## Phases of Interphase (cont.)

- B) Synthesis Phase (S)
    - 1. Cell's DNA is copied
    - 2. At the end of the stage, each chromosome consists of 2 chromatids attached at a centromere.
- 



## Phases of Interphase (cont.)

- C) Second Growth Phase ( $G_2$ )
  - 1. Hollow microtubules are assembled
  - 2. Microtubules are used to move chromosomes during mitosis





## Second Phase of the Cell Cycle

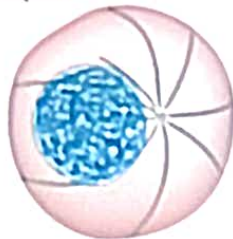
### D) Mitosis

1. Nucleus is divided into 2 nuclei
2. Each nucleus ends up with the same number of chromosomes as the original cell.
3. Includes prophase, metaphase, anaphase and telophase.

## Phases of M-phase (Mitosis)

From an ultrastructural standpoint, **M phase** processes are the most complex. In comparison, few changes are visibly apparent in most cells during interphase, which consists of the combined G1, S, and G2 phases. M phase is subdivided into 4 main periods--prophase, metaphase, anaphase, and telophase.

Interphase



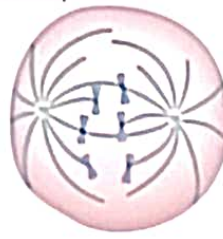
Chromosome duplication and cohesion.  
Centrosome duplication

Prophase



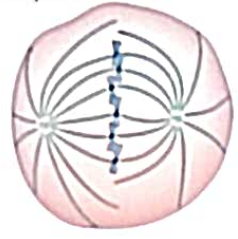
Breakdown of interphase microtubule display and its replacement by mitotic spindles.  
Mitotic spindle separation.  
Chromosome condensation.  
Centrosome separation.

Prometaphase



Nuclear envelope breakdown.  
Chromosomes captured.  
b-oriented and brought to the spindle equator

Metaphase

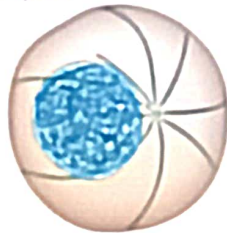


Chromosomes aligned at the metaphase plate

# Phases of Mitosis

In **prophase**, replicated chromosomes condense and become visible.

**Interphase**



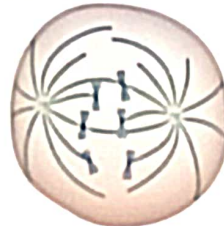
Chromosome duplication and cohesion,  
Centrosome duplication

**Prophase**



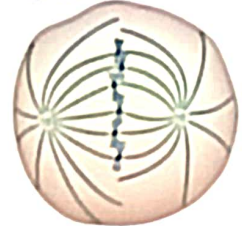
Breakdown of interphase  
microtubule display and its  
replacement by mitotic asters,  
Mitotic aster separation,  
Chromosome condensation.

**Prometaphase**



Nuclear envelope breakdown,  
Chromosomes captured,  
bi-oriented and brought to  
the spindle equator

**Metaphase**



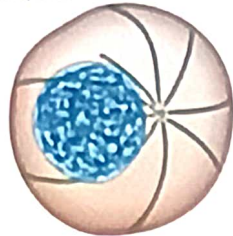
Chromosomes aligned at the  
metaphase plate

## Phases of Mitosis

In **prometaphase**, the nuclear membrane retracts, and the mitotic apparatus known as the spindle forms. Kinetochores assemble at centromeres and attach the chromosomes to the mitotic spindle fibers.

In **metaphase**, chromosomes line up on the metaphase plate in the center of the spindle.

Interphase



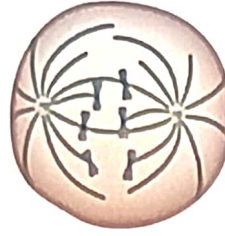
Chromosome duplication and cohesion,  
Centrosome duplication

Prophase



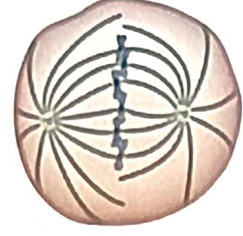
Breakdown of interphase  
microtubule display and its  
replacement by mitotic asters,  
Mitotic aster separation,  
Chromosome condensation,  
Kinetochore assembly

Prometaphase



Nuclear envelope breakdown,  
Chromosomes captured,  
bi-oriented and brought to  
the spindle equator

Metaphase



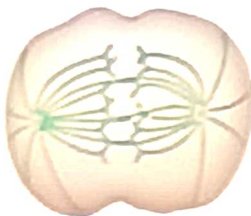
Chromosomes aligned at the  
metaphase plate

## Phases of Mitosis

In **anaphase**, sister chromatids of each duplicated chromosome separate and are drawn toward the two spindle poles.

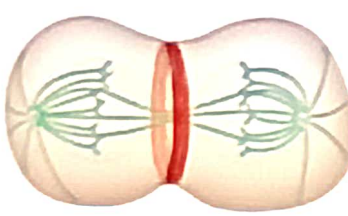
Then in **telophase**, the mitotic spindle disassembles, chromosomes decondense, the nuclear envelope reforms surrounding the chromosomes, and the cell undergoes cytokinesis—the physical division of the cytoplasm.

Anaphase



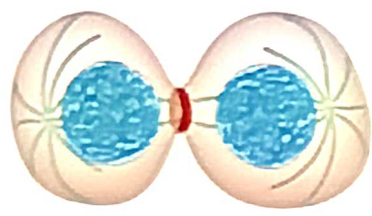
APC activated and  
cohesins degraded  
Anaphase A: Chromosome  
movement to poles  
Anaphase B:  
Spindle pole separation

Telophase



Nuclear envelope reassembly  
Assembly of contractile ring

Cytokinesis



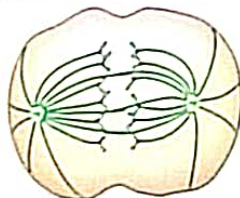
Reformation of interphase microtubule array.  
Contractile ring forms cleavage furrow



## Final Stage of the Cell Cycle

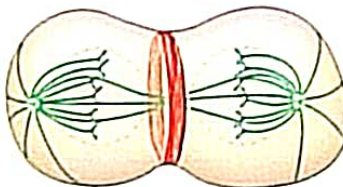
**Cytokinesis-** During this final stage, the cytoplasm divides.

Anaphase



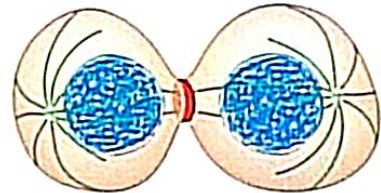
APOC activated and  
cohesins degraded  
Anaphase A: Chromosome  
movement to poles  
Anaphase B:  
Spindle pole separation

Telophase



Nuclear envelope reassembly,  
Assembly of contractile ring

Cytokinesis

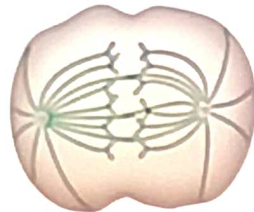


Reformation of interphase microtubule array,  
Contractile ring forms cleavage furrow

# Final Stage of the Cell Cycle

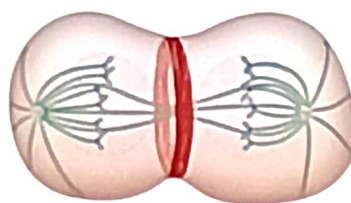
**Cytokinesis-** During this final stage, the cytoplasm divides.

Anaphase



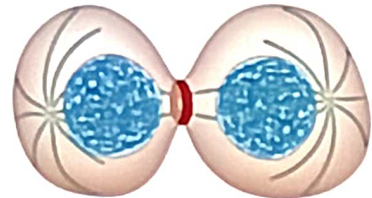
APC/C activated and cohesins degraded  
Anaphase A: Chromosome movement to poles  
Anaphase B:  
Spindle pole separation

Telophase



Nuclear envelope reassembly,  
Assembly of contractile ring

Cytokinesis



Reformation of interphase microtubule array,  
Contractile ring forms cleavage furrow