

CELL DIVISION & CELL CYCLE

Big Picture

The cell cycle is the life cycle of a cell. A cell spends its life growing, replicating DNA, performing other life functions, and dividing. For eukaryotic cells, the cell cycle consists of two general phases: interphase and the mitotic phase. Cell division is part of the life cycle for almost every cell. It is a more complicated process in eukaryotic than prokaryotic cells. Eukaryotes have multiple chromosomes and many organelles, all of which must be duplicated and separated for the cell to divide.

Key Terms

Mitosis: Process in which the nucleus of a eukaryotic cell divides.

Prophase: First phase of mitosis during which chromatin condense into chromosomes, the nuclear envelope breaks down, centrioles separate, and a spindle begins to form.

Metaphase: Second phase of mitosis during which chromosomes line up at the equator of the cell.

Anaphase: Third phase of mitosis during which sister chromatids separate and move to opposite poles of the cell.

Telophase: Last stage of mitosis during which chromosomes uncoil to form chromatin, the spindle breaks down, and new nuclear membranes form.

Cytokinesis: Splitting of the cytoplasm to form daughter cells when a cell divides.

Chromatin: Grainy material that DNA forms when it is not coiled into chromosomes.

Chromosome: Coiled structure made of DNA and proteins containing sister chromatids that is the form the genetic material of a cell goes through cell division.

Chromatid: One of two identical copies of a chromosome that are joined together at a centromere before a cell divides.

Centromere: Region of sister chromatids where they are joined together.

Homologous Chromosomes: Pair of chromosomes that have the same size and shape and contain the same genes.

Metaphase Plate: The invisible line at the equator (center) of the cell where the chromosomes containing the sister chromatids line up during metaphase.

Cell Plate: The structure that forms during cytokinesis in plants and eventually leads to the plasma membrane and cell wall of the two daughter plants.

Cell Cycle

For prokaryotes, the cell cycle is simple: the cell grows, DNA replicates, the cell divides.

For eukaryotes, the cell cycle is more complex. It includes two main phases: interphase and mitotic phase.

Interphase

Interphase includes the growth phase 1 (G₁), synthesis phase (S), and growth phase 2 (G₂). A phase out of the cell cycle is G₀, which the cell enters when it needs to rest temporarily or reaches a point in its life when it can no longer replicate.

- During G₁, the cell's main job is to grow. It creates copies of its organelles in preparation for cell division as well as the necessary proteins for DNA replication.
- In the synthesis phase, the cell's DNA is replicated.
- During G₂, the cell makes the final preparations to divide, such as making additional proteins and organelles.

There are regulatory proteins that control the cell cycle and make sure the cell is ready to move from one phase to the next. Cancer occurs when the cell cycle is not regulated.

Mitotic Phase

A key part of cell division is to create copies of the genetic material.

The mitotic phase includes **mitosis** and **cytokinesis**.

- Mitosis is a multi-step process in which the nucleus of the cell divides.
- Cytokinesis, which comes after mitosis, is the division of the cytoplasm to create two daughter cells.

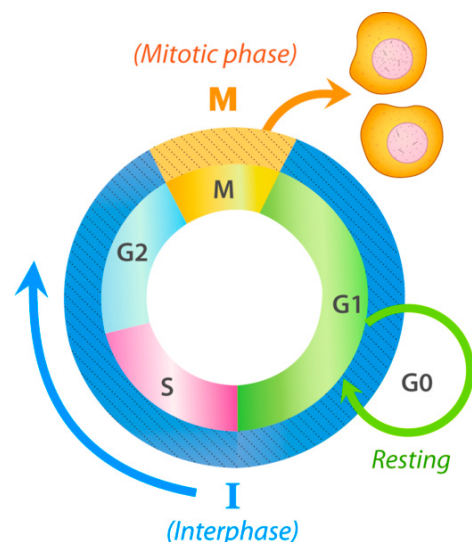


Image Credit: CK-12 Foundation, CC-BY-NC

Figure: Cell cycle for eukaryotes

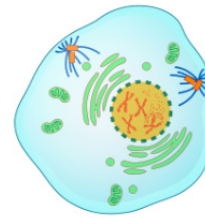
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Mitosis

In eukaryotes, after the cell has grown large enough to divide, it enters mitosis. There are several steps in mitosis:

1) Prophase

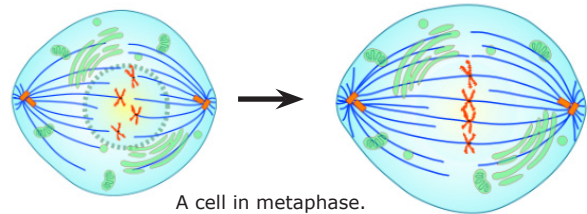
- longest phase in mitosis
- chromatin condenses into chromosomes
- nuclear membrane breaks down
- centrioles, structures found in the cell near the nucleus, separate and move to opposite poles (sides) of the cell
- spindle fibers begin to form from the centrioles



A cell in prophase.

2) Metaphase

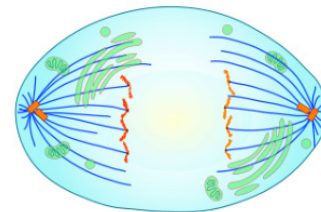
- kinetochores on the spindle fibers attach to the centromere of the chromosomes
- chromosomes line up together at the **metaphase plate**, located at the center of the cell



A cell in metaphase.

3) Anaphase

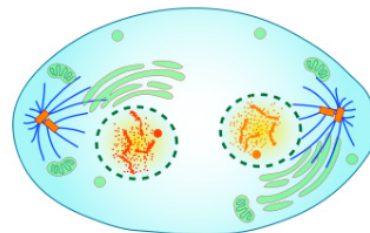
- spindle fibers shorten, pulling apart the sister chromatids to opposite poles
- by the end of the phase, each side of the cell has a complete set of chromosomes



A cell in anaphase.

4) Telophase

- chromosomes uncoil back into chromatin
- nuclear membranes form around the two sets of DNA
- spindle fibers break down



A cell in telophase.



To remember the order of the phases of mitosis, remember this mnemonic:

People Make A Team

Prophase, Metaphase, Anaphase, Telophase

Image Credit: Martha Lee, Public Domain

Cytokinesis

Cytokinesis occurs differently for animal cells and plant cells. For animal cells, a cleavage furrow forms and the cytoplasm pinches inwards until two daughter cells are formed. The process is called cleavage. For plant cells, a **cell plate** forms in the middle of the cell, and then a new plasma membrane and cell wall forms.



If you want to remember the six main steps of cell division, use this mnemonic:

Interesting People Make A Team Cooler

Interphase, Prophase, Metaphase, Anaphase, Telophase, Cytokinesis

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CYTOKINESIS

