Cell division

Cell division is the process by which a parent cell divides into two daughter cells. Cell division usually occurs as part of a larger cell cycle in which the cell grows and replicates its chromosome before dividing.

In eukaryotes, there are two distinct types of cell division: a vegetative division (mitosis), producing daughter cells genetically identical to the parent cell, and a cell division that produces haploid gametes for sexual reproduction (meiosis), reducing the number of chromosomes from two of each type in the diploid parent cell to one of each type in the daughter cells. In cell biology, mitosis is a part of the cell cycle, in which, replicated chromosomes are separated into two new nuclei.

Cell division gives rise to genetically identical cells in which the total number of chromosomes is maintained. In general, mitosis (division of the nucleus) is preceded by the S stage of interphase (during which the DNA replication occurs) and is often followed by telophase and cytokinesis; which divides the cytoplasm, organelles, and cell membrane of one cell into two new cells containing roughly equal shares of these cellular components. The different stages of mitosis all together define the mitotic (M) phase of animal cell cycle—the division of the mother cell into two genetically identical daughter cells.[3] Meiosis results in four haploid daughter cells by undergoing one round of DNA replication followed by two divisions. Homologous chromosomes are separated in the first division, and sister chromatids are separated in the second division. Both of these cell division cycles are used in the process of sexual reproduction at some point in their life cycle. Both are believed to be present in the last eukaryotic common ancestor.

Prokaryotes (bacteria and archaea) usually undergo a vegetative cell division known as binary fission, where their genetic material is segregated equally into two daughter cells, but there are alternative manners of division, such as budding, that have been observed. All cell divisions, regardless of organism, are preceded by a single round of DNA replication.

For simple unicellular microorganisms such as the amoeba, one cell division is equivalent to reproduction – an entire new organism is created. On a larger scale, mitotic cell division can create progeny from multicellular organisms, such as plants that grow from cuttings. Mitotic cell division enables sexually reproducing organisms to develop from the one-celled zygote, which itself is produced by fusion of two gametes, each having been produced by meiotic cell division. After growth from the zygote to the adult, cell division by mitosis allows for continual construction and repair of the organism. The human body experiences about 10 quadrillion cell divisions in a lifetime.

The primary concern of cell division is the maintenance of the original cell's genome. Before division can occur, the genomic information that is stored in chromosomes must be replicated, and the duplicated genome must be cleanly divided between progeny cells.[8] A great deal of cellular infrastructure is involved in ensuring consistency of genomic information among generations.

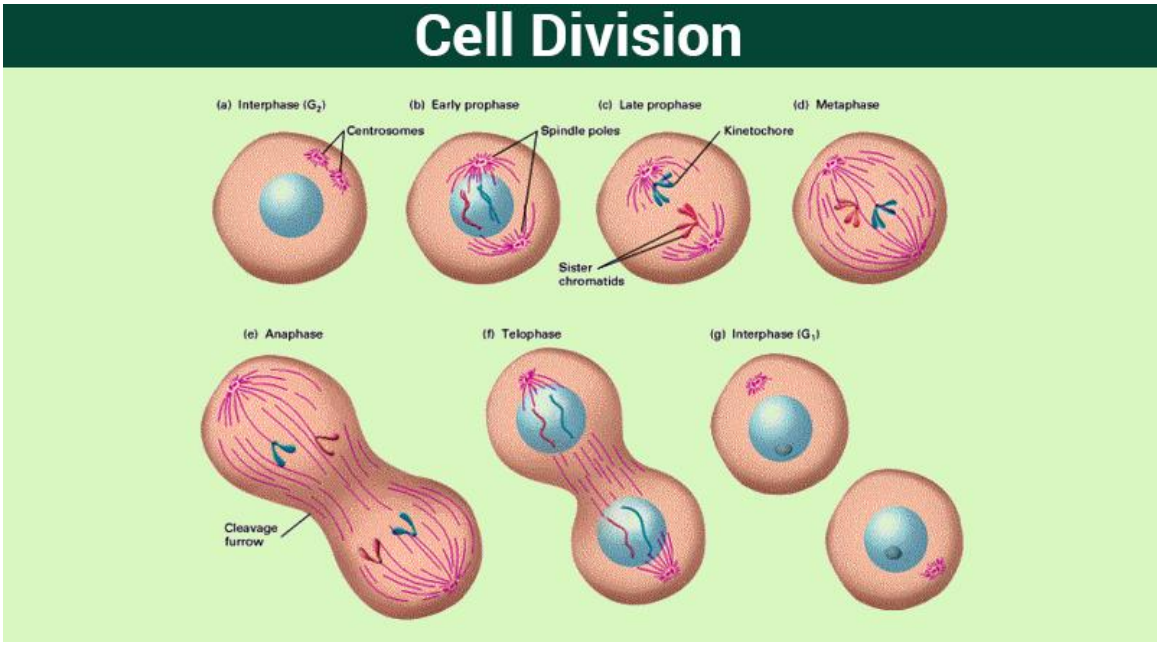
Types of Cell Division

There are two distinct types of cell division out of which the first one is vegetative division, wherein each daughter cell duplicates the parent cell called mitosis. The second one is meiosis, which divides into four haploid daughter cells.

Mitosis: The process cells use to make exact replicas of themselves. Mitosis is observed in almost all the body's cells, including eyes, skin, hair, and muscle cells.

Meiosis: In this type of cell division, sperm or egg cells are produced instead of identical daughter cells as in mitosis.

Binary Fission: Single-celled organisms like bacteria replicate themselves for reproduction.



Phases of the Cell Cycle

There are two primary phases in the cell cycle:

1. **Interphase**: This phase was thought to represent the resting stage between subsequent cell divisions, but new research has shown that it is a very active phase.
2. **M Phase (Mitosis phase)**: This is where the actual cell division occurs. There are two key steps in this phase, namely cytokinesis and karyokinesis.

The interphase further comprises three phases:

1. **G0 Phase (Resting Phase):** The cell neither divides nor prepares itself for the division.
2. **G1 Phase (Gap 1)**: The cell is metabolically active and grows continuously during this phase.
3. **S phase (Synthesis)**: The DNA replication or synthesis occurs during this stage.
4. **G2 phase (Gap 2):** Protein synthesis happens in this phase.

5. **Quiescent Stage (G0)**: The cells that do not undergo further division exits the G1 phase and enters an inactive stage. This stage is known as the quiescent stage (G0) of the cell cycle.

There are four stages in the **M Phase,** namely:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

Interphase

During the interphase period, the cell replicates its DNA (chromosomes) as it prepares for the division. Chromosomes at this stage are not easily visible since they are uncoiled.

Prophase

This is the first phase in mitosis. The nuclear envelope also starts to dissolve. The chromosomes also starts coiling and spindle fibers start forming as centrosomes divide and start migrating to either side of the cell.

During the pro-metaphase the nuclear envelope breaks down and the kinetochore microtubules appear to interact with polar microtubules of the spindle fibers.

This brings about the movement of the chromosomes

Metaphase

At this stage, chromosomes, which consist of chromatids held together by the centromere start migrating to the equator of the spindle fibers. The chromosomes therefore become aligned on a plane as the kinetochore fibers attach to the spindle fibers.

Anaphase

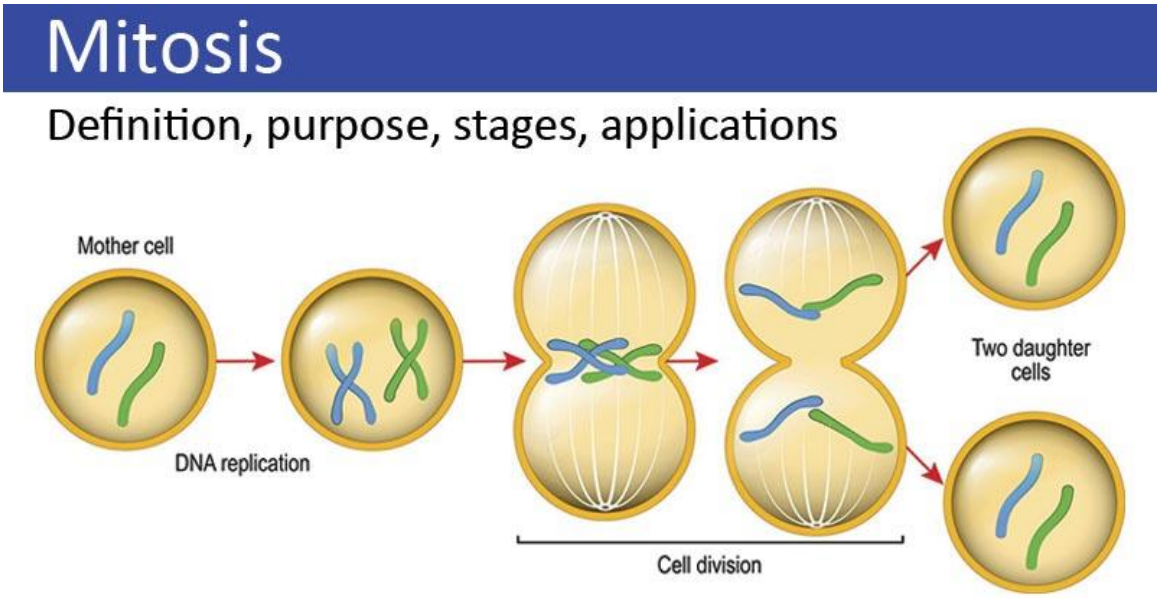
This phase starts with separation of centromeres thus separating the chromatids hence doubling the number of chromosomes. The new chromosomes then begin moving towards the poles of the cells

Telophase

During telophase, chromosomes reach poles of their respective spindles. The nuclear membrane also starts to reappear and chromosomes uncoil.

The spindle fibers also start breaking down and the cell divides in to two. The cells then start developing in to different adults. This phase passes the two cells in to the interphase stage.

During G1 interphase, the chromosomes have one chromatid. The chromosomes then replicates and each of them gets two sister chromatids.


Mitosis
Definition, purpose, stages, applications
Mother cell
DNA replication
Two daughter cells
Cell division