## CELL CYCLE

- The process through which a cell replicates its genome, manufactures other cellular components, and ultimately splits into two daughter cells is known as the cell cycle. It represents a genetically regulated series of events that transpire in a newly formed cell, facilitating the duplication of its contents, subsequent growth, and eventual division into two distinct entities.
- Upon entering the cell cycle, a cell undergoes various phases, each preparing it for the impending cell division. The synthesis of DNA, duplication of cell organelles, and the production of specific proteins are integral requirements that a cell must fulfill as it proceeds towards mitosis. The cell meticulously synthesizes these constituents in a sequential manner to ensure a well-organized division and distribution of components between the two resulting daughter cells. This meticulous process guarantees the transmission of an intact genome into the daughter cells, ensuring that the progenies are both structurally and functionally sound. Subsequently, these daughter cells undergo growth and, upon reaching maturity, embark on their own cell division.
- While cellular growth is a continuous process throughout the life of a cell, the duplication of organelles, DNA replication, and related activities occur during specific stages of the cell cycle. Therefore, the cell cycle represents the duration or time span between the formation of new daughter cells and their subsequent division, marking a fundamental aspect of cellular life and reproduction.

### Phases of Cell Cycle

The cell cycle comprises two principal phases:

- **Interphase:** Interphase is the period sandwiched between two successive M phases, serving as a preparatory stage for cell division. Constituting a biosynthetic phase, interphase spans over 95% of the cell cycle duration. During this phase, the cell engages in crucial activities such as the duplication of organelles and the replication of its DNA, the genetic material that carries vital information for cellular functions.
- **M phase or Mitotic phase:** The M phase, or Mitosis, is the stage in which the actual cell division takes place. Building upon the constituents synthesized during interphase, the cell undergoes a process of division, ultimately resulting in the creation of two daughter cells. This phase is the culmination of the cell cycle, marking the execution of the cell's intricate preparation for reproduction.
- The duration of the cell cycle can vary significantly among different organisms and even within different cell types. For instance, yeast cells demonstrate a rapid division, completing the cycle approximately every 90 minutes. In contrast, a typical human cell follows a more extended cell cycle, dividing approximately every 24 hours. This variability underscores the dynamic nature of the cell cycle, tailored to the specific requirements of distinct organisms and cell functionalities.
- **Interphase:** Interphase, a protracted and non-dividing growth phase within the cell cycle, serves as a crucial period during which the cell readies itself for eventual division. This highly active stage encompasses both cell growth and the meticulous replication of DNA in an orderly fashion. Characterized by intense growth and synthesis, interphase acts as a preparatory period during which the cell accumulates the necessary biomolecules essential for the upcoming cell division. Despite being termed the "resting phase," interphase doesn't denote a lack of activity related to cell division; rather, it involves critical changes within the cell and nucleus before entering the division phase. Interphase can be subdivided into three distinct stages:
- **$G_1$ Phase (Pre-DNA Synthesis Phase/Post Mitotic Phase):** The $G_1$ phase represents the interval between mitosis and the initiation of DNA replication. During this phase, the cell does not engage in DNA synthesis but remains metabolically active. Continuous growth in cell size, along with the synthesis of nucleotides, ATP, proteins, amino acids, and RNA (essential for the subsequent S phase), occurs in $G_1$. Organelle duplication is predominantly observed in this phase. The duration of $G_1$ varies among

different cells, being shorter in frequently dividing cells and longer in less frequently dividing cells. Cells such as nerve cells, which do not frequently divide, may enter the $G_0$ phase, a quiescent stage where metabolic activity persists but proliferation remains dormant until required.

- **S Phase (DNA Synthesis Phase):** The 'S' or synthesis phase is marked by the synthesis or replication of DNA, leading to the doubling of the DNA content. For instance, if the initial DNA amount is represented as 2C, after the S phase, it becomes 4C. Despite the doubling of nucleic acid, the chromosome count remains the same. The existing DNA serves as a template for the synthesis of new DNA, forming chromatin fibers that attach in pairs. The chromatin then condenses into two sister chromatids linked by a centromere. In animal cells, DNA replication occurs within the nucleus during the S phase, while centrioles duplicate in the cytoplasm. It is noteworthy that plant cells lack centrioles.
- **$G_2$ Phase (Post DNA Synthesis Phase/Pre-Mitotic Phase):** The $G_2$ phase, situated between S and M phases, is the second gap phase. Synthesis of tubulin proteins takes place during this stage, and organelles such as mitochondria, chloroplasts, and Golgi bodies duplicate. DNA synthesis ceases, but the cell continues synthesizing RNA, proteins, and other components required for the ensuing phase. In animal cells, mitotic division occurs in diploid somatic cells, while in plant cells, mitotic division is observed in both haploid and diploid cells.