CELL CYCLE AND CELL DIVISION

CELL CYCLE

INTRODUCTION

- Growth and reproduction are characteristics of cells, indeed of all living organisms.
- All cells reproduce by dividing into two, with each parental cell giving rise to two daughter cells each time they divide.
- These newly formed daughter cells can themselves grow and divide, giving rise to a new cell population that is formed by the growth and division of a single parental cell and its progeny.
- In other words, such cycles of growth and division allow a single cell to form a structure consisting of millions of cells.
- Cell division is a very important process in all living organisms.
- Some substances stimulate cell division these are called **mitogen - e.g. Cytokinins, Epidermal Growth Factor or EGF, Platelet Derived Growth Factor or PDGF, Lymphokines**.
- Some substances inhibit cell division these are called mitotic poison **e.g. Cyanides, Azides, Chalones, Colchicine.**
- Low surface volume ratio, nucleocytoplasmic ratio also stimulate cell division in the cell.
- During the division of a cell, DNA replication and cell growth also take place.
- All these processes, i.e., cell division, DNA replication, and cell growth, hence, have to take place in a coordinated way to ensure correct division and formation of progeny cells containing intact genomes.
- The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and eventually divides into two daughter cells is termed cell cycle.
- Although cell growth (in terms of cytoplasmic increase) is a continuous process, DNA synthesis occurs only during one specific stage in the cell cycle.
- The replicated chromosomes (DNA) are then distributed to daughter nuclei by a complex series of events during cell division.
- These events are themselves under genetic control.

CELL CYCLE

- It involves programmed cyclic changes in the cell that leads to duplicates its genome, change in cellular components and ultimately cell divides to form two cells and is termed as cell cycle.
- This process is genetically controlled.
- The duration between two cell cycles is generation time.
- The duration of cell cycle is vary from organism to organism and for difference cell type. For example **human cell** takes approximately **24 hours** while **yeast cell** takes about **90 minutes** to divide (one time).

PHASES OF CELL CYCLE

- A typical eukaryotic cell cycle is illustrated by human cells in culture. These cells divide once in approximately every 24 hours.
- Yeast can progress through the cell cycle in only about 90 minutes. The time period of cell cycle is varied from organism to organism and also from cell type to cell type.

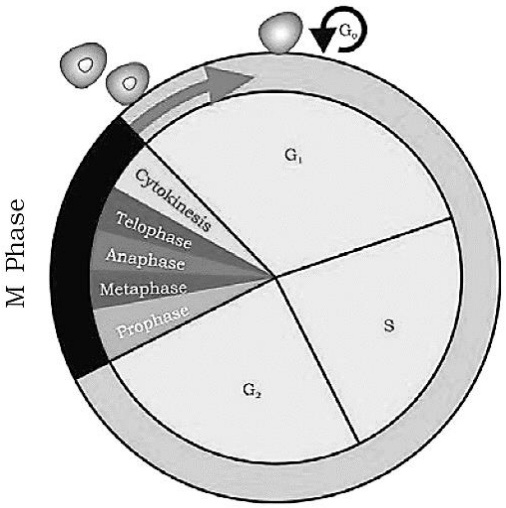


Figure: A diagrammatic view of cell cycle indicating formation of two cells from one cell

Cell cycle involves two stages :

(1) **Interphase**

(2) **Division phase/M-phase**

1. **Interphase :-** This is phase between two successive M-phase. In interphase cell grows in size and prepares itself for next division. Interphase is most active phase of cell cycle. The interphase last more than 95% of the duration of cell cycle.

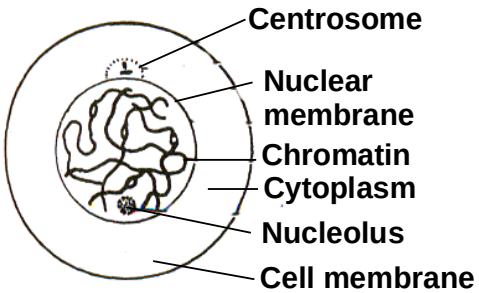
- A series of metabolic changes occurs during interphase in cell. These changes were not visible under microscope, So some scientist termed interphase as resting phase. It is the time during which cell is preparing for division by undergoing both cell growth and DNA replication in an orderly manner.

Howard and Pelc classified interphase info three sub stages :-

(i) **G_1 - phase or Pre DNA synthesis phase (I^{st} Gap phase)**

- G_1 phase corresponds to the interval between mitosis and initiation of DNA replication. During G_1 phase the cell is metabolically active and continuously grows
- During G_1 most of cell organelles increases in cell and cell rapidly synthesizes different types of RNA and proteins. Due to availability of protein, synthesis of new protoplasm takes place in cell and it starts growing in size. Cell grows maximum in G_1 stage.

S-PHASE (SYNTHETIC PHASE):



(i)

Figure: Interphase

- **Replication of DNA** of chromosome takes place in S-phase that is amount of DNA per cell doubles but not chromosome number. For example if amount of DNA is 2C than it will becomes 4C in this phase.
- **Histone protein synthesizes** in this phase.
- **Replication of centrioles (centrosome) takes place in cytoplasm.**

G_2-phase (Second gap phase or second growth phase or postsynthetic phase or pre-mitotic phase):

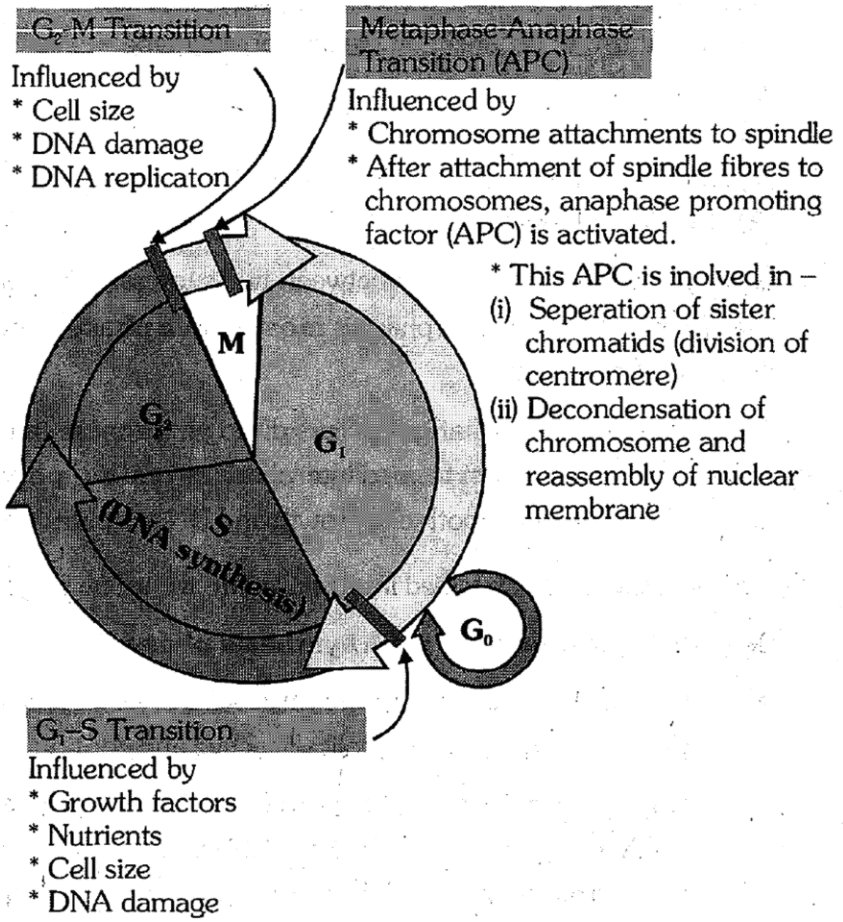
- **It is the phase of cytoplasmic growth.**
- Synthesis of RNA and proteins takes place. **Tubulin protein** is **formed**.

G_0 phase-

- Some cells in the adult animals do not appear to exhibit division (e.g. heart cells) and many other cells divide only occasionally, as needed to replace cells that have been lost because of injury or cell death. These cells that do not divide further exit G1 phase to enter an inactive stage called quiescent stage (G_0) of the cell cycle.
- Cells in this stage remain metabolically active but no longer proliferate (divide) unless called on to do so depending on the requirement of the organism.

Checkpoints of cell cycle :-

- Cell cycle is running by a group of special proteins "Cyclins and Cdks (MPF). (Nurse, T.Hunt & Hartwell 2001 studies on saccharomyces)
- Cell cycle is running by a group of special proteins "Cyclins and Cdks.
- The activity of enzymes, known as cyclin dependant kinases. (Cdk's) regulates the cell cycle. Kinase is an enzyme that removes a phosphate group from ATP & add to another protein. The kinases involved in the cell cycle are called Cdks because they are activated when they combined with key protein called cyclin.
- At some check points $\begin{pmatrix} G_1 \rightarrow S \\ G_2 \rightarrow M \end{pmatrix}$ a kinase enzyme combines with cyclin & this moves the cell cycle forwardly.



- G_2–M transition is triggered by maturation promoting factor (MPF) formed by M–cyclin + CDK_2.