**Cell cycle**

* Cell cycle is the series of events from the time a cell is produced until it completes mitosis & produce new cells

**Cell cycle consists of two major phases**

* Interphase
* Mitotic phase
* Mitotic phase is a relatively short period of cell cycle
* It alternates with the much longer interphase, where cell prepares itself for division
* Interphase is the time when a cell’s metabolic activity is very high, as it perform its various function

**It is divided into three phases:**

* G1 (First phase)
* S phase (Synthesis)
* G2 (second gap)

**G1 Phase**

* After its production,a cell starts its cell cycle in G1 phase
* During this phase,cell increase its supply of proteins,increases the number of its organelles (such as mitochondria,ribosomes),and grows in size
* This phase is also marked by the synthesis of various enzymes that is required in next phase I.e S phase for the duplication of chromosomes

**S Phase**

* In this phase, cell duplicates its chromosomes
* As a result, each chromosome consists of two sister chromatids

**G2 Phase**

* In the G2 phase, cell prepares protein that are essential for mitosis, mainly for the production of spindle fiber
* After the G2 phase of interphase, cell enters the division phase i.e. M phase
* It is characterized by mitosis, in which cell divides into two daughter cells
* Cells that have temporarily or permanently stopped dividing are said to have entered a state of quiescence called G0 phase

**G0 Phase**

* In multicellular eukaryotes, cells entered G0 phase from G1 and stop dividing
* Some cells remaining G0 for indefinite period i.e. neurons
* Some cells entered G0 phase semi permanently i.e. some cells of liver and kidney
* Many cells do not enter G0 and continue to divide throughout an organism’s life i.e. epithelial cells



**Mitosis**

* In 1980, a German biologist **Welter Flaming** observed that in a dividing cell, nucleus passes through a series of changes which he called mitosis
* Mitosis is the type of cell division in which a cell divides into two daughter cells, each with the same number of chromosomes as were present in parent cell
* Mitosis occurs only in eukaryotic cells
* In multicellular organism, the somatic cells undergo mitosis
* Prokaryotic cells undergo a process similar to mitosis called binary fission

**Phases of Mitosis**

The process of mitosis is complex and regulated

**There are two major phases i.e.**

The division of nucleus known as karyoKinesis

The division of cytoplasm known as cytokinesis

1. **karyokinesis**

The divion of nucleus is further divided into 4 phases

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

**Prophase**

* Normally the genetirorc material in nucleus is in a loose threadlike form called chromatin
* And the onset of prophase, chromatin condenses into highly ordered structure called chromosomes
* Since the genetic material has already been duplicated earlier in S phase, each chromosome is made of two sister chromatids, bound tighter at the same centromere
* Each chromosome also has kinetochore at centromere
* Kinetochore is a complex protein structure that is the point where spindle fibers attach
* There are two centrioles close to nucleus
* Each centriole duplicates and two daughter centrosomes are formed
* Both centrosomes migrate to the opposite pole of cell.
* The give rise to microtubules by joining tubulin proteins Preset in cytoplasm
* The microtubules, thus formed are called spindle fiber
* Complete set of spindle fiber is known as mitotic spindle
* By this time, nucleolus and nuclear envelope have degraded and spindle fibers have invaded the central space

**In plants**

* In highly vacuolated plant cell, nuecleus have to miagrte the centre of cell before prophase
* The cells of plants lack centrioles
* Spindle fibers are formed by aagregation of tubulin protein on the surface of nuclear envelope during prophase

**Metaphase**

* When spindle fibers have grown to sufficient length, some spindle fibers, known as kinetochore fibers, attach with the kinetochore of chromosomes
* Two kinetochore fibers from opposite poles attach with each chromosomes
* Chromosomes arrange themselves along the equator of cell forming a metaphase plate
* A number of other fibers non-kinetic, from the opposite centrosomes attach with each other

**Anaphase**

* When a kinetochore spindle fiber connects with the kinetochore of chromosome, it starts to pull towards the originating centrosomes
* The pulling force divides the chromosomes sister chromatids and they separate
* These sister chromatids are now sister chromosomes & they are pulled apart toward the respective centrosomes
* The other spindle fiber non kinetochore are elongate at the end of anaphase cell has succeeded in separating identical copies of chromosomes into two groups at the opposite pole

**Telophase**

* Telophase is the reversal of prophase
* A new nuclear envelope forms around each set of separated chromosomes
* Both set of chromosomes, now surrounded by nuclear envelopes, unfold back into chromatin
* Nuclear division is completed but cell division has yet one more set to complete

**Cytokinesis**

**In animal cells**

* Cytokinesis is the division of cytoplasm
* In animal cells cytokinesis occur by a process known as cleavage
* A cleavage furrow develops where the metaphase plate used to be
* The furrow deepens & eventually pinches the parent cell into two daughter cells

**Cytokinesis in plant cells**

* Cytokinesis occurs in plant cells differently
* Vesicles derived from the Golgi apparatus move to the middle of cell & fuse to form a membrane bounded disc called cell plate of phragmoplast
* The plate grows outward & move vesicles fuse with it
* Finally, membrane of cell plate fuse with plasma membrane & its contents join the parental cell wall
* The result is two daughter cells, each bounded by its own plasma membrane & cell wall



**Significance of mitosis**

* Importance of mitosis is the maintenance of chromosomal set e.g. each daughter cell receives chromosomes that are alike in composition & equal in number of chromosomes of parental cell
* Following are the occasions in the lives of organisms where mitosis happens

**Development & growth**

* The number of cells within an organism increase by mitosis
* This is the basis of mitosis of the development of a multicellular body from a single cell e.g. zygote & also the basis of the growth of multicellular body

**Cell replacement**

* In some parts of body e.g. skin & digestive tract, cells are constantly sloughed off and replaced by new ones
* New cells are formed by mitosis & so are exact copies of the cell being replaced
* Similarly red blood cells have short life span about four months & new red blood cells are formed by mitosis
* **Regeneration**
* Some organisms can regenerate parts of their bodies
* The production of new cells is achieved by mitosis e.g. sea star regenerate its lost arm through mitosis



**Asexual reproduction**

* Some organisms produce genetically similar off spring to a sexual reproduction
* Mitosis is a means of a sexual reproduction i.e. hydra reproduces a sexually by buddying
* The cells at the surface of hydra undergo mitoses and from a mass called bud
* Mitosis continues in the cell of bud and it grows into a new individual. The same division happens during a sexual reproduction i.e. vegetative propagation in plants



**Errors in mitosis**

* Errors in the control of mitosis may cause cancer.
* All cells have genes that control the timing and number of mitosis.
* Sometimes mutation occurs in such genes and cells continue to divide.
* It results in growth of abnormal cells tumors. As long as these tumors remain in their original location. There are called benign
* But if they invade other issues they are called malignant or cancerous tumors and they cells are called cancer cells
* Such tumors scan send cancer cells to other parts in body where new tumor may formed this phenomena is called metastasis (spreading of diseasese).