Cell Division

It is a process by which a mature cell multiplies and forms new cell that resemble mother cell in various characters. It is completed in two stages i.e. karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm).

Cell cycle

All changes that occur in a cell during its growth and division are collectively called cell cycle. It includes duplication of genomes, increase the volume and division into two daughter cells.

It completes into three main stages.

A. Interphase: It is the period between two successive cell divisions. It is also known as resting phase.

It is divided into three sub-phases.

- **a. G1 phase (Gap 1 phase):** It is also called pre-synthetic or first growth phase. In this phase, cell synthesizes various substances including RNAs, proteins, carbohydrates and lipids. It occurs at a high metabolic rate which increases the volume of the cell.
- **b. S phase (Synthetic phase):** It is remarkable for various synthetic activities. Here, duplication of DNA occurs. The cell also synthesizes histone protein.
- **c. G2 phase (Gap 2 phase):** It is also called post-synthetic or second growth phase. In this phase, synthesis of RNA and spindle protein takes place. It increases the volume of nucleus in the cell. Cell organelles like mitochondria, plastids and centrioles are duplicated in this phase.

B. M – phase (Mitotic phase): It is also known as karyokinesis. It contains mitotic cell division which completes in various stages.

C. Cytokinesis: The cytoplasm divides in this phase. During cytokinesis, the cell cytoplasm and cell organelles are distributed equally to two opposite halves of the cell.

Types of Cell Division

Depending upon the chromosomes and process, it is of 3 types.

1. **Amitosis Cell Division:** It is a direct cell division. It is a simple process that basically occurs in prokaryotic cells, yeast etc.

   It begins with the elongation of nucleus that gradually constricts in the middle. Cell membrane also develops constriction along the constriction of nucleus.

The constriction deepens and as a result two daughter cells are formed from single cell.
Figure:

2. **Mitosis Cell Division:** It is indirect cell division where one mother cell divides to produce two daughter cells having same number of chromosome.
It occurs in all types of eukaryotic cells including somatic cell, germ cell etc. It is also known as somatic cell division and equational cell division.
Here, karyokinesis occurs at first which follows cytokinesis. The different phases of karyokinesis of mitosis cell division are as follows.

A. Prophase:

i. It is the first phase.
ii. Chromosome becomes distinct by coiling of chromatin fibres.
iii. Chromosome appears in two chromatids. Each chromatids held together by centromere.
iv. Nucleolus and nuclear membrane starts to disappear.
v. Chromosomal sheath appear around chromosome.
Figure:

B. Metaphase:

i. It is the second phase.
ii. Nucleolus and nuclear membrane totally disappear.
iii. Chromosomes come to lie at equatorial plane.
iv. Poles are appearing towards opposite sides of cell.
v. Spindle fibre arises from each pole that join centromere of chromosome.
Figure:

C. Anaphase:

i. It is the third phase.
ii. Spindle fibre starts to contract.
iii. Chromosome is split longitudinally to form chromatids due to contraction of spindle fibre.
iv. Each chromatids move towards two opposite poles along with shorten spindle fibre.
Figure:

D. Telophase:

i. It is the last phase.

ii. Each chromatids reach towards opposite pole. Spindle fibre totally disappears.
iii. Each chromatids starts to duplicate to form chromosome.
iv. Chromosomal sheath disappear.
v. Nucleolus and nuclear membrane starts to reappear.
Figure:

After completion of all the phases, the cytokinesis occurs by two different ways.

A. Cell plate formation method: It occurs in plant cell where cell plate is formed at the middle of cytoplasm and between two daughter nuclei. Cell plate forms from small granular bodies produced at golgi bodies or ER, which later gather at equator to form cell plate.

B. Furrowing method: It occurs in animal cell. Here, furrows appear between two nuclei. It deepens and separating protoplasm into two equal parts.

Significance of Mitosis

a. The daughter cells are identical to each other and to the mother cell.
b. The daughter cells are quantitatively and qualitatively similar to its mother cell.
c. Asexual reproduction in lower plants basically occurs by mitosis.
d. Vegetative reproduction in higher plants is a consequence of mitosis.
e. It is common method of multiplication of cells in multicellular organism.
f. It helps in recovery of cuts and wounds.
g. Chromosomal number is maintained by mitosis.

3. Meiosis Cell Division: It is indirect cell division where one mother cell divides into four daughter cells having half number of chromosomes.
It occurs in specific cells at specific time. It is also known as reductional cell division and germinal cell division. It consists of two complete divisions. Hence, a diploid cell produces four haploid cells.
Here, the first division is meiotic or reductional and the second division is mitotic or equational.

Meiosis I: The first meiotic division is more important because it is the reduction division.

A. Prophase I: It is the first stage of meiosis. It is the longest phase of meiosis division. It is again divided into sub-stages.

a. Leptotene:

i. The volume of nucleus increase.
ii. Chromatin fibre condenses and chromosome becomes visible.
iii. Chromosome appears in long, single and thin threaded structure.
iv. Nucleolus and nuclear membrane remain intact.
Figure:

b. Zygotene:

i. Chromosome becomes short and thick due to coiling.
ii. Homologous chromosomes come together and lie side by side.
iii. Pairing of chromosomes start at one or more points.
Figure:

c. Pachytene:

i. Chromosomes are divided into chromatids.
ii. Exchange of segments of chromatid takes place between non-sister chromatids. It is known as crossing over.
iii. The region of crossing over is known as chaismata.
iv. The number of chaismata depends upon the length of chromosome.
Figure:

d. Diplotene:

i. Homologous chromosomes begin to repel each other except at the point of chaismata.
ii. Nucleolus starts disappearing while nuclear membrane remains intact.
Figure:

e. Diakinesis:

i. Chromosomes moves towards nuclear membrane.
ii. Nuclear membrane and nucleolus totally disappear.
Figure:

B. Metaphase I:

i. The chromosomes come to lie at equatorial plane.
ii. Poles are developed towards two opposite sides.
iii. Spindle fibre appears that joins pole with centromere of chromosome.
Figure:

C. Anaphase I:

i. Spindle fibre start to contract.
ii. Chromosome is split at the point of chaismata.
iii. The chromosomes then move towards two opposite poles along with shortening of spindle fibre.

Figure:

D. Telophase I:

i. The separated chromosomes deposited towards two opposite pole.
ii. Here, reduction of chromosome takes place.
iii. Spindle fibre totally disappears.
iv. Nuclear membrane and nucleolus reappear.
v. Cytokinesis doesn't take place.
Figure:

Meiosis II: It is very much similar with mitotic division. Hence, it termed as equational division.

A. Prophase II:

i. Chromosomes begin to shorten and become visible.
ii. Each chromosome consists of two chromatids fused only at centromere.
iii. Nucleolus and nuclear membrane starts to disappear.
Figure:

B. Metophase II:

i. Nuclear membrane and nucleolus totally disappear.
ii. Chromosomes arrange on equatorial plane.
iii. Poles are appearing towards two opposite sides.
iv. Spindle fibre appears that connect pole and centromere of chromosome.
Figure:

C. Anaphase II:

i. Spindle fibre starts to contract.
ii. Chromosomes then split longitudinally into chromatids.
iii. Each chromatids move towards two opposite poles along with shortening spindle fibre.
Figure:

D. Telophase II:

i. The chromatids reach towards two opposite poles.
ii. Spindle fibre and poles totally disappear.
iii. The chromatids start to duplicate to form chromosome.
iv. Nucleolus and nuclear membrane starts to reappear.

Figure:

After completion of all the phases, cytokinesis occurs. Then it forms four cells from one mother cell.

Significance of Meiosis

a. It helps to maintain the chromosome number constant in each species.
b. The recombination of genes occurs due to crossing over.
c. The recombination of genes results in genetic variation.
d. It leads to evolution.
e. It shows inter-relationship between living organisms.
f. It maintains alternation of generation.