

## Cell division

- **Cell division** is a progressive process.
- This is the most dramatic period of the cell cycle, involving a major reorganisation of virtually all components of the cell.

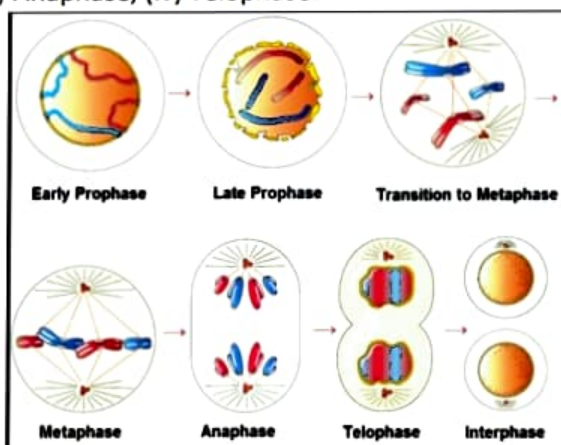
### 1. Amitosis

- Amitosis is a simple method of direct division characterised by the splitting of nucleus followed by that of cytoplasm.

- In this method, the nucleus elongates and constricts in the middle to form two daughter nuclei. This is followed by a centripetal constriction of the cytoplasm to form two daughter cells.
- It occurs in meganucleus of *Paramecium*, nuclei of intermodal cell of *Chara*, ageing and diseased cells, etc.

## 2. Mitosis

- The number of chromosomes in parent and progeny cell remain the same. So, it is also called the **equational division**.
- Mitosis is divided into following four stages of **nuclear division**: (i) Prophase, (ii) Metaphase, (iii) Anaphase, (iv) Telophase.



### (i) Prophase

- Prophase is the first stage of mitosis which follows the S and G<sub>2</sub> phases of interphase.
- The new DNA molecules formed during the S phase are not distinct but intertwined.
- Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material becomes untangled during the process of chromatin condensation.
- The centrosome, which is duplicated during the S phase of interphase, now begins to move towards the opposite poles of the cell. The completion of prophase is marked by the following characteristics events:
  - (a) Chromosomal material condenses to form compact mitotic chromosomes. Chromosomes are seen to be composed of two chromatids attached together at the centromere.
  - (b) Centrosome begins to move towards opposite poles. Each centrosome radiates out microtubules called **asters**. The two asters together with spindle fibres form mitotic apparatus.

(c) Cell at the end of prophase, when viewed under the microscope, do not show Golgi complexes, endoplasmic reticulum, nucleolus and nuclear membrane.

## (ii) Metaphase

- The complete disintegration of the nuclear envelope marks the start of the metaphase. The chromosomes are spread throughout the cytoplasm of the cell. By this stage, condensation of chromosomes is completed.
- Metaphase chromosome is made up of two sister chromatids, which are held together by the centromere. Small disc-shaped structures at the surface of the centromeres are called **kinetochores**. These structures serve as the sites of the attachment of spindle fibres.
- Metaphase is characterised by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its kinetochore to spindle fibres from one pole and its sister chromatid connected by its kinetochore to spindle fibres from the opposite pole. The plane of alignment of the chromosomes at metaphase is referred to as the **metaphase plate**.
- The key features of metaphase are:
  - a) Spindle fibres attach to kinetochores of chromosomes.
  - b) Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres to both poles.

## (iii) Anaphase

- Each chromosome arranged at the metaphase plate is split simultaneously and the two daughter chromatids now referred to as chromosomes of the future daughter nuclei, begin their migration towards the two opposite poles.
- The anaphase is characterised by the following key events:
  - a) Centromeres split and chromatids separate.
  - b) Chromatids move to opposite poles.
- Different shapes of chromosomes may be observed at anaphase (V or J or L or I-shaped), depending upon position of kinetochore or centromere.

**Table: Types of chromosomes**

Types of chromosomes	Shape	Centromere position
Metacentric	V	Median
Submetacentric	L	Sub-median
Acrocentric	J	Sub-terminal
Telocentric	I	Terminal

## (iv) Telophase

- At the beginning of telophase the chromosomes that have reached their respective poles decondense and lose their individuality. The individual chromosomes can no

longer be seen and each set of chromatin material tends to collect at a mass in the two poles.

- The telophase is characterised by following key events:
  - a) Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements.
  - b) Nuclear envelope develops around the chromosome cluster at each pole forming two daughter nuclei.
  - c) Nucleolus, Golgi complex and ER reform.

## Cytokinesis

- Mitosis accomplishes not only the segregation of duplicated chromosomes into daughter nuclei, but the cell itself is divided into two daughter cells by a separate process called cytokinesis at the end of which cell division is completed.
- In an animal cell, this is achieved by the appearance of a furrow in the plasma membrane. The furrow gradually deepens and ultimately joins in the centre dividing the cell cytoplasm into two.
- Plant cells however, are enclosed by a relatively inextensible cell wall, therefore they undergo cytokinesis by a different mechanism. In plant cells, wall formation starts in the centre of the cell and grows outward to meet the existing lateral walls. The formation of the new cell begins with the formation of a simple precursor, called the cell plate that represents the middle lamella between the walls of two adjacent cells. At the time of cytoplasmic division, organelles like mitochondria and plastids get distributed between the two daughter cells.
- In some organisms karyokinesis is not followed by cytokinesis as a result of which multinucleate condition arises leading to the formation of syncytium (e.g., liquid endosperm in coconut).

## Significance of Mitosis

- Mitosis is of great significance in the life of an organism.

  1. **Growth:** Somatic cells are formed by mitosis, therefore it is essential for growth and development of multicellular organisms.
  2. **Maintenance of surface/volume ratio:** An overgrown somatic cell is induced to divide so that mitosis helps in maintaining a proper surface/volume ratio.
  3. **Maintenance of chromosome number:** Mitosis involves equitable distribution of all chromosomes so that all the cells of a multicellular organism have the same number and type of chromosomes.
  4. **Repair and regeneration:** It is the mechanism of replacing old or worn out cells and helps in regenerating part or whole of the organism.
  5. **Reproduction:** It is the method of multiplication of unicellular organisms.
  6. **Healing:** An injury is healed by repeated mitotic divisions of the surrounding cells.