JSR IAS ACADEMY

GENERAL SCIENCE

BIOLOGY

Main concepts of Life Science

CELL DIVISION

Cell Division

Types of Cell Division

The three types of cell division that occur in animal cells are:

I. Amitosis - **Direct Division**
II. Mitosis - **Indirect Division**
III. Meiosis - **Reduction Division**

I. Amitosis

- It is the **simplest mode of cell division and it occurs in unicellular animals, aging cells and in foetal membranes.**
- During amitosis, **nucleus elongates first, and a constriction appears in it which deepens and divides the nucleus into two**.
- Followed by this **cytoplasm divides resulting in the formation of two daughter cells.**

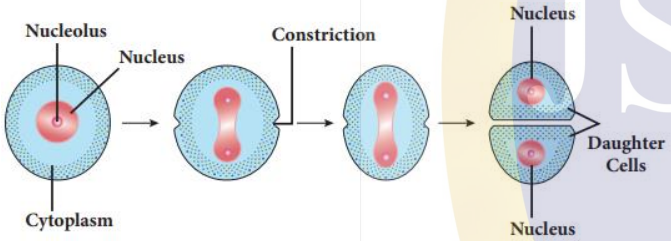


Figure 18.21 Amitosis

II. Mitosis

- It was first discovered by **Fleming in 1879.**
- In this cell division **one parent cell divides into two identical daughter cells**,
- each with a **nucleus having the same amount of DNA, same number of chromosomes and genes** as the parent cells.
- It is also called as **equational division**.

Mitosis consists of two events, they are:

1. Karyokinesis

2. Cytokinesis Interphase:

1. Karyokinesis

- The **division of the nucleus into two daughter** nuclei is called Karyokinesis.
- It **consists of four phases**. They are: Prophase, Metaphase, Anaphase and Telophase.

Prophase (pro-first):

- Centrosome **splits into centrioles and occupy opposite poles of the cell.**
- Each centriole is surrounded by **aster rays.**
- Spindle fibres **appear between the two centrioles.**
- Nuclear membrane and nucleolus disappear gradually.

Metaphase (meta – after):

- The **duplicated chromosomes arrange on the equatorial plane and form the metaphase plate.**
- Each **chromosome gets attached to a spindle fibre by its centromere.**
- The **centromere of each chromosome divides into two each** being associated with a chromatid.

Anaphase (ana – up, back):

- The **centromeres attaching the two chromatids divide and the two daughter chromatids of each chromosome separate**
- migrate towards the two opposite poles.

Telophase (tele – end):

- Each chromatid (or) daughter chromosome lengthens, becomes thinner and turns into a network of chromatin threads.
- Spindle fibres breakdown and disappear.
- Nuclear membrane and nucleolus reappear in each daughter nucleus.

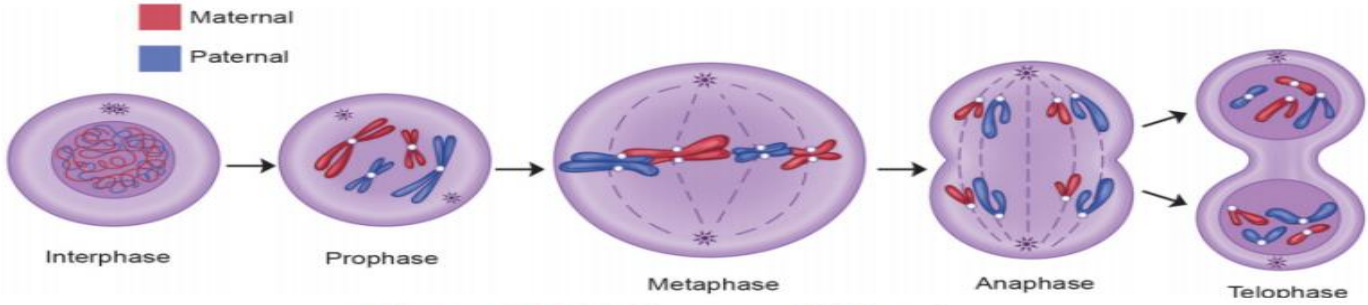
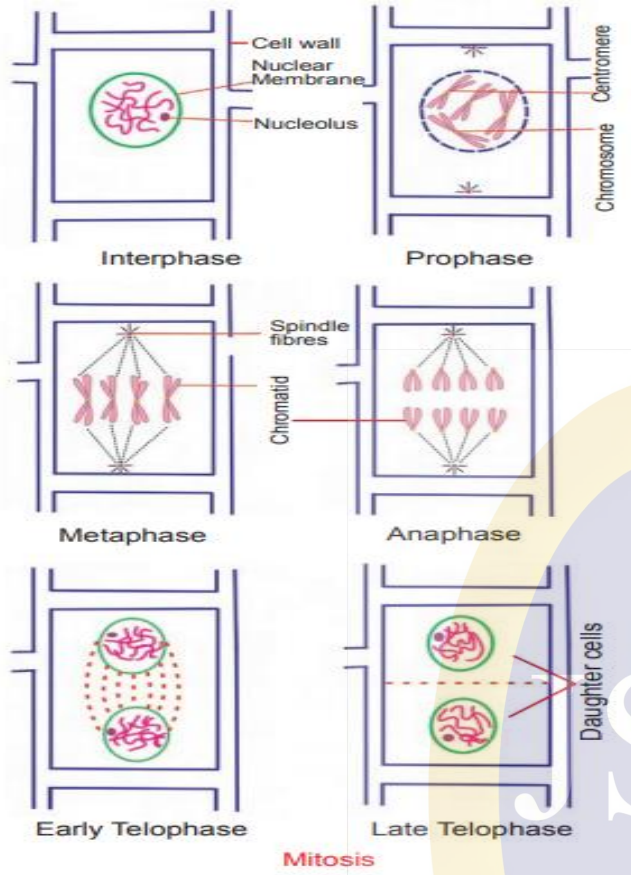


Figure 18.22 Events of Mitosis



2. Cytokinesis

The division of the **cytoplasm into two daughter cells by constriction of the cell membrane is called cytokinesis.**

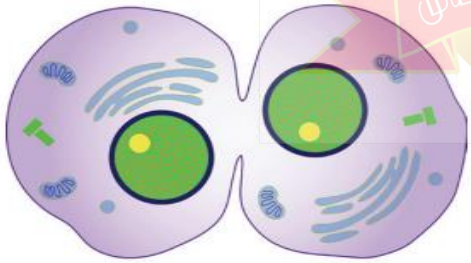


Figure 18.23 Cytokinesis

Significance of Mitosis

1. This equational division results in the **production of diploid daughter cells (2n) with equal distribution of genetic material (DNA).**

2. In multicellular organisms growth, organ development and increase in body size are accomplished through the process of mitosis

3. Mitosis helps in repair of damaged and wounded tissues by renewal of the lost cells.

III. Meiosis

- The term meiosis was coined by **Farmer in 1905.**
- It is the **kind of cell division that produces the sex cells or the gametes.**
- It is also called **reduction division because the chromosome number is reduced to haploid (n) from diploid (2n).**
- Meiosis **produces four daughter cells from a parent cell.**

Meiosis consists of two divisions.

1. Heterotypic Division or First Meiotic Division
2. Homotypic Division or Second Meiotic Division

A. Heterotypic division

- It divides the **diploid cell into two haploid cells.**
- The daughter cells **resulting from this division are different from the parent cell in the chromosome number (Heterotypic).**

This consists of 5 stages:

a. Prophase I b. Metaphase I c. Anaphase I d. Telophase I e. Cytokinesis I

a. Prophase I

Prophase I **takes a longer duration** and is **sub divided into five stages.**

They are: Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

Leptotene:

They form a **bouquet stage**.

Zygotene (Zygon-adjoining):

- Two homologous chromosomes approach each other and begin to pair.
- Pairing of homologous chromosomes is called as **synapsis.**

Pachytene (Pachus-thick):

- The chromosomes are visible as long paired twisted threads.
- The pairs so formed are called **bivalents.**
- Each bivalent **now contains four chromatids** (tetrad stage).
- **X- shaped arrangements** known as **chiasmata.**

- the broken segments may be interchanged (crossing over).
- As a result, **the genetic recombination takes place.**

Diplotene:

Each individual chromosome of each bivalent begins to **split longitudinally into two similar chromatids.**

Diakinesis:

- The paired chromosomes are shortened and thickened.
- The nuclear membrane and nucleolus begin to disappear.
- Spindle fibres make their appearance.

b. Metaphase I

c. Anaphase I

- Each homologous chromosome with its two chromatids and undivided centromere move towards the opposite poles of the cell.
- This stage of the chromosome is called **Diad.**

d. Telophase I

The nuclear membrane and the nucleolus reappear and thus two daughter nuclei are formed.

e. Cytokinesis I:

The cytoplasmic division occurs and two haploid cells are formed.

B. Homotypic Division

- In this division, the two haploid cells formed during first meiotic division divide into four haploid cells.
- The daughter cells are similar to parent cell in the chromosome number (Homotypic).

It consists of five stages.

1. Prophase – II
2. Metaphase – II
3. Anaphase – II
4. Telophase – II
5. Cytokinesis – II

e. Cytokinesis II:

Two cells are formed from **each haploid daughter cell, resulting in the formation of four cells with haploid number of chromosomes.**

Significance of Meiosis

The constant number of chromosomes in a given species is maintained by meiotic division.

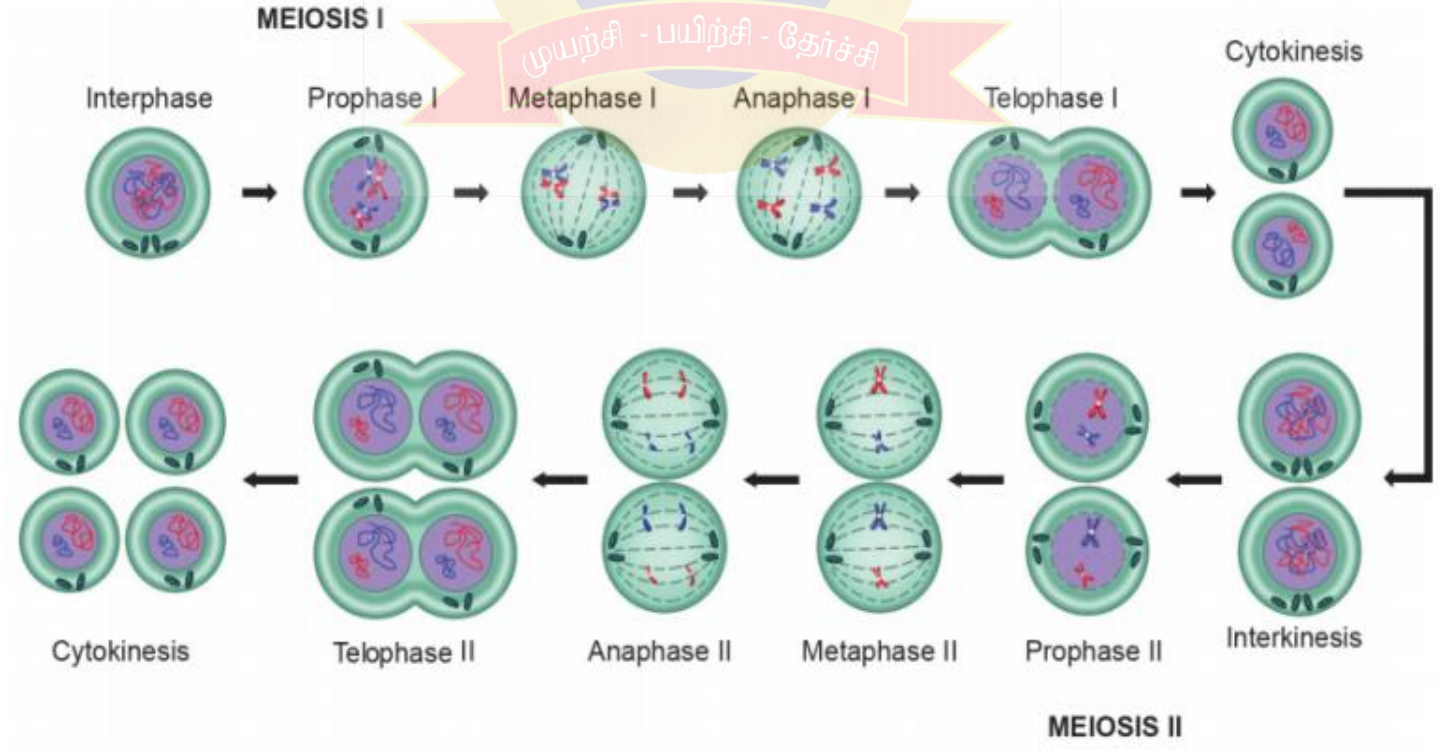


Figure 18.24 Events of Meiosis

Table 18.3 Differences between Mitosis and Meiosis

Mitosis	Meiosis
Occurs in somatic cells.	Occurs in reproductive cells.
Involved in growth and occurs continuously throughout life.	Involved in gamete formation only during the reproductively active age.
Consists of single division.	Consists of two divisions.
Two diploid daughter cells are formed.	Four haploid daughter cells are formed.
The chromosome number in the daughter cell is similar to the parent cell (2n).	The chromosome number in the daughter cell is just half (n) of the parent cell.
Identical daughter cells are formed.	Daughter cells are not similar to the parent cell and are randomly assorted.

DO YOU KNOW?

Nerve cells do not undergo cell division due to the absence of centrioles, but they are developed from glial cells by neurogenesis

INFO BIT

Age of our body cells

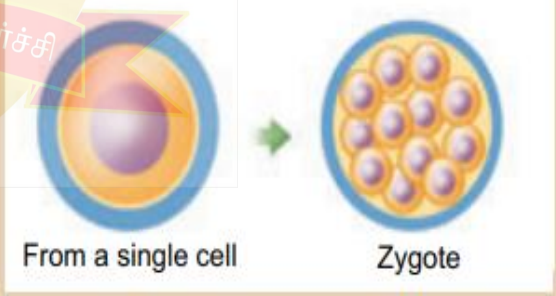
- Cells of the eye lens, nerve cells of cerebral cortex and most muscle cells last a life time but once dead are not replaced.
- Epithelial cells lining the gut last only about 5 days.

Duration of cell replacement

- Skin cells- about every 2 weeks.
- Bone cells- about every 10 years.
- Liver cells- about every 300 – 500 days.
- Red blood cells last for about 120 days and are replaced.

DO YOU KNOW?

Our body is developed from a single cell called zygote. The zygote undergoes continuous mitotic division and forms the foetus consisting multitude of cells of different shape, size and content. Foetal cells gradually attain change in structure and function. This process is known as cell differentiation.



Osmosis

The process by which the water molecules pass through a membrane from a region of higher water concentration to the region of lower water concentration is known as osmosis.

- The process in which the water molecules enter into the cell is known as **endosmosis.**
- The process in which the water molecules move out of the cell is known as **exosmosis.**

plasmolysis.

In plant cells, due to excessive exosmosis, the cytoplasm along with the plasma membrane shrinks away from the cell wall. This process is known as **plasmolysis.**

Endocytosis

In **endocytosis,** the cell membrane takes a substance into the cell by folding inwards and forming a vesicle that encloses the substance.

Lysosomes take substances or aging organelles in, by the process of **endocytosis.**

Exocytosis.

If a substance within a cell is enclosed in a vesicle and carried to the plasma membrane to be released outside the cell, it is said to be **exocytosis.**

Enzymes and hormones are secreted by cells through the process of **exocytosis.**

Phagocytosis

During **phagocytosis** substances are taken up in solid form. Cells which involve in this process are called phagocytes and said to be phagocytic. (e.g. white blood cells).

pinocytosis.

Cells take in liquids continuously through microscopic capillary structures on their cell membranes. This method of transport of substances is called **pinocytosi**