Ratna Sagar

RATNA SAGAR | PRIMUS | BYWORD | E-LIVE

Education, Our Mission

As per the latest ICSE syllabus 2022

Ratna Sagar
Education, Our Mission!

Revised and Updated

LIVING SCIENCE BIOLOGY

D K Rao • J J Kaur

10

EDUCATION, OUR MISSION

ICSE
Living Science
Biology

Class 10

Chapter 1 Cell Cycle and Cell Division

LEARNING OBJECTIVES

Why do Cells Divide?

The Cell Cycle

- Interphase
- M phase or Mitosis

Types of Cell Division

Mitosis

- Interphase – The resting phase
- Karyokinesis – Phases of mitosis
- Significance of mitosis

Meiosis – The Reduction Division

- First meiotic division (Meiosis I)
- Second meiotic division (Meiosis II)
- Significance of meiosis

What is a Cell and What are its Types?

All living beings are made up of cells. A cell is the structural and functional unit of life.

In multicellular organisms, there are two types of cells.

1. The somatic cells or the body cells – They form the body of the organism.

2. The reproductive cells or sex cells – They are gamete-producing cells.

Why do Cells Divide?

The cells divide to produce new cells. The new cells are produced for:

1. Growth: During cell division, a single cell divides to produce new cells which form a cluster of similar cells to form tissues and organs.

2. Replacement of dead cells: The existing cells in our body are destroyed regularly. These cells should be replaced by the new cells for the normal functioning of the body. Cell division of parent cells in the bone marrow helps in the replacement of dead cells with the new cells.

3. Repair of tissues: In case of injuries or normal wear and tear of tissues, cells divide and new cells fill up the broken cut ends to heal wounds. Thus, cell division is essential for the repair of the tissues.

4. Reproduction: New cells arise from pre-existing cells. The sex cells (sperms and eggs) are formed because of cell division . These sex cells contain only half the normal number of chromosomes. During fertilization, these sex cells combine to form zygote. Thus, cell division is essential for reproduction.

The Cell Cycle

A cell cycle or a cell division cycle is the series of events in a cell leading to its division and duplication of its DNA to produce two daughter cells. A cell cycle has two basic phases: ❖ Interphase ❖ M phase or Mitosis

A cell cycle may be defined as a series of events in a cell leading to an increase in the mass and cytoplasmic components of the cell, duplication of DNA, and then division of nucleus and cytoplasm of the cell and finally forming two daughter cells. A cell cycle extends from the time a cell is formed till the time it completes division.

Interphase

During interphase a cell prepares itself for cell division. The interphase is the longest phase of cell cycle. It is metabolically the most active phase of the cell cycle. It has three sub-phases:

1. G1 or first growth phase: This is the **first** 'Gap' (interval) **phase of cell growth** before DNA replication.

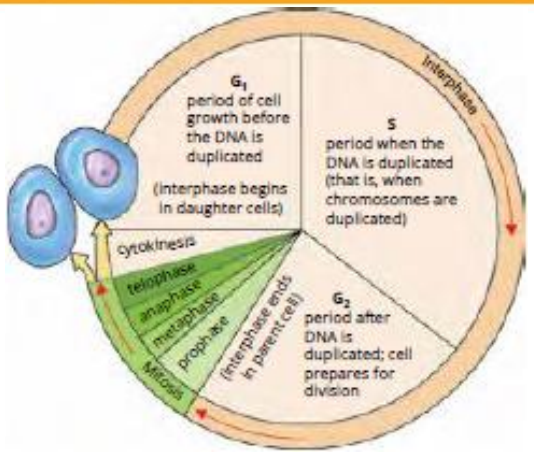
2. S or synthesis phase: This is the **phase of DNA replication**. The **DNA is synthesized** and **chromosomes are duplicated** during this phase but they remain attached.

3. G2 or second growth phase: It is the second 'Gap' phase after DNA replication. It is a shorter phase in which RNA and proteins necessary for cell division continue to be synthesized. Now the cell becomes ready for next cell division, i.e. mitosis.

G0 phase (Resting phase): This is the phase when the cell has stopped dividing and left the cell cycle. It is resting state of a cell.

M phase or Mitosis

Cell growth stops. Nuclear division (prophase, metaphase, anaphase and telophase) takes place which is usually followed by cytoplasmic division. The cell cycle does not go endlessly. It stops permanently at some point of time. Its duration differs from one cell type to another cell type.



Eukaryotic cell cycle, generalized. The length of each part differs among different cell types

Types of cell division

There are two types of cell division in higher organisms.

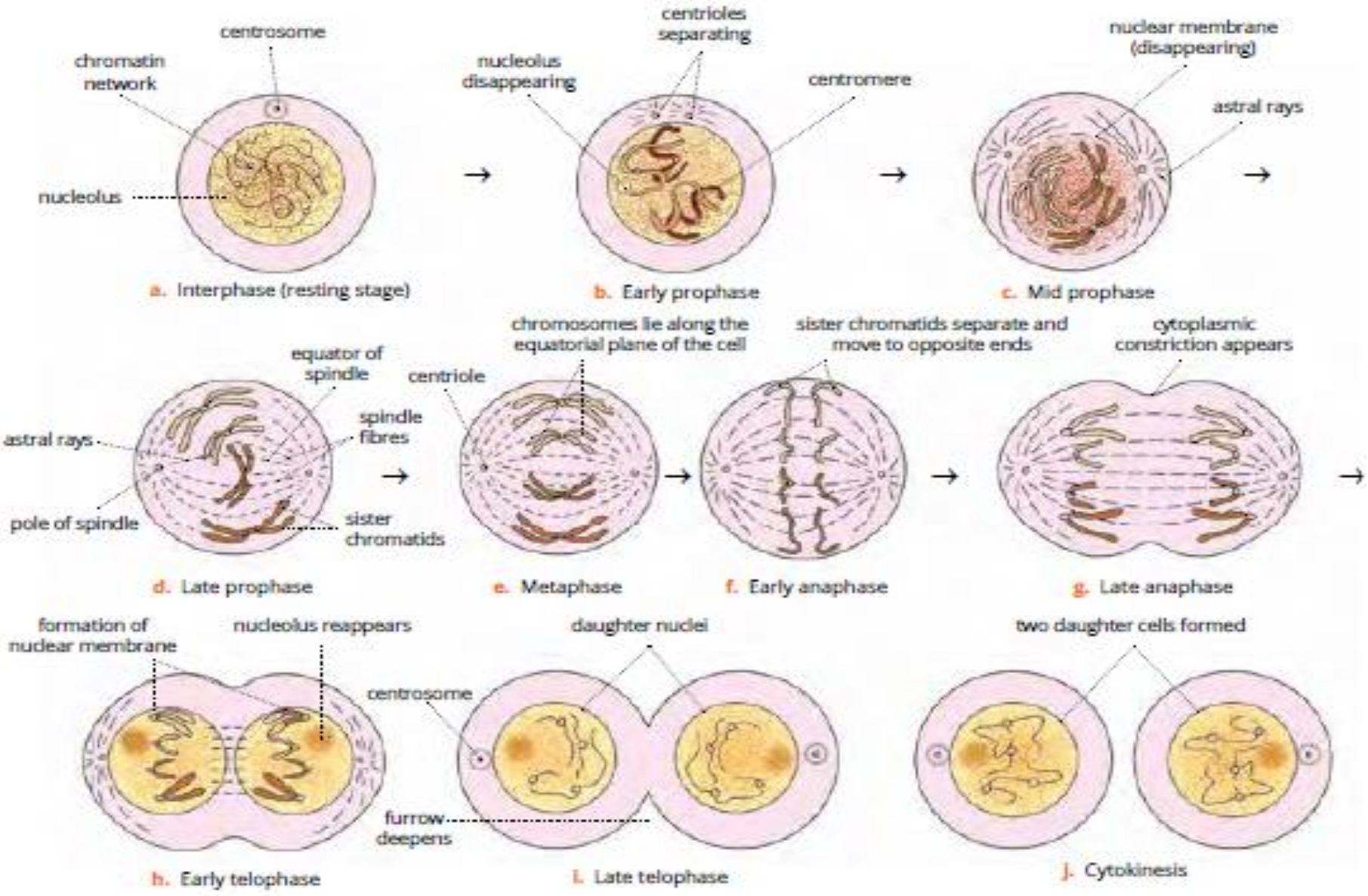
1. Mitosis – **Occurs in somatic cells** leading to growth and development.

2. Meiosis – **Occurs in reproductive cells** or sex cells leading to gamete formation.

Mitosis

Mitosis or mitotic cell division is an equational division in which one parent cell divides to form two daughter cells. The daughter cells formed are identical to each other and also to the parent cell in every respect. In mitosis, the same normal chromosome number of the parent cell is maintained at each stage of mitotic division of the cell and hence it is referred as equational division.

Note: Refer to Table 1.1 for the summary of the cycle.



Stages of mitosis in an animal cell

Interphase – The resting phase

Interphase is the growth period between two successive divisions of a cell. Thus, it is a preparatory phase just before the cell starts dividing. This stage is said to be a resting phase because **no external change in chromosomes is visible**. However, the cell is metabolically most active.

Karyokinesis – Phases of mitosis

The nuclear division or karyokinesis during mitosis occurs in four phases – prophase, metaphase, anaphase and telophase.

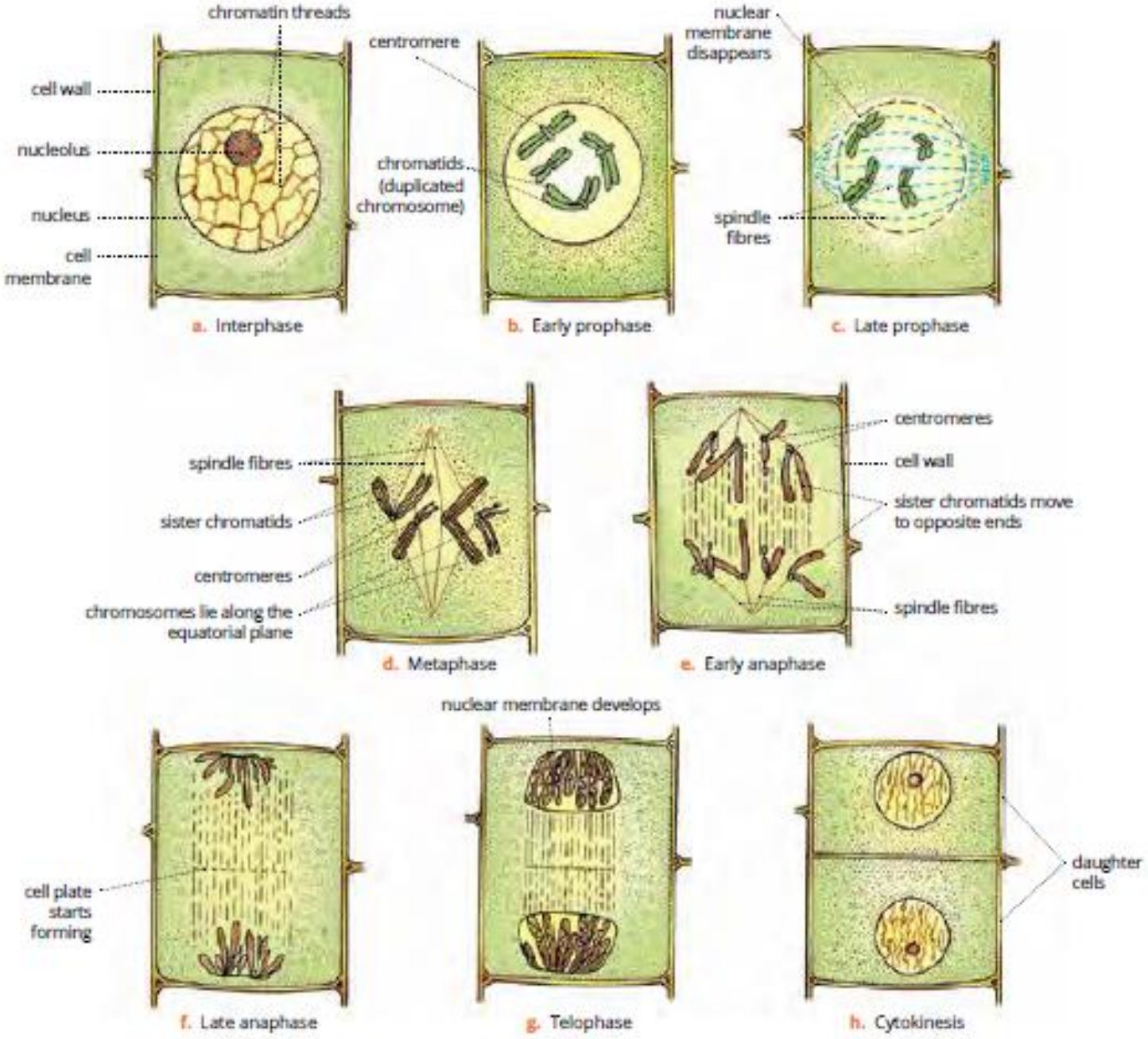
Significance of mitosis

1. Mitosis maintains the same number of chromosomes in all the cells of an individual. In other words, **mitosis is an equational division** in which **two daughter cells produced are identical to each other** and even to their parent cell. This type of cell division usually takes place in the somatic cells such as tips of roots, stems, etc.

2. It plays a significant role in **replacement of cells** lost during wear and tear, and in wound healing.

3. It is responsible **for the growth of an organism**. A fertilized cell develops into an embryo and finally into an adult as a result of mitotic cell division.

4. Mitosis helps the cells **in maintaining the proper size**.



5. It is a method of asexual reproduction in **unicellular organisms**.

6. If mitotic cell division becomes uncontrolled, it may cause tumours or cancerous growth.

Mitosis in a plant cell

Meiosis – the reduction division

Meiosis takes place in the reproductive cells that produce gametes, sperms and ova. Meiosis is a modified mitosis in which **chromosomes divide once and the nucleus divides twice**. As a result of which **the number of chromosomes is reduced to half**. Thus, the four cells resulting from a meiotic division have a haploid number of chromosomes. It means that the **number of chromosomes becomes half in each sex cell**. This is because when the male and female gametes fuse during fertilization, the **diploid** (double) number of chromosome pairs is restored. **Meiosis is a reductional division.**

Meiosis has two nuclear divisions.

1. First meiotic division (reduction division)

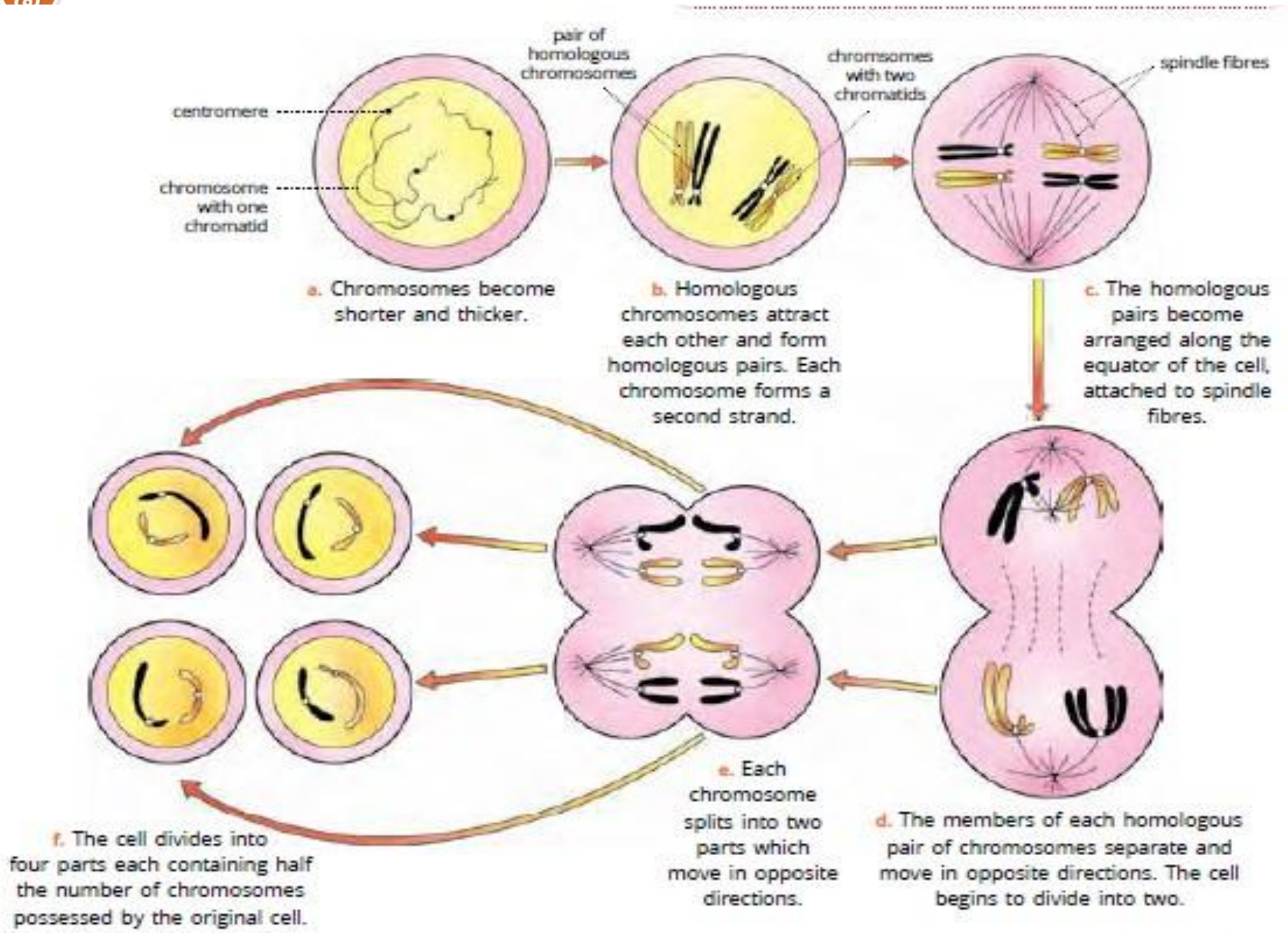
2. Second meiotic division (mitotic division/ equational division)

Thus, in meiotic cell division, all the stages, i.e. prophase, metaphase, anaphase and telophase are repeated twice.

During meiosis, the diploid cells are reduced to haploid cells (number of chromosomes is halved).

Diploid → Haploid
(2n) (n)

In absence of meiosis, the number of chromosomes will double and the offspring will not be able to survive.



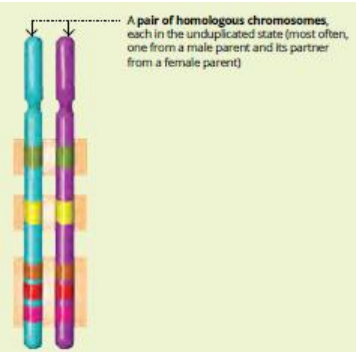
Different stages of meiosis in an animal cell

First meiotic division (Meiosis I)

Homologous chromosomes come together (associate) and subsequently segregate into daughter cells. Thus, the number of chromosomes is reduced from diploid (double) to the haploid (single) state. That is why it is known as reduction division.

Homologous chromosomes

They are chromosome pair containing one chromosome from the father and one from the mother. They are not identical. They are similar in length, gene position and location of centromere. The gene, however, contains different alleles.



The following events take place during this division.

Chromosomes pair and separate

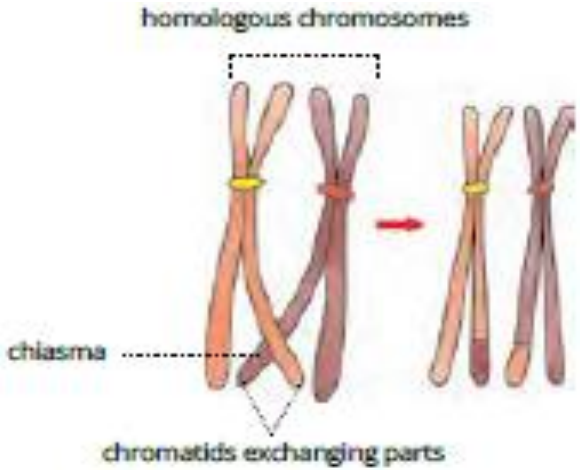
❖ The homologous chromosomes (one received from father and one received from mother) attract each other and come to lie in pairs. The pairing of homologous chromosomes is known as synapsis and the pair is known as bivalent.

Chiasmata formation or crossing over

❖ Chromosome continues to shorten and thicken. Each chromosome splits lengthwise into two chromatids so that each homologous pair now has four chromatids and is termed as **tetrad**.

❖ The non-sister chromatids of a tetrad break open and rejoin each other. This is known as **crossing over** or **chiasmata formation**.

❖ Exchange of some genes or portions of chromatids takes place between paternal and maternal chromatids of a pair of homologous chromosomes during meiosis. This is known as crossing over.



Crossing over between maternal and paternal chromatids

❖ Due to crossing over of homologous chromosomes, chromosomes separate out. Nucleolus and nuclear membrane disappear.

❖ The members of homologous chromosomes completely separate from each other and move towards the opposite poles. Nuclear membrane reappears leading to the formation of two daughter nuclei.

Note: **Refer to Table 1.3 for Differences between mitosis and meiosis**

Second meiotic division (Meiosis II)

It is similar to mitosis. During this, the two chromatids of each chromosome separate and move to opposite poles. Nuclear membrane reappears and four cells are formed. Finally each cell formed is haploid (n), i.e. it contains half the number of chromosomes of the original cell (diploid, 2n).

Significance of meiosis

1. The number of chromosomes is reduced to half in the daughter cells.
2. It results in the formation of haploid sex cells (sperms and ova), which after fertilization restore the diploid number of chromosomes in the zygote.
3. During crossing over which occurs in meiosis, part of chromatids are exchanged between homologous chromosomes which bring out variations in the offsprings.
4. The four chromatids of a homologous pair of chromosomes are passed on to four different daughter cells. This also causes gametic variation.

SUMMARY...

- New cells arise from pre-existing cells by the process of cell division.
- Cell division is necessary for growth, replacement of dead cells, healing of wounds and reproduction.
- A cell division starts when a new cell forms. It proceeds through interphase and ends when the cell reproduces by mitosis and cytokinesis.
- There are two types of cell divisions – mitosis and meiosis.
- Mitosis is an equational division required for growth and development.
- Mitosis maintains the same number of chromosomes in all the cells of an individual.
- Meiosis is a special type of cell division which produces sex cells or gametes. It is known as reduction division.
- Meiotic division prevents the multiplication of chromosomes, and thus maintains the stability of species.
- The cell cycle has following two basic phases – interphase [first growth phase (G1), synthesis phase (S) and second growth phase (G2)] and mitosis.
- Mitosis has four phases – prophase, metaphase, anaphase and telophase.
- Meiosis has two nuclear divisions – first meiotic division and second meiotic division.


RATNA SAGAR
PRIMUS
BYWORD
E-LIVE
THANK
YOU