Cell Cycle and Cell Division

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Outline

- Cell cycle
- Mitosis
- Four stages
- Significance of Mitosis
- Meiosis
- Meiosis I and Meiosis II

Objectives

- To have an Over view of the Cell cycle as well as stages of mitosis and meiosis.

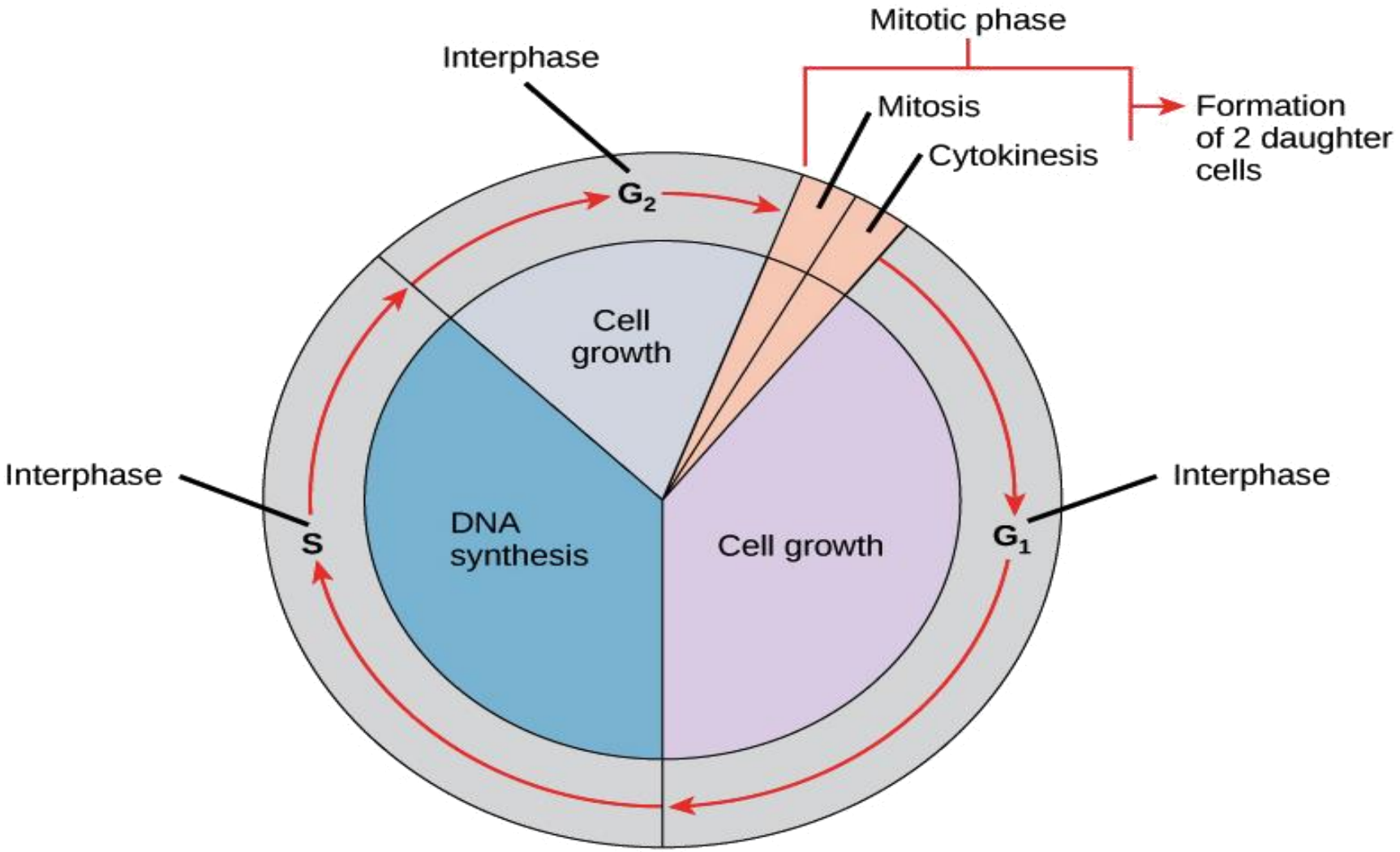
▪ Cell cycle

- Is defined as the series of **changes** that a **cell undergoes** which results in **division of cells into two daughter cells** and its growth.

✓ Human cell divides once in approximately 24 hours, which may vary in different organisms.

✓ In yeasts it takes about **90 minutes** to complete the cell division process.

Cell cycle is divided into two basic phases



❖ Interphase:

- ✓ It is the phase between two successive **M phases**.
- ✓ Interphase lasts for **95% of a cell cycle**.
- ✓ This phase is called as resting phase
- ✓ But during this period the cells prepare itself for nuclear division by cell growth.

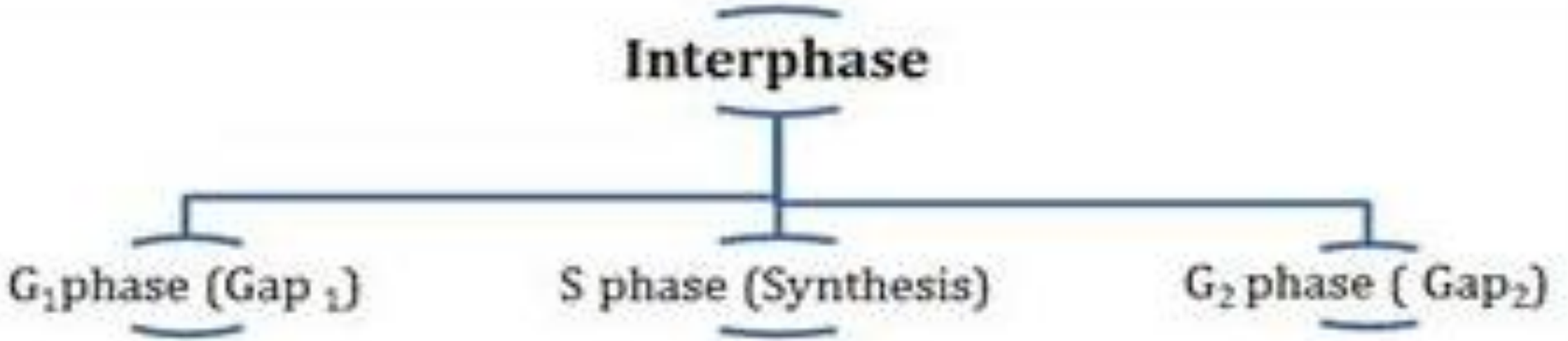
❖ M Phase:

✓ When the actual **cell division or mitosis occurs**.

✓ It starts with **karyokinesis** (nuclear division) or **duplication of chromosome**

✓ And end with **cytokinesis** or division of cell matrix (cytoplasm division).

- **The interphase is divided into three further phases:**



▪ G1 phase:

- Represents the interval between mitosis and initiation of DNA replication.

- Cell is continuously active and grows in size.

▪ During synthesis phase:

- Replication or synthesis of DNA takes place and amount of DNA get doubles per cell.

▪ During G2 phase :

- Protein is synthesized in preparation for mitosis.
- In adult animals, some cells do not divide or may divide occasionally.
- These cells do not divide further and exits the G1 phase to enter an inactive stage called **Quiescent Stage (G0) of cell cycle**.

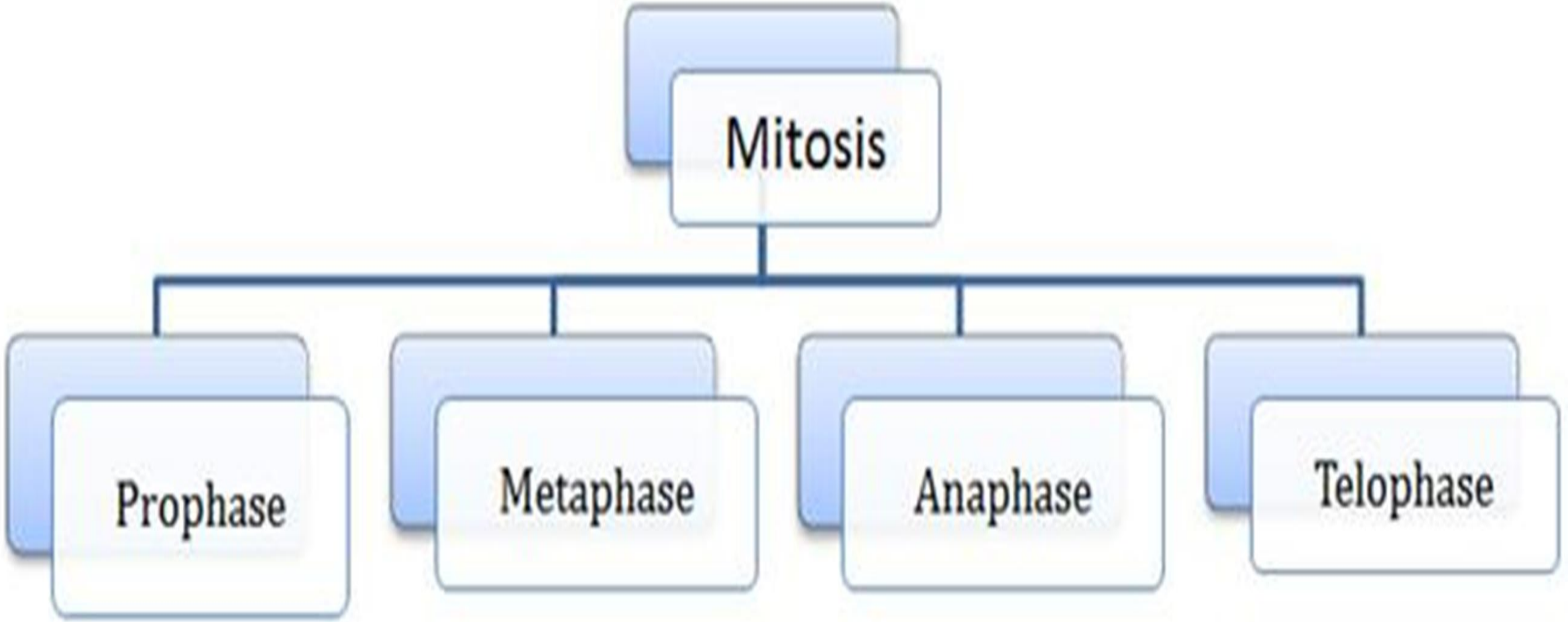
Mitosis

- The cell completely undergoes reorganization and is divided into its offspring.

✓ The offspring's have the same chromosome numbers as their parents and hence It is also called the phase of equational division.

✓ This is a phase of chromosome separation and nuclear division (karyokinesis).

- **This phase is divided into the following:**



1. Prophase:

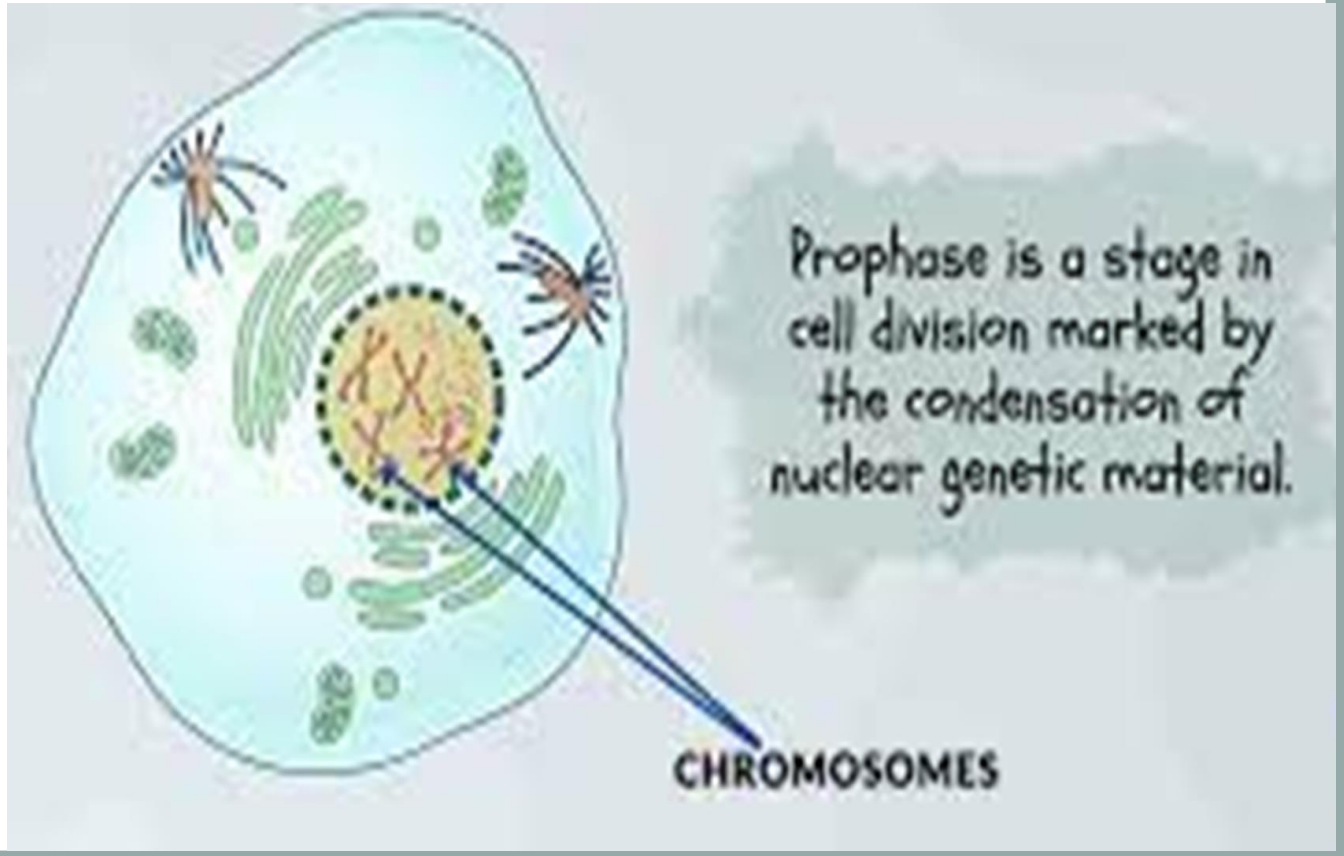
- Is the first phase of mitosis. It involves following events.

✓ Initiation of condensation of chromosomal materials.

✓ Movement of centrioles towards opposite poles of the cell.

✓ At the end of prophase:

- Endoplasmic reticulum
- Nuclear membrane
- Golgi complex
- **All disappears**



- **Metaphase:**

- Starts with complete disappearance of nuclear membrane.

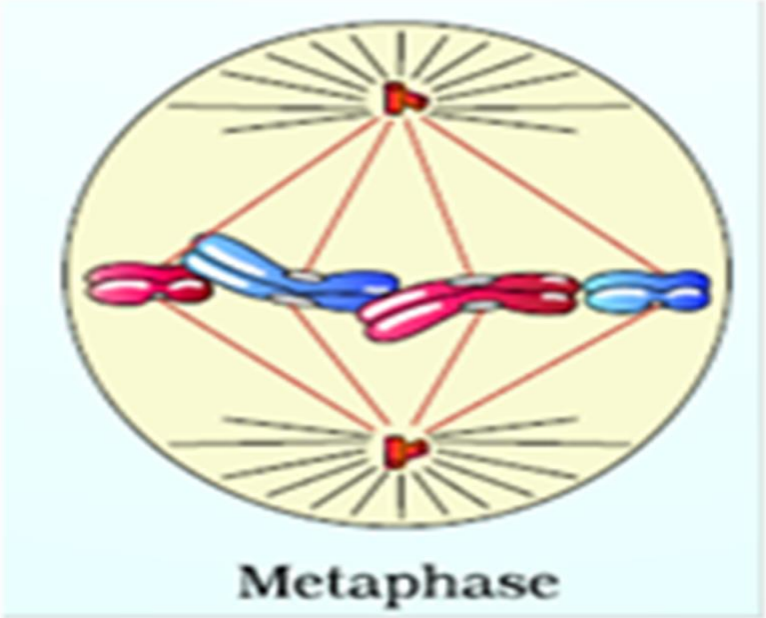
✓The most suitable stage for study of morphology of chromosomes.

- It involves:

✓ Condensation of chromosomal materials in to compact.

- ✓ And distinct chromosomes made up of two sister chromatids

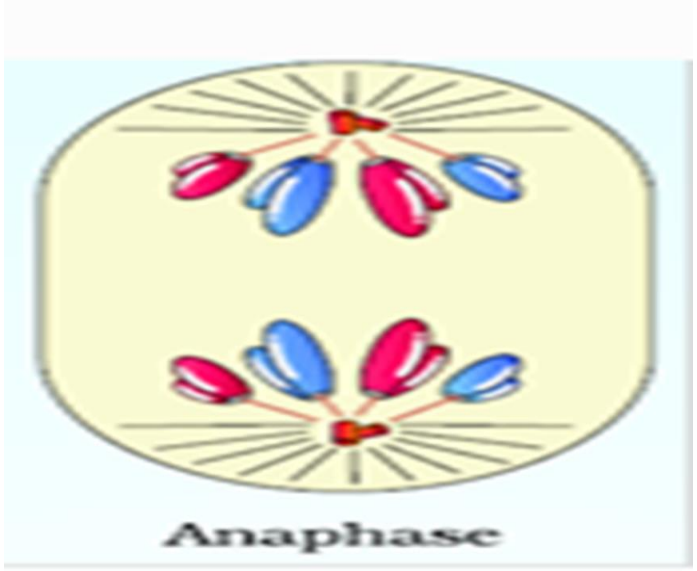
- ✓ Chromosomes arrange at center of cell called metaphase plate.



Anaphase involves following steps:

I. Splitting of each chromosome at centromere into two sister chromatids.

II. Two chromatids start moving towards opposite poles.

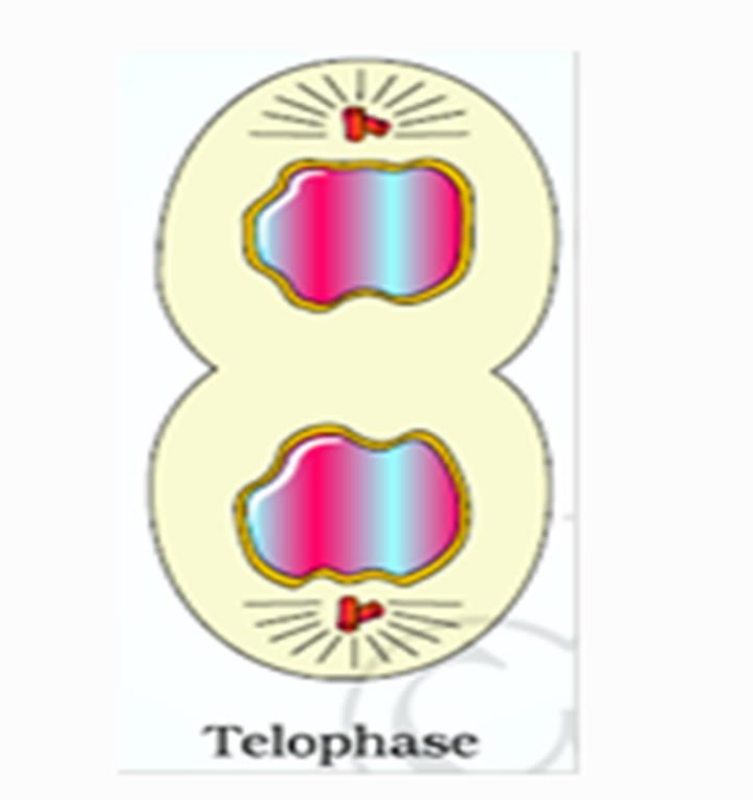


▪ Telophase

- ✓ Is the last stage of mitosis which involves
- ✓ Chromosomes reach at opposite poles and loose its identity as discrete unit.
- ✓ Nuclear membrane reassembles around the chromosome clusters.
- ✓ Nucleolus, Golgi complex and ER reappear.

Cytokinesis

- ✓ Is the division of cytoplasm of a cell after karyokinesis (division of chromosome) into two daughter cells.



Significance of Mitosis

- Mitosis produces diploid daughter cells with identical genetic complement.
- It helps in repair of cells, especially in lining of gut and blood cells.
- Meristematic division in apical and lateral cambium results in continuous growth of plants.

Meiosis

- The cell division that reduces the **number of chromosome into half,**

- ✓ And results in the production of **haploid daughter cells** is called meiosis.

- ✓ It helps in production of haploid phase in the life cycle of sexually reproducing organism.

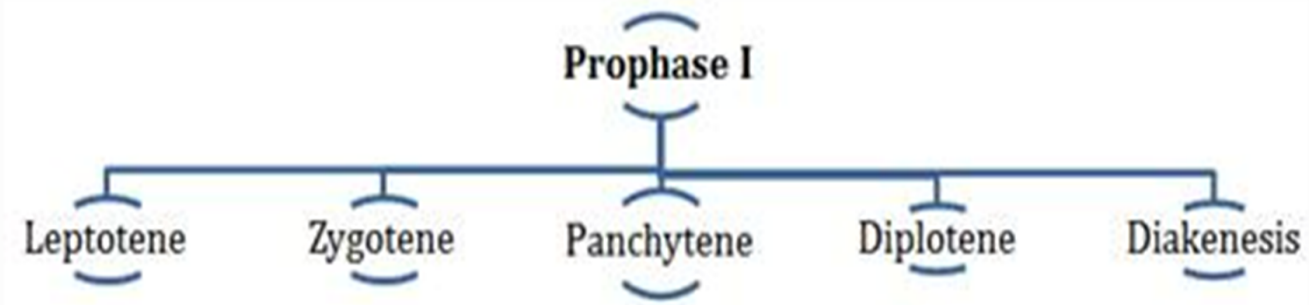
▪ It involves following events

1. Two sequential cycles of nuclear and cell division called **meiosis I** and **meiosis II** but single cycle of DNA replication.

2. It involves **pairing of homologous chromosome** and recombination of them.

3. **Four haploid cells** are formed at the end of **meiosis II.**

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II



- **During Leptotene:**

✓ The chromosome becomes distinct and visible under microscope.

- **During Zygotene stage:**

✓ Chromosomes start pairing together (synapsis). The paired chromosomes are called homologous chromosome.

▪ During Pachytene stage:

- ✓ Crossing over between non-sister chromatids of homologous chromosome occurs for exchange of genetic materials.

▪ Diplotene:

- ✓ Is recognized by dissolution of synaptonemal complex and tendency to separation of bivalent except at the site of crossing over.

▪ Diakinesis:

✓ The nuclear membrane breaks and nucleolus disappear.

▪ In metaphase I:

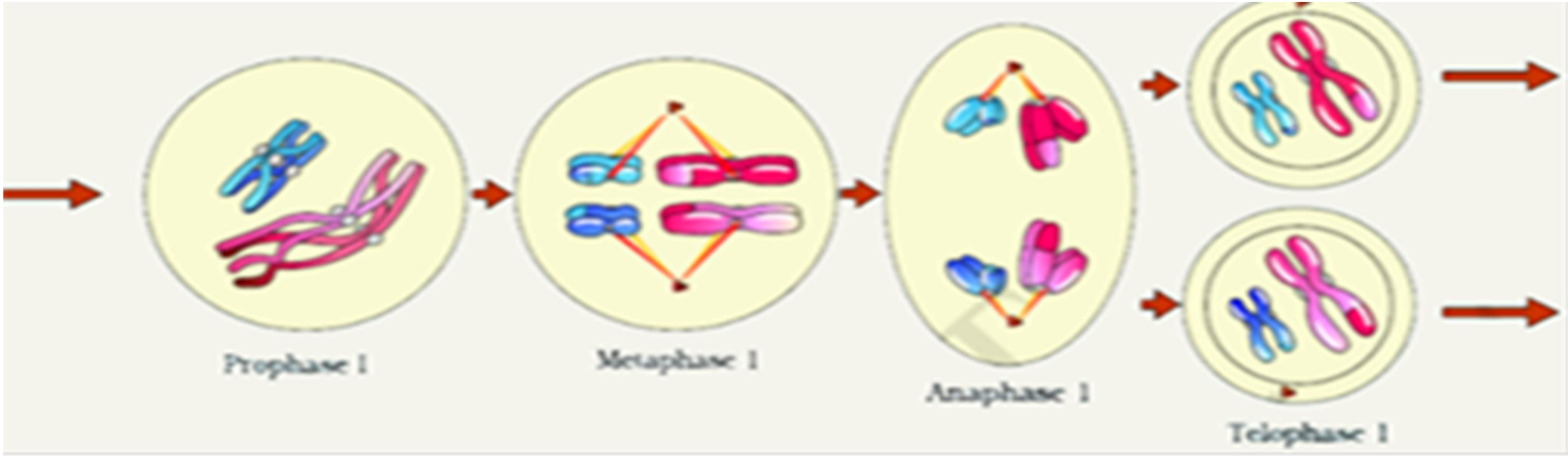
✓ The bivalent chromosome align at equatorial plate

▪ Anaphase I:

✓ Homologous chromosome separate but sister chromatids remain attached at centromere.

▪ During Telophase I:

✓ Nuclear membrane and nucleolus reappears and cytokinesis follows. This is called as diad of the cells.



Meiosis II

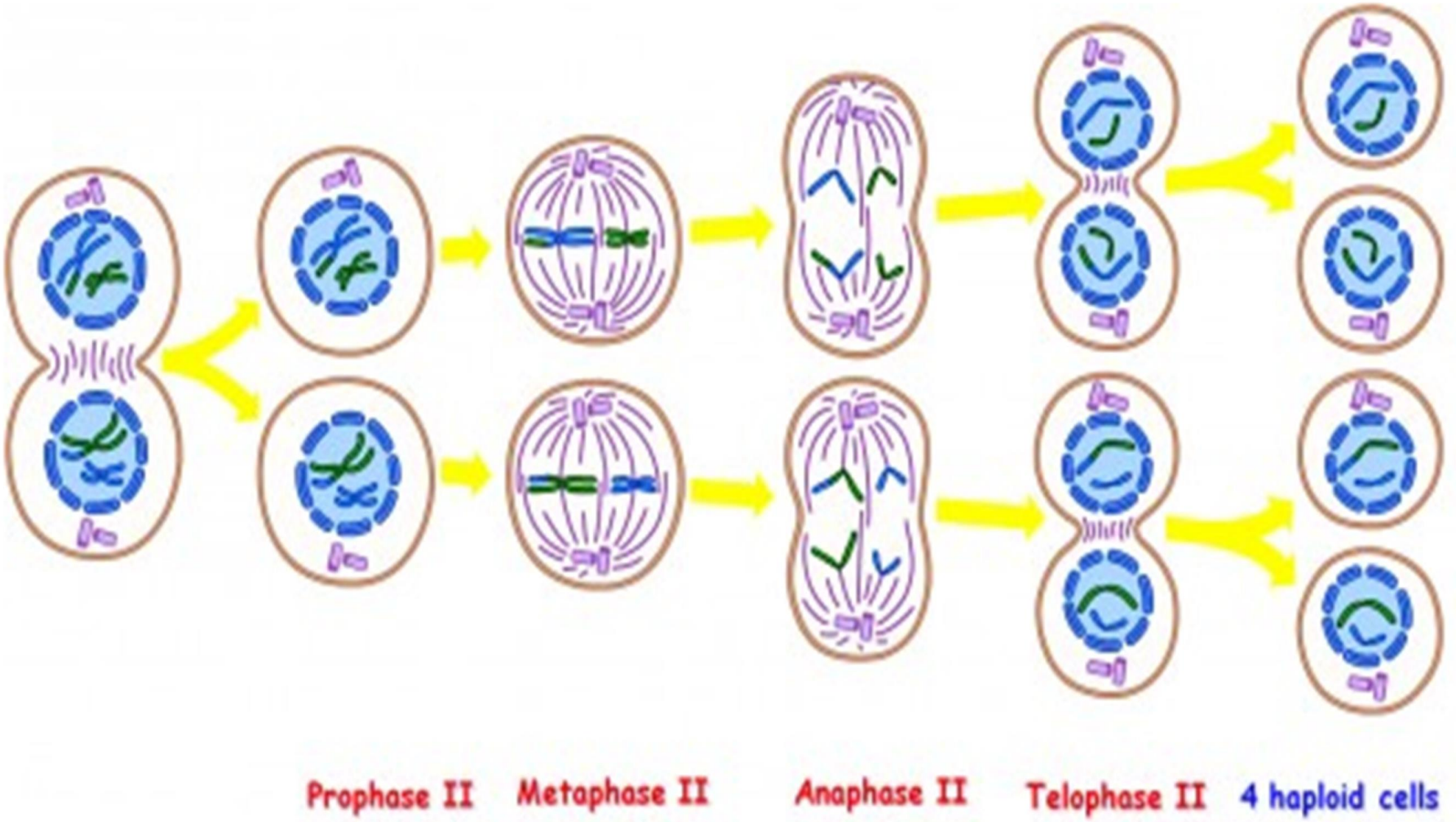
- It is initiated immediately after cytokinesis before chromosome gets elongated.
- Prophase II: Nuclear membrane disappears and chromosome becomes compact.
- Metaphase II stage: The chromosomes align at equator.

✓ Anaphase II:

- Start with splitting of centromere of each chromosome to move towards opposite poles.

✓ Telophase II:

- Two groups of chromosomes get enclosed by nuclear membrane followed by cytokinesis to form four haploid daughter cells.


Prophase II
Metaphase II
Anaphase II
Telophase II
4 haploid cells

Significance of Meiosis

- Meiosis forms the gametes that are essential for sexual reproduction.
- Crossing over introduces new recombination of traits.
- Helps in maintenance of chromosome number of sexually reproducing organism.
- Provides evidence of basic relationship of organisms.

Difference between Mitosis and meiosis

Mitosis	Meiosis
1. Takes place in the somatic cells. 2. It is a single division which produces two cells. 3. Haploid and diploid both kind of cells may undergo mitosis. 4. Crossing over absent. 5. Pairing of chromosome does not occur.	1. Takes place in reproductive cells. 2. It is a double division which produces four cells. 3. Only diploid cells undergo meiosis cell division. 4. Crossing over takes place. 5. Pairing of homologous chromosome occurs.

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