EDU SERUMX College of Nursing

TOPIC: Cell Cycle

B.Sc Nursing -1st year

Detailed Notes

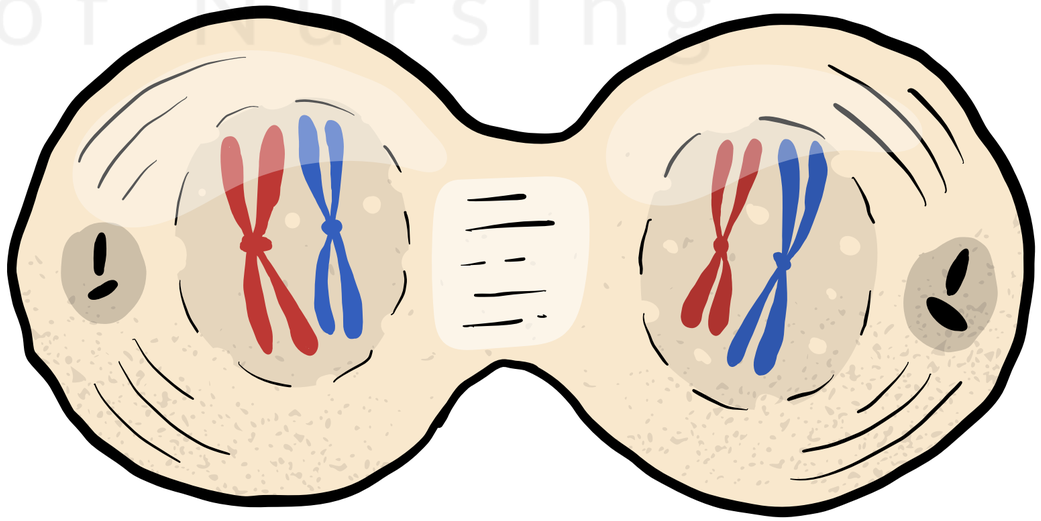
NOTES: B.SC. NURSING (SEM-1ST)

APPLIED PHYSIOLOGY (UNIT-1)

GENERAL SCIENCE- BIOLOGY (UNIT-3)

DEFINITION:

The cell cycle is a sequence of events that occur in a cell leading to its division and duplication (replication). It results in the formation of two genetically identical daughter cells from a single parent cell. This process is essential for growth, development, tissue repair, and reproduction.



1. INTERPHASE:

Interphase is the longest phase and is divided into three sub-phases

Phase	Full Form	Key Events
G_1 Phase	Gap 1	Cell increases in size, produces RNA, enzymes, and proteins needed for DNA replication.
S Phase	Synthesis	DNA replication occurs – each chromosome duplicates to form sister chromatids.
G_2 Phase	Gap 2	Final preparation for mitosis; synthesis of microtubules and cell organelles; checks for DNA damage.

Characteristics of Interphase:

Nucleus is visible.
Chromosomes are not distinctly visible (uncoiled chromatin).
Active metabolism occurs.
Preparation for cell division.

2. M Phase (Mitotic Phase):

Mitosis occurs in somatic cells and results in two genetically identical diploid daughter cells.
M phase includes karyokinesis (nuclear division) and cytokinesis (cytoplasmic division).

KARYOKINESIS (MITOSIS):

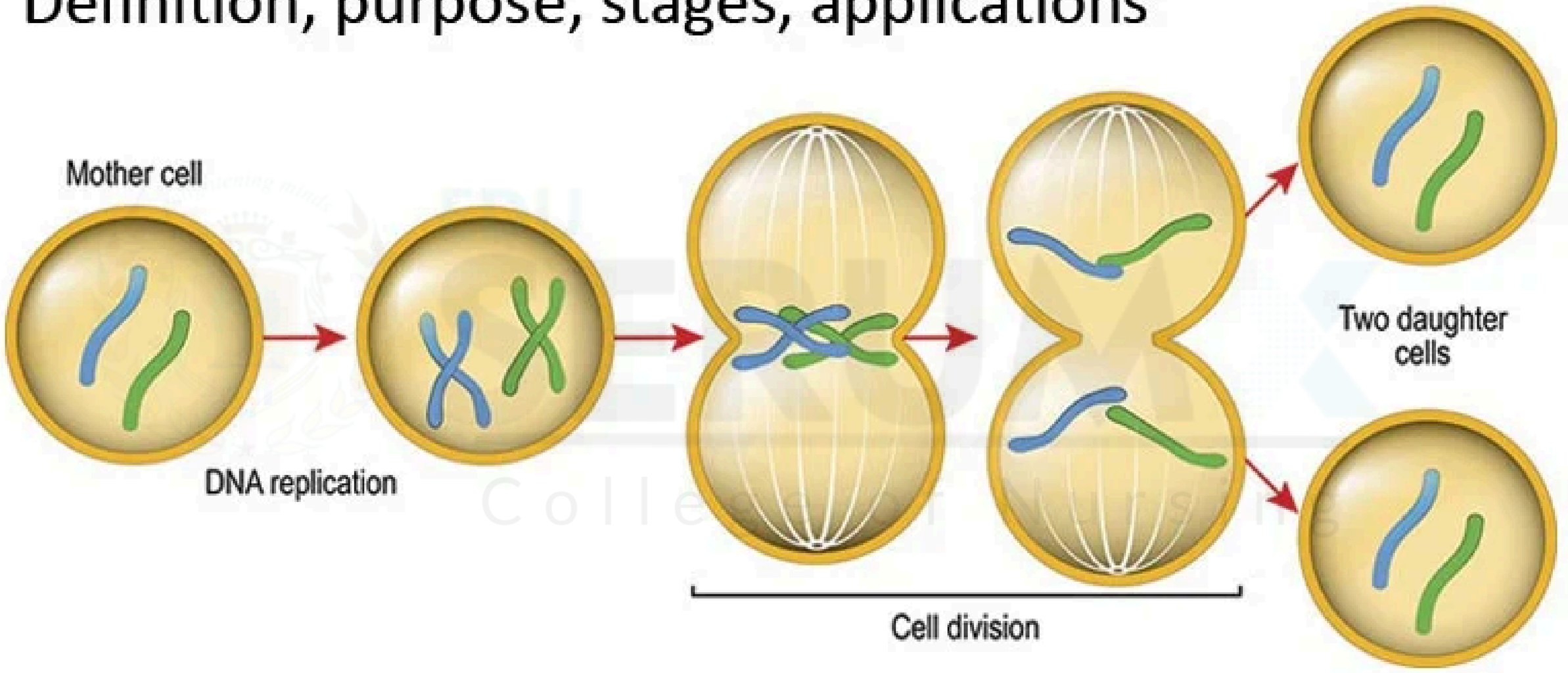
Stages :
Prophase: Chromatin condenses, spindle fibers begin to form, and nuclear membrane breaks down.
Metaphase: Chromosomes align at the cell's equator.
Anaphase: Sister chromatids are pulled apart to opposite poles.
Telophase: Chromatids de-condense, and nuclear envelope reforms.

Stage	Description	Diagram View
Prophase	- Chromatin condenses into visible chromosomes. - Spindle fibers begin to form. - Nuclear membrane starts to break down.	Visible coiled chromosomes
Metaphase	- Chromosomes align at the cell's equator. - Spindle fibers attach to centromeres.	All chromosomes line up in center
Anaphase	- Sister chromatids are pulled apart to opposite poles. - Centromeres split.	Chromatids moving away from center
Telophase	- Chromatids de-condense back into chromatin - Nuclear envelope reappears. - Cell prepares to split.	Two new nuclei forming

CYTOKINESIS:

Division of cytoplasm occurs.
Results in two daughter cells with identical genetic content.
In animal cells, a cleavage furrow forms; in plant cells, a cell plate forms.

Definition, purpose, stages, applications



CLINICAL SIGNIFICANCE FOR NURSING:

Wound Healing – Cell cycle enables repair of damaged tissues.
Growth and Development – Growth in children involves rapid cell division.
Cancer – Uncontrolled cell cycle due to mutation in regulatory genes.
Chemotherapy – Targets rapidly dividing cells, especially in M phase.
Radiation Therapy – Damages DNA of dividing cells.

EXAMPLE: SKIN WOUND HEALING

When the skin is injured (e.g., cut or burn):
Nearby skin cells are stimulated to enter the cell cycle.
DNA replicates → Mitosis occurs → New skin cells are formed.
New cells replace damaged tissue and restore the skin barrier.

KEY TERMS TO REMEMBER:

Chromatin – Uncondensed DNA in nucleus.
Chromosome – Condensed chromatin during mitosis.
Centromere – Region joining sister chromatids.
Spindle Fibers – Pull chromatids apart.
Diploid (2n) – Normal number of chromosomes (e.g., 46 in humans).
Sister Chromatids – Identical copies formed after DNA replication.

MITOSIS – ASEXUAL REPRODUCTION

Definition : Mitosis is a type of cell division in which a single cell divides to produce two identical daughter cells, each having the same number and type of chromosomes as the parent cell.
It is also called equational division because the chromosome number remains the same (diploid → diploid).

Importance :

- Growth: Helps in increasing the number of cells during growth.
- Repair: Replaces damaged or dead cells.
- Regeneration: Heals wounds by generating new cells.
- Asexual reproduction: In unicellular organisms like amoeba.

Where does Mitosis occur?

- Occurs in somatic (body) cells – skin cells, liver cells, bone cells, etc.
- Not involved in gamete (egg/sperm) formation – that is meiosis.

Phases of Mitosis : Mitosis is divided into 4 main phases:

- Prophase
- Metaphase
- Anaphase
- Telophase

It is preceded by Interphase, and followed by Cytokinesis.

1. INTERPHASE
(Preparation phase – Not part of mitosis but very important)

Sub-stages:
G1 phase – Cell grows, protein synthesis.
S phase – DNA is replicated (very important!).
G2 phase – Prepares for mitosis.

Example: In wound healing, cells near the injury go into interphase to prepare for division.

2. PROPHASE (FIRST STAGE OF MITOSIS)

Chromosomes become visible (as condensed structures).
Each chromosome has two sister chromatids joined at centromere.
Nuclear membrane starts breaking down.
Spindle fibers start forming from centrioles.
Clinical note: Chemotherapy targets dividing cells during prophase and metaphase

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3. METAPHASE ("MIDDLE")

Chromosomes align at the center (equatorial plate) of the cell.
Spindle fibers attach to the centromeres of chromosomes.
🔍 Example: In lab, metaphase cells are often used to study chromosomes (karyotyping).

4. ANAPHASE ("APART")

Sister chromatids separate and move to opposite poles of the cell.
The centromere splits.
Remember: "Ana = Apart"

5. TELOPHASE ("TWO")

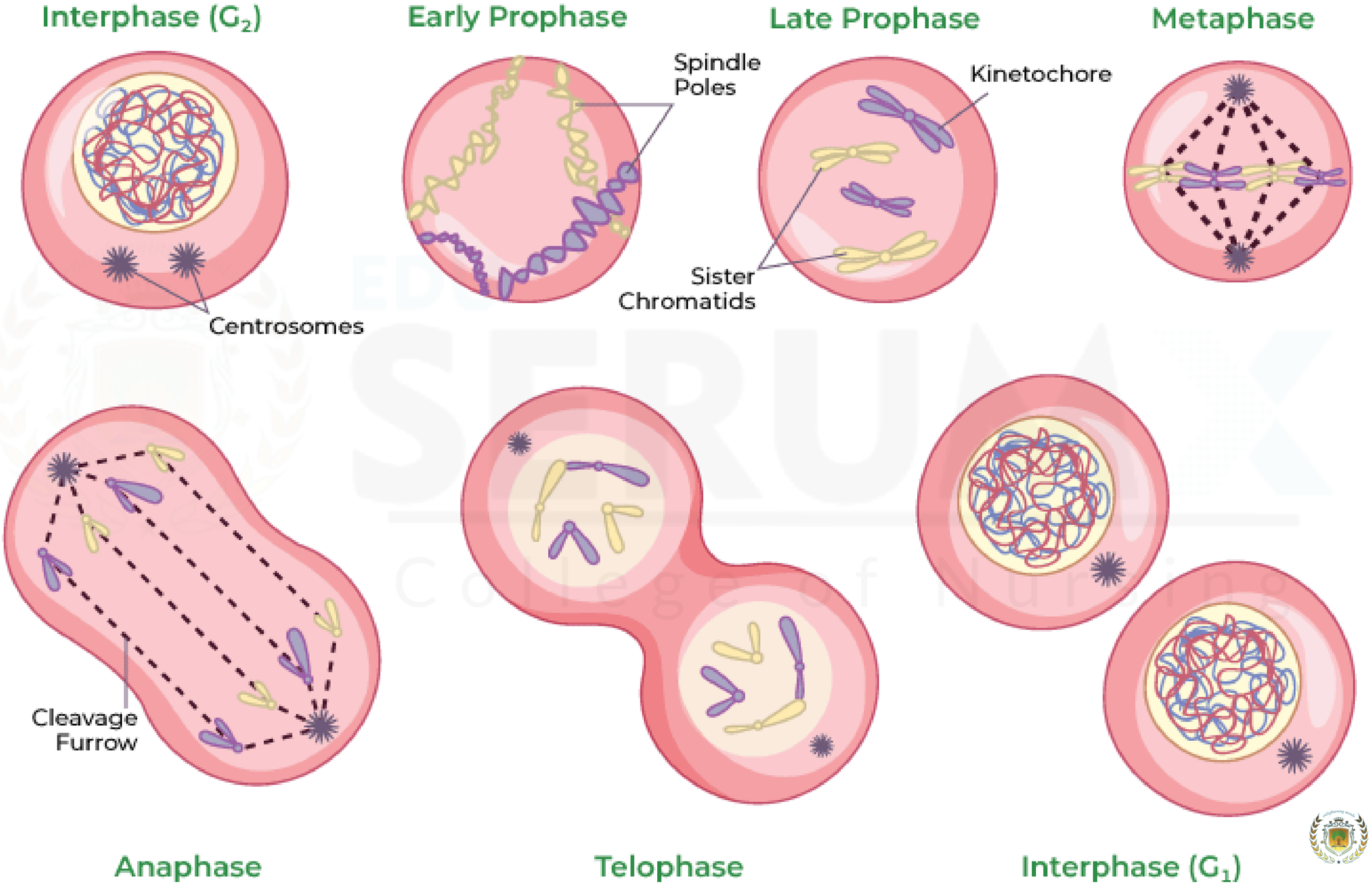
Chromatids reach poles and decondense (become invisible).
Nuclear envelope reforms around both groups of chromosomes.
Cell has two nuclei now.

6. CYTOKINESIS (DIVISION OF CYTOPLASM)

The cytoplasm divides to form two identical daughter cells.
Each daughter cell has the same number of chromosomes as the parent cell.
In animal cells: It occurs by "cleavage furrow."
In plant cells: A "cell plate" forms.

Examples Where Mitosis Happens in Humans

- Skin cells replacing old cells.
- Bone marrow producing new blood cells.
- Liver cells regenerating after injury.



CLINICAL RELEVANCE OF MITOSIS IN NURSING

- Cancer: Uncontrolled mitosis causes tumor formation.
- Chemotherapy: Targets mitotically active cells.
- Wound healing: Relies on mitosis for regeneration.
- Skin renewal: Epidermal cells constantly divide by mitosis.

COMPARISON: MITOSIS VS MEIOSIS

Feature	Mitosis	Meiosis
Type of cells	Somatic (body)	Gametes (egg/sperm)
No. of divisions	One	Two
Daughter cells	2 identical	4 different (haploid)
Chromosome no.	Same as parent (2n → 2n)	Half (2n → n)
Use	Growth, repair	Reproduction

MEIOSIS: SEXUAL CELL DIVISION

Meiosis is a type of cell division that occurs in sexually reproducing organisms to produce gametes (sperm and egg cells in animals, pollen and ovules in plants). It reduces the chromosome number by half, ensuring that offspring have the same number of chromosomes as their parents.

Definition:

Meiosis is a cell division process that converts a diploid (2n) cell into four haploid (n) cells, each with half the number of chromosomes.

Main Functions of Meiosis:

1. To form gametes (sperm and egg in animals; pollen and ovules in plants).
2. To maintain the chromosome number across generations.
3. To introduce genetic variation through:
    - Crossing over
    - Independent assortment

Overview of Meiosis:

Meiosis occurs in two main stages, each with four phases:

4. Meiosis I (reduction division): Chromosome number is halved.
5. Meiosis II (similar to mitosis): Chromatid number is halved.

MEIOSIS I – REDUCTION DIVISION

1. PROPHASE I (LONGEST PHASE)

Divided into 5 sub-stages:

Sub-Stage	Description
Leptotene	Chromosomes condense and become visible.
Zygotene	Homologous chromosomes pair up (synapsis) to form **bivalents**.
Pachytene	**Crossing over** occurs – exchange of genetic material between non-sister chromatids.
Diplotene	Chromosomes begin to separate but remain connected at **chiasmata** (cross-over points).
Diakinesis	Nucleolus disappears, nuclear membrane breaks down, spindle forms.

2. METAPHASE I

Homologous chromosome pairs (bivalents) align at the equator.
Independent assortment occurs (random arrangement of chromosomes).

3. ANAPHASE I

Homologous chromosomes (not chromatids) separate and move to opposite poles.

4. Telophase I and Cytokinesis

Nuclear membrane may reform.
The cell divides to form two haploid daughter cells.

MEIOSIS II – EQUATIONAL DIVISION

Occurs just like mitosis, but starts with haploid cells.

1. PROPHASE II

- Chromosomes condense.
- New spindle fibers form.

2. METAPHASE II

- Chromosomes line up at the equator.

3. ANAPHASE II

Sister chromatids separate and move to opposite poles.

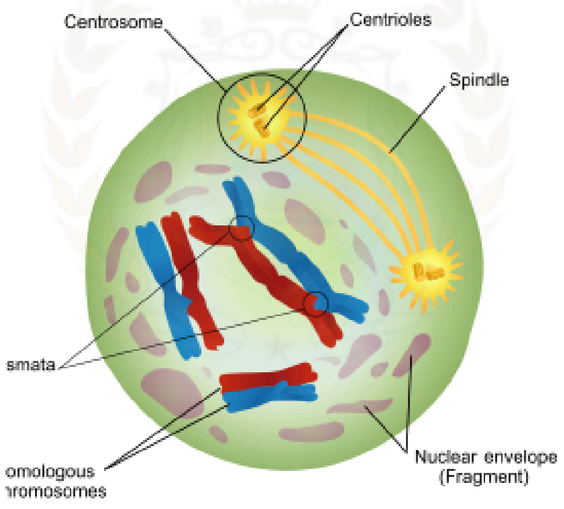
4. TELOPHASE II AND CYTOKINESIS

- Nuclear membranes reform.
- Cytoplasm divides.
- Four non-identical haploid cells are formed.

IMPORTANT OUTCOMES OF MEIOSIS

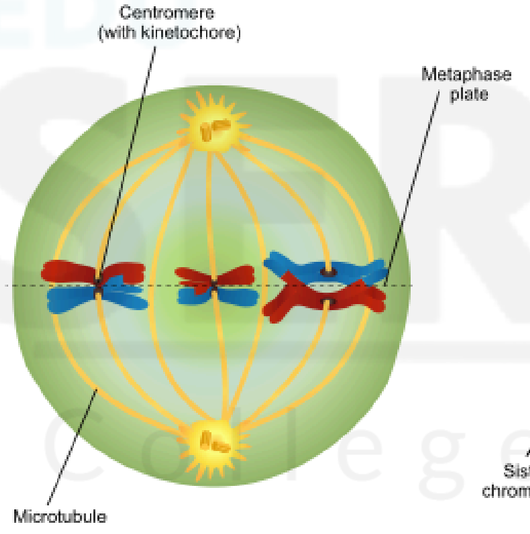
Feature	Description
Number of daughter cells	4
Chromosome number	Haploid (n)
Genetic content	All daughter cells are genetically **different** from each other and from the parent.
Occurs in	Germ cells (testes/ovaries in animals, anthers/ovules in plants)
Purpose	Sexual reproduction

Prophase I



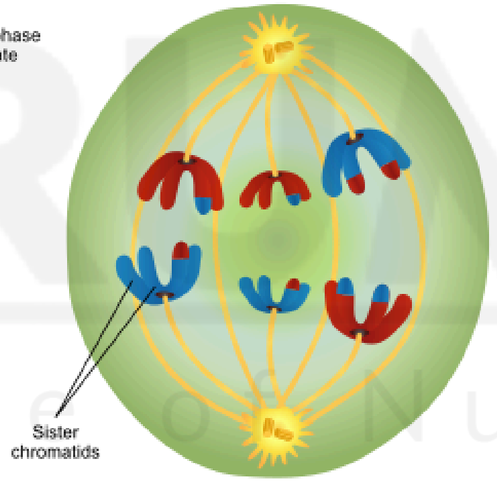
The chromosomes condense, and the nuclear envelope breaks down. Crossing-over occurs.

Metaphase I



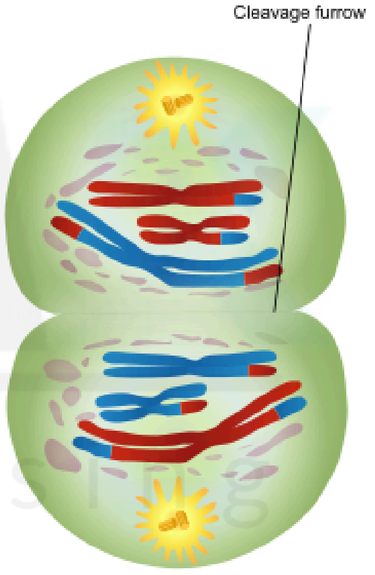
Pairs of homologous chromosomes move to the equator of the cell.

Anaphase I



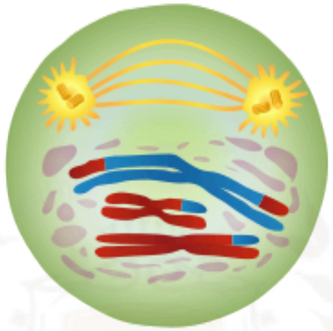
Homologous chromosomes move to the opposite poles of the cell.

Telophase I & cytokinesis

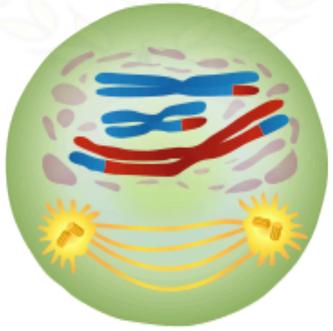


Chromosomes gather at the poles of the cells. The cytoplasm divides.

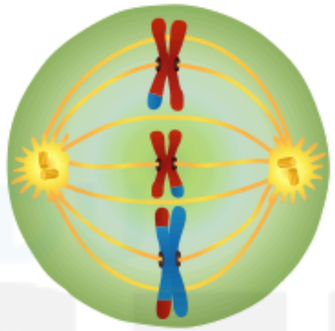
Prophase II



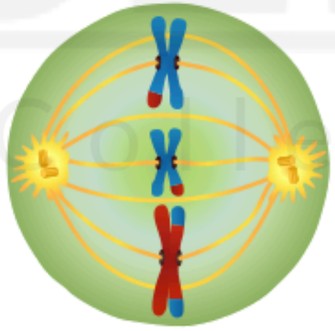
A new spindle forms around the chromosomes.



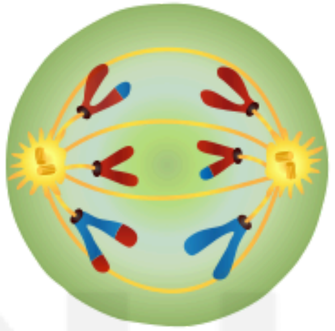
Metaphase II



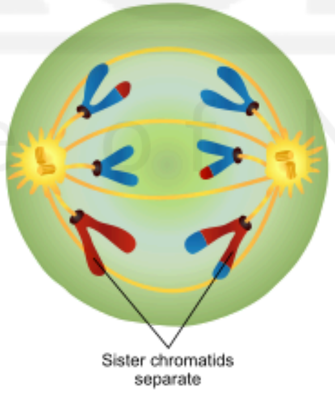
Metaphase II chromosomes line up at the equator.



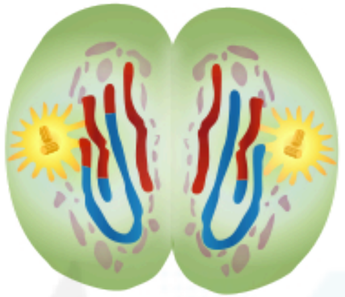
Anaphase II



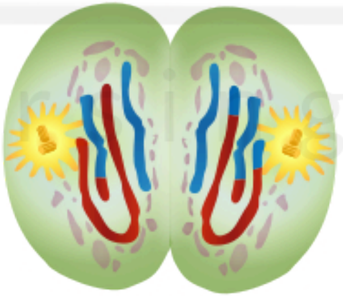
Centromeres divide. Chromatids move to the opposite poles of the cells.



Telophase II & cytokinesis



A nuclear envelope forms around each set of chromosomes. The cytoplasm divides.



COMPARISON: MEIOSIS VS MITOSIS

Feature	Meiosis	Mitosis
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Number of divisions	Two	One
Daughter cells	Four	Two
Chromosome number	Haploid (n)	Diploid (2n)
Genetic variation	Yes	No
Purpose	Sexual reproduction	Growth and repair