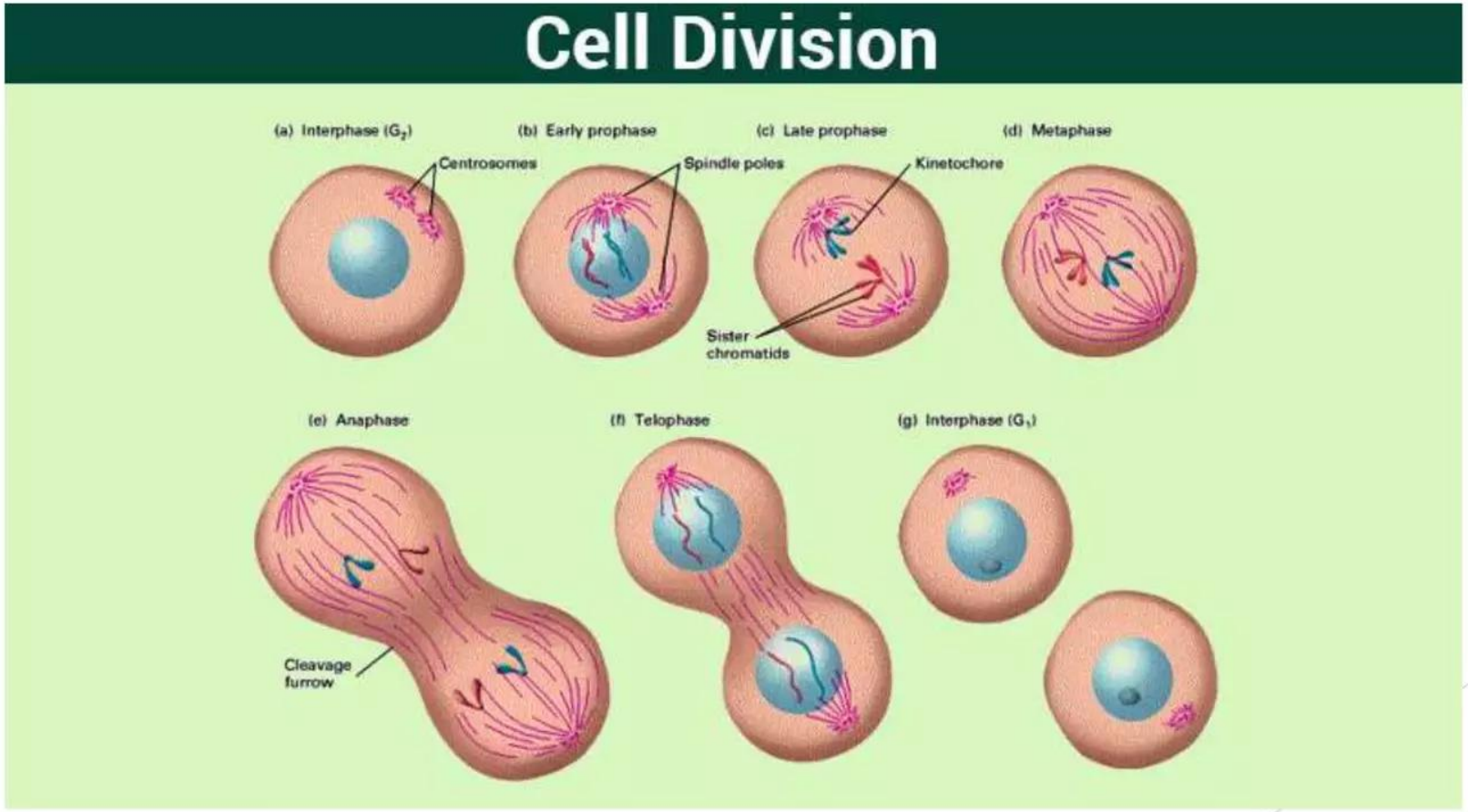
REVIEW OF CELLULAR DIVISON : Meiosis & Mitosis

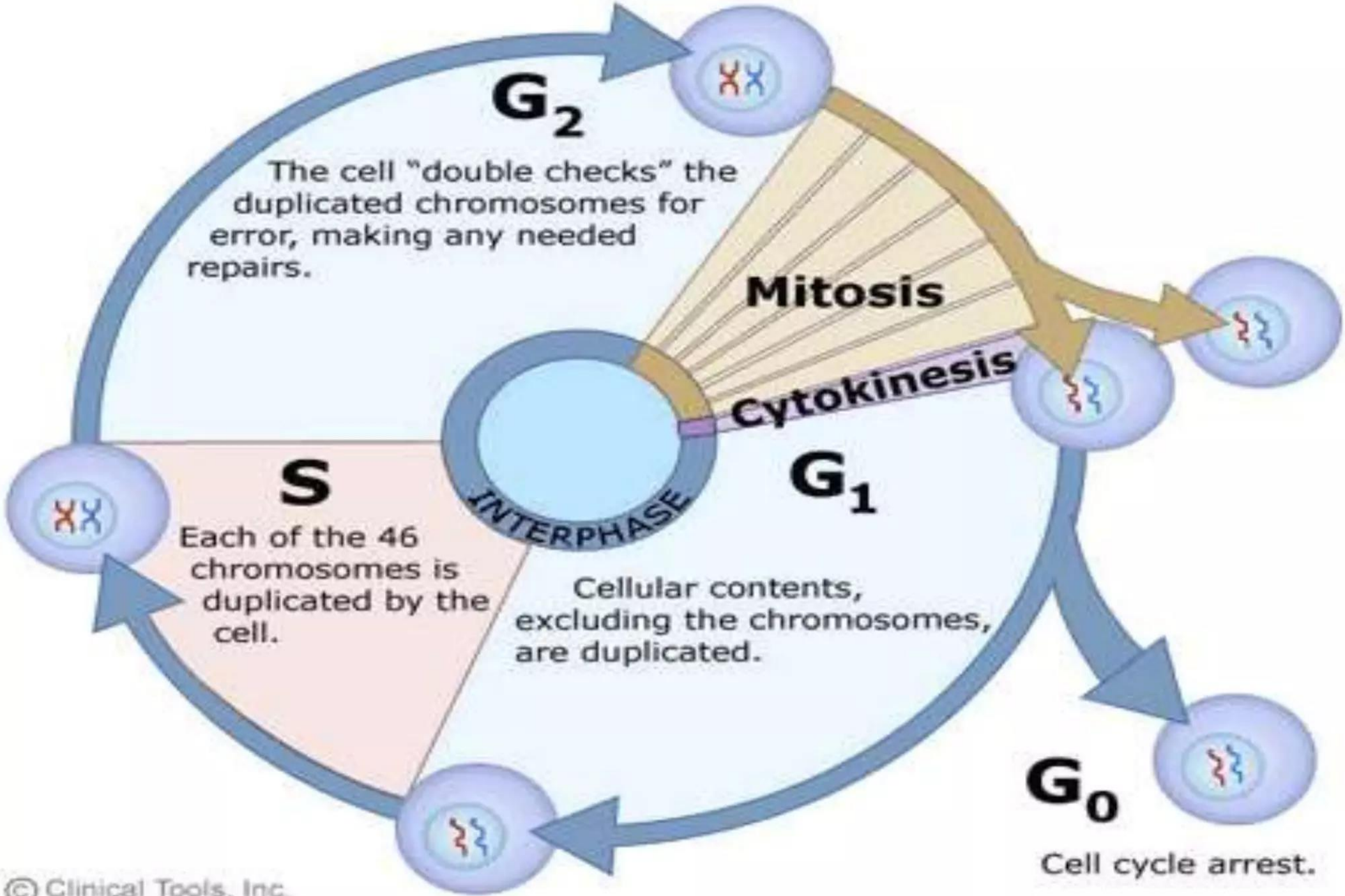


CELL DIVISION

- Genetic Information is passed from parent to all descendent cells through cell division namely mitosis.
- There are two cell division –
  - Mitosis (Somatic Cell Division)
  - Meiosis (Germ cell Division)

CELL CYCLE

- The Cell Cycle is defined as the series of events that take place in a cell leading to its division and duplication (replication).
- Major Phases of Cell Cycle
  - Cell cycle consists of two major phases namely
    - Interphase Phase
    - Mitotic Phase


G2
The cell "double checks" the duplicated chromosomes for error, making any needed repairs.
Mitosis
Cytokinesis
INTERPHASE
G1
S
Each of the 46 chromosomes is duplicated by the cell.
Cellular contents, excluding the chromosomes, are duplicated.
G0
Cell cycle arrest.
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Resting G0 phase

- The term “post-mitotic” is sometimes used to refer to both quiescent and declining cells. Non proliferative cells in multicellular eukaryotes generally enter the quiescent G0 state from G1 and may remain quiescent for long periods of time.

CELL CYCLE

INTERPHASE

- It is the period between successive mitosis of the cell cycle. The interphase is sub divided in to three phases –
  - G1 phase
  - S phase
  - G2 phase

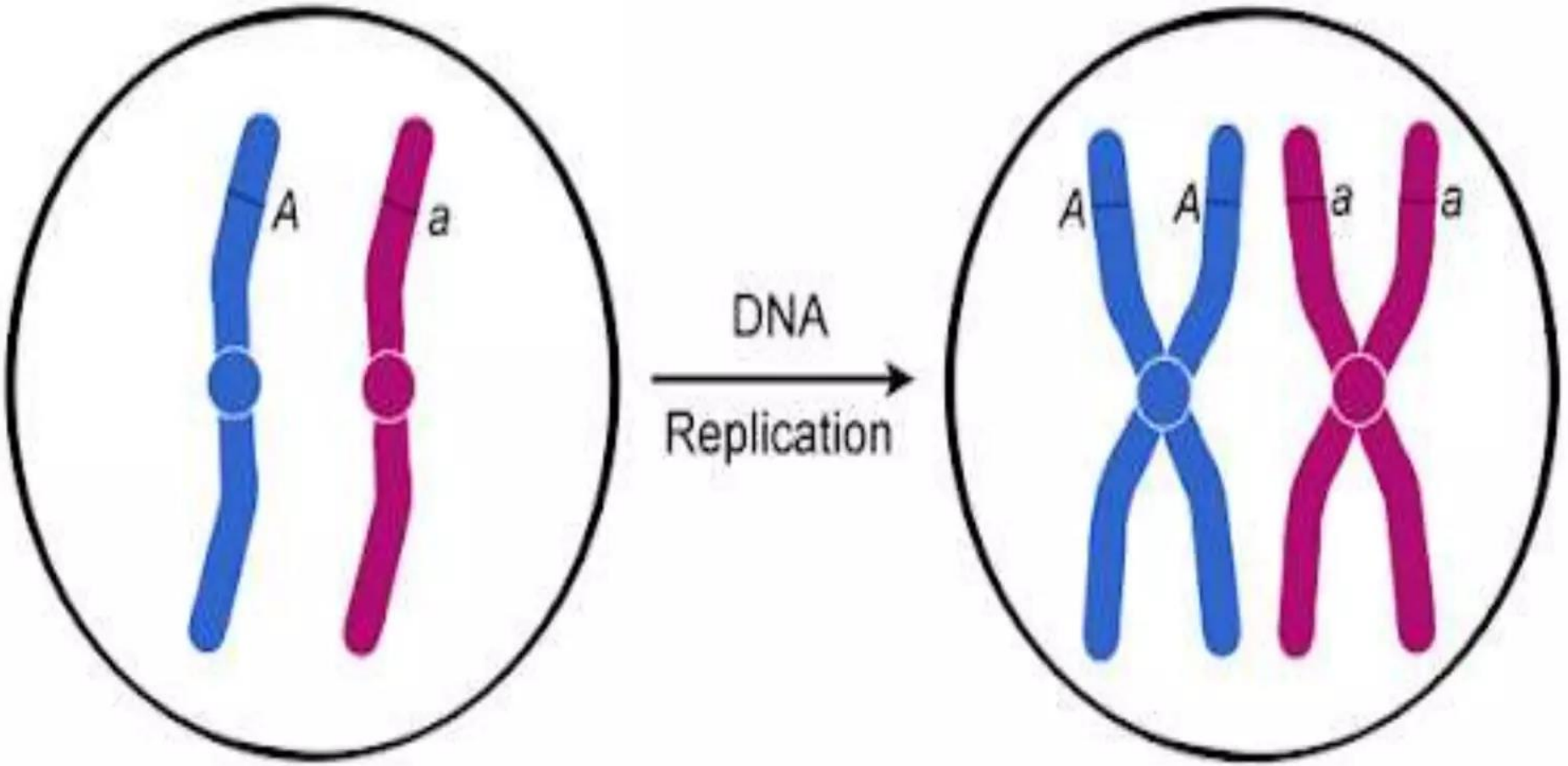
G1 Phase

- The first phase within interphase, from the end of the previous M phase until the beginning of DNA synthesis called G1 (G indicating Gap).
- It is also called the growth phase.
- This phase is marked by synthesis of various enzymes that are required in S phase, mainly those needed for DNA replication.
- Duration of G1 is highly variable, even among different cells of the same species.

S PHASE

- The S phase starts when DNA synthesis, when it is complete, all of the chromosomes have been replicated. E.g. each chromosomes has two (sister) chromatids
- During this phase, the amount of DNA in the cell has effectively doubled
- Rate of RNA transcription and protein synthesis are very low during this phase.

S PHASE



G2 PHASE

- Cell continues to grow and if a problem occurs in DNA replication, it will be repaired.
- Cell will prepare for mitosis.
- Cell synthesizes proteins needed for cell division

MITOSIS (M Phase)

- Mitosis is the final phase of cell cycle in which two identical (daughter cells) are produced.

- Mitosis is defined as the process of somatic cell division to form two identical daughter cells, each with the same chromosomes complement as the parent cell.

Characteristics features

- It produces two genetically identical "daughter cells" having complete set of genetic information.
- These daughter cells have exactly the same number of chromosomes (i.e. 46) as the original parent cell.
- The daughter cells are diploid because they contain 46 chromosomes (i.e. 2N= 2 X 23)

MITOSIS (M Phase)

- Estimated (10% of cycle) Includes 2 parts :

1) Mitosis
   - Prophase
   - Metaphase
   - Anaphase
   - Telophase

2) Cytokinesis

PROPHASE

- Duration (15 min)
- Chromosomes condense (get thicker) and coil, they become visible under light microscope.
- The two sister chromatids of each chromosomes attach at a point called centromere.
- Spindle fibers begin to form from two centrosome, and they will start moving apart.

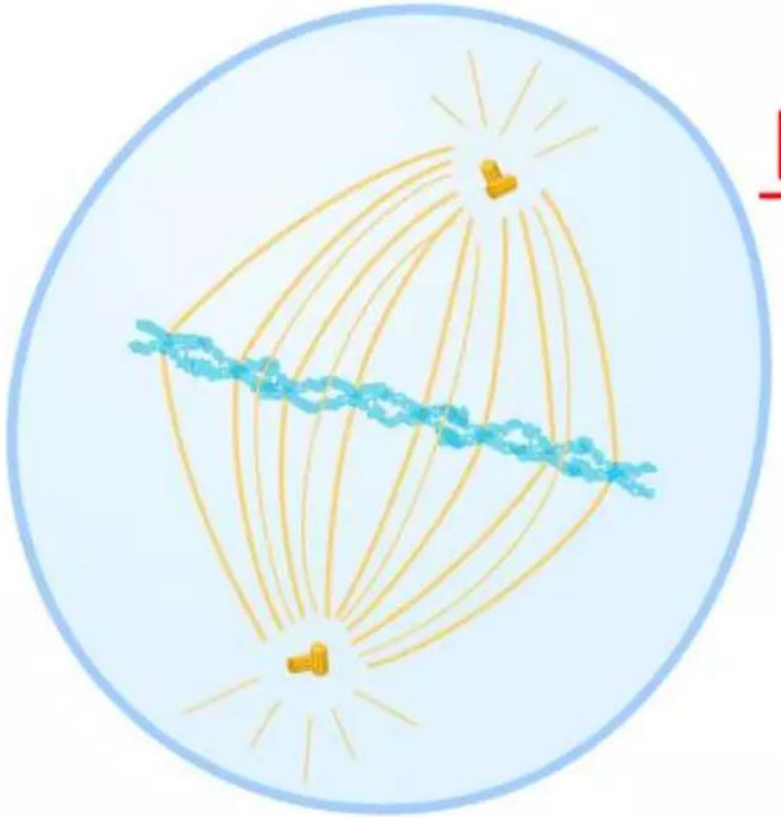
PROPHASE


Prophase in Mitosis ar
Early miotic spindle
Two sister chromatids
Prophase in Mitosis

METAPHASE

- Duration (20 min)
- Chromosomes reach their most highly condensed state.
- The spindle fibers begin to contract to the centromeres of the chromosomes, which are now arranged along the middle of the spindle.

METAPHASE



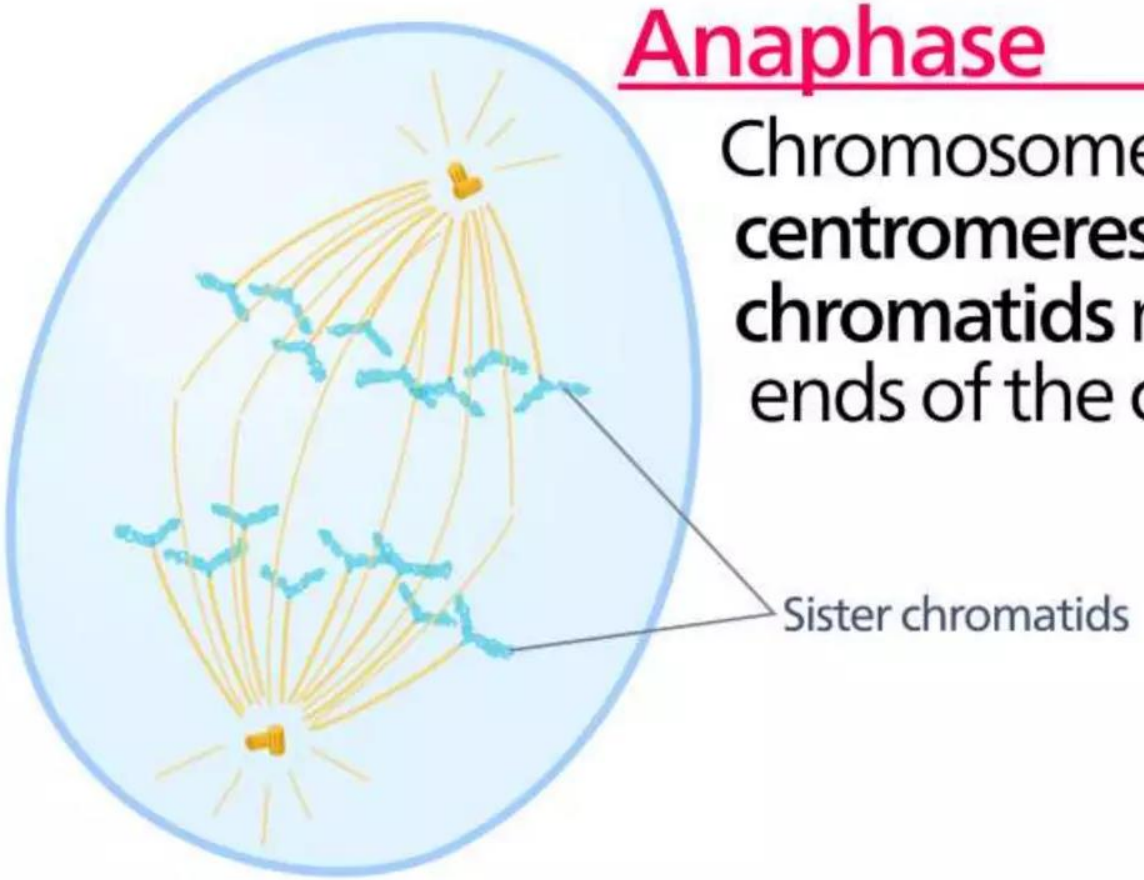
Metaphase

Chromosomes line up along **metaphase plate** (imaginary plane)

ANAPHASE

- 3 Min
- The centromere of each chromosome splits, allowing the sister chromatids to separate.
- The chromatids are then pulled by the spindle fibers toward opposite sides of the cell.
- The two sets of chromosomes are identical.

ANAPHASE



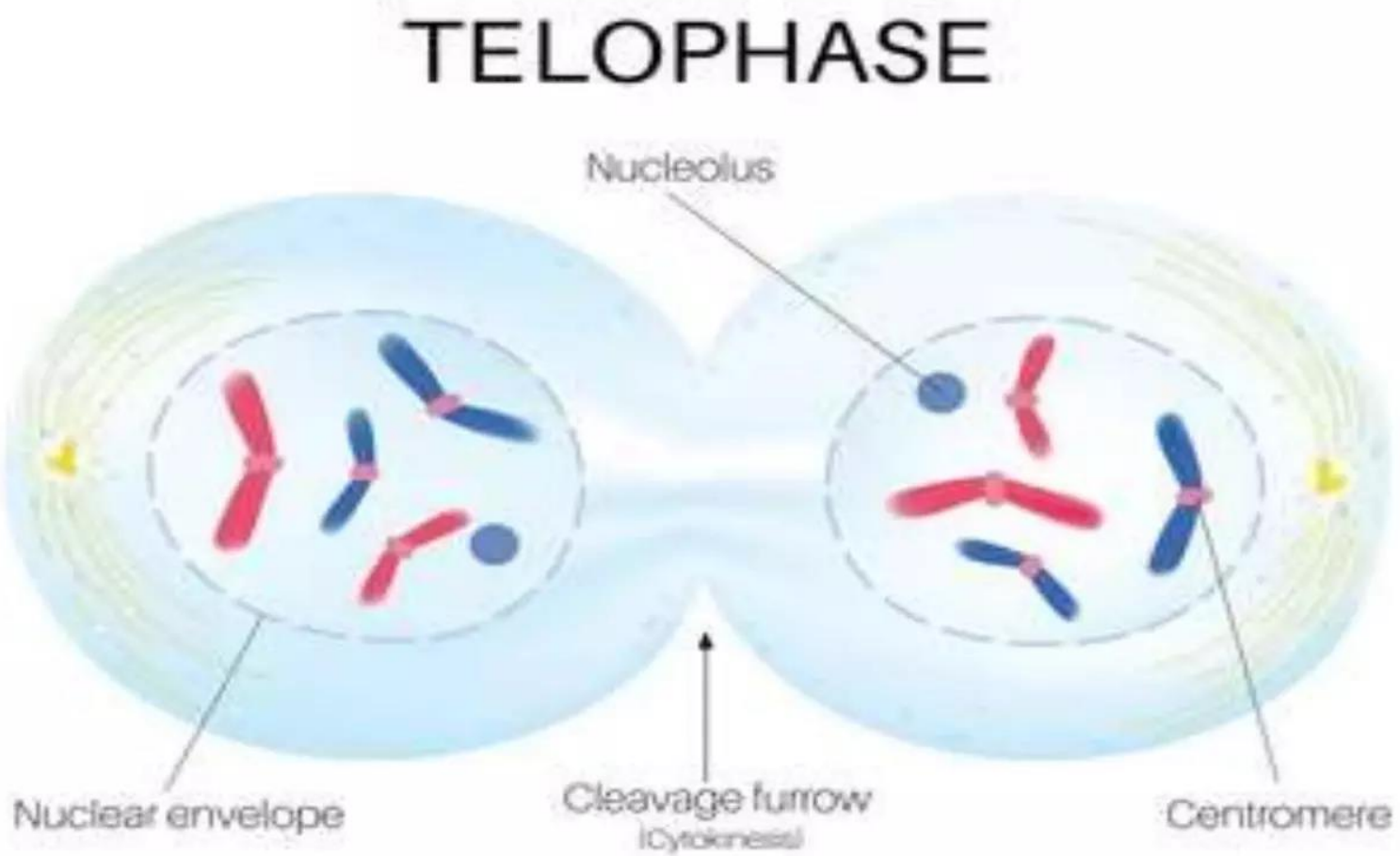
Anaphase

Chromosomes break at **centromeres**, and **sister chromatids** move to opposite ends of the cell

TELOPHASE

- (10 min)
- New nuclear membranes are formed around each of the two sets of 46 chromosomes.
- The spindle fibers disappear.
- Chromosomes become thinner.
- Cytoplasm starts dividing by contractile ring. At the end, we will have two diploid daughter cells, which are identical.

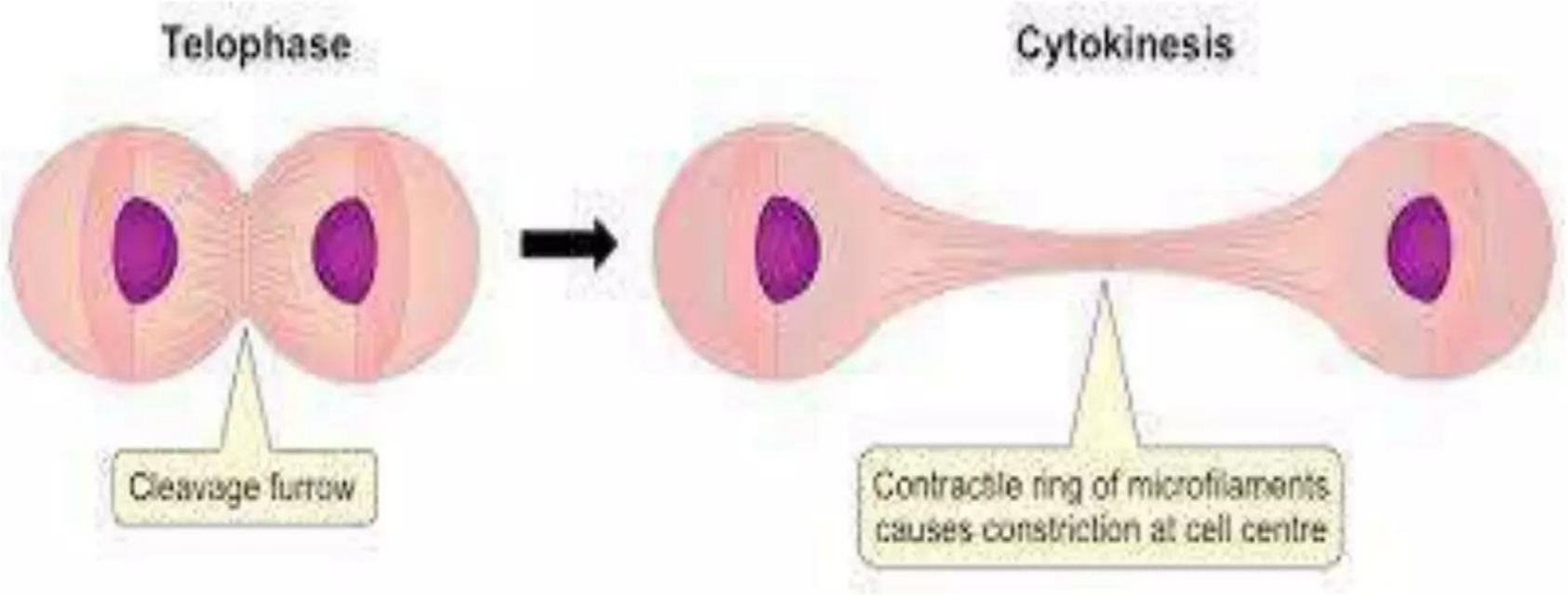
TELOPHASE


TELOPHASE
Nucleolus
Nuclear envelope
Cleavage furrow
(cytokinesis)
Centromere

CYTOKINESIS

- The division of the cytoplasm and organelles Begin in anaphase and completed by the end of telophase .
- This is the last stage of mitosis. It is the process of splitting the daughter cells apart.
- Each daughter cells contains the same number and same quality of chromosomes

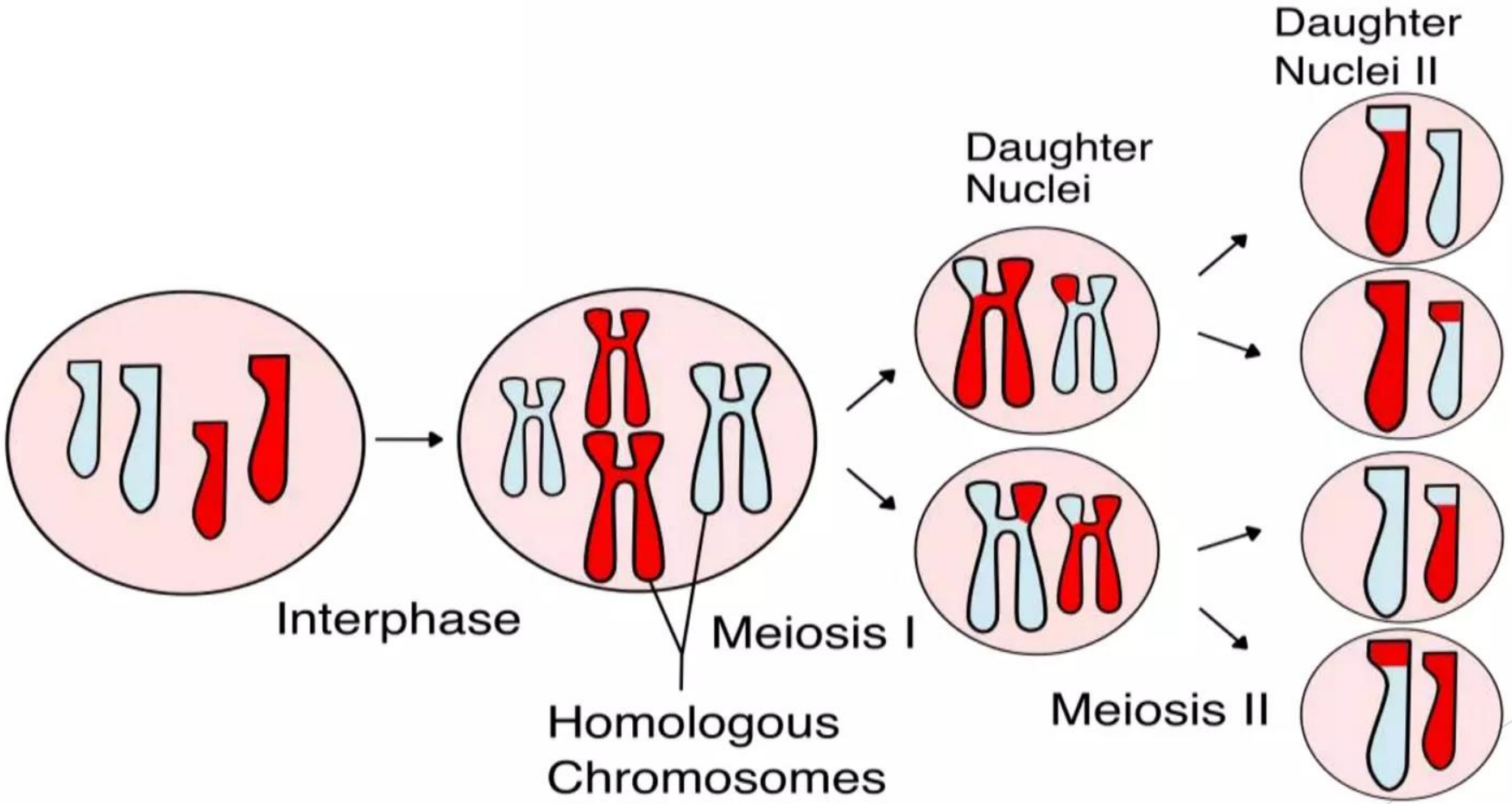
TELOPHASE


Telophase
Cytokinesis
Cleavage furrow
Contractile ring of microfilaments causes constriction at cell centre

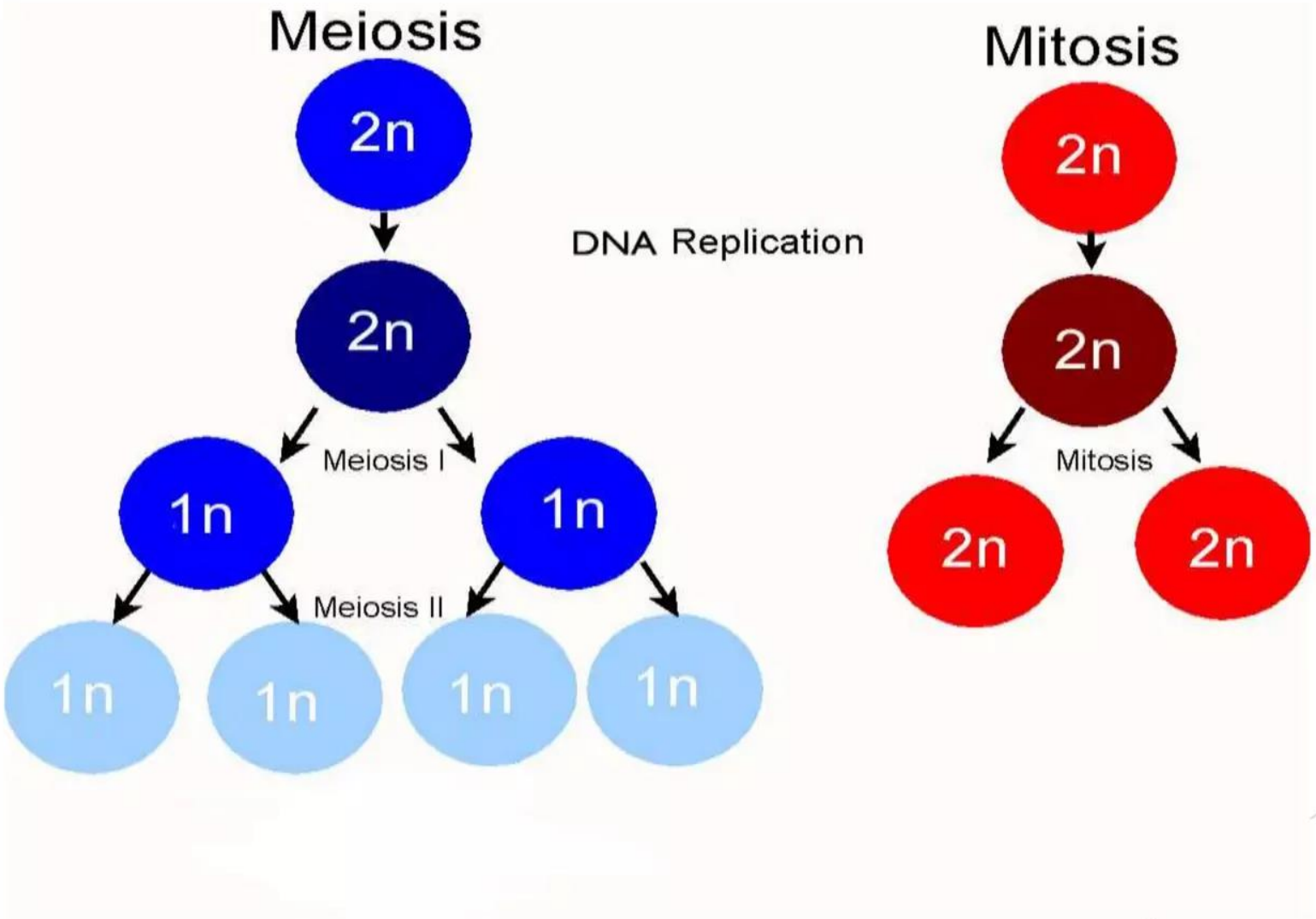
MEIOSIS

- It is defined as special form of germ cell division that produces reproductive cells in which each daughter cells receives half the number of chromosomes i.e. 23
- Site of Meiosis – Occurs in only in germ cell of the gonads
- Sperm in Males
- Ova in females

MEIOSIS


Daughter
Nuclei II
Daughter
Nuclei
Interphase
Meiosis I
Homologous
Chromosomes
Meiosis II

DIFFERENCE


Meiosis
2n
2n
Meiosis I
1n
1n
Meiosis II
1n
1n
1n
1n
DNA Replication
Mitosis
2n
2n
Mitosis
2n
2n

MEIOSIS STAGES

- Like Mitosis Interphase of the cell cycle includes G1,S,G2 Phases. Interphase is followed by Meiosis.

- Meiosis consists of two successive stages –
  - Meiosis I
  - Meiosis II

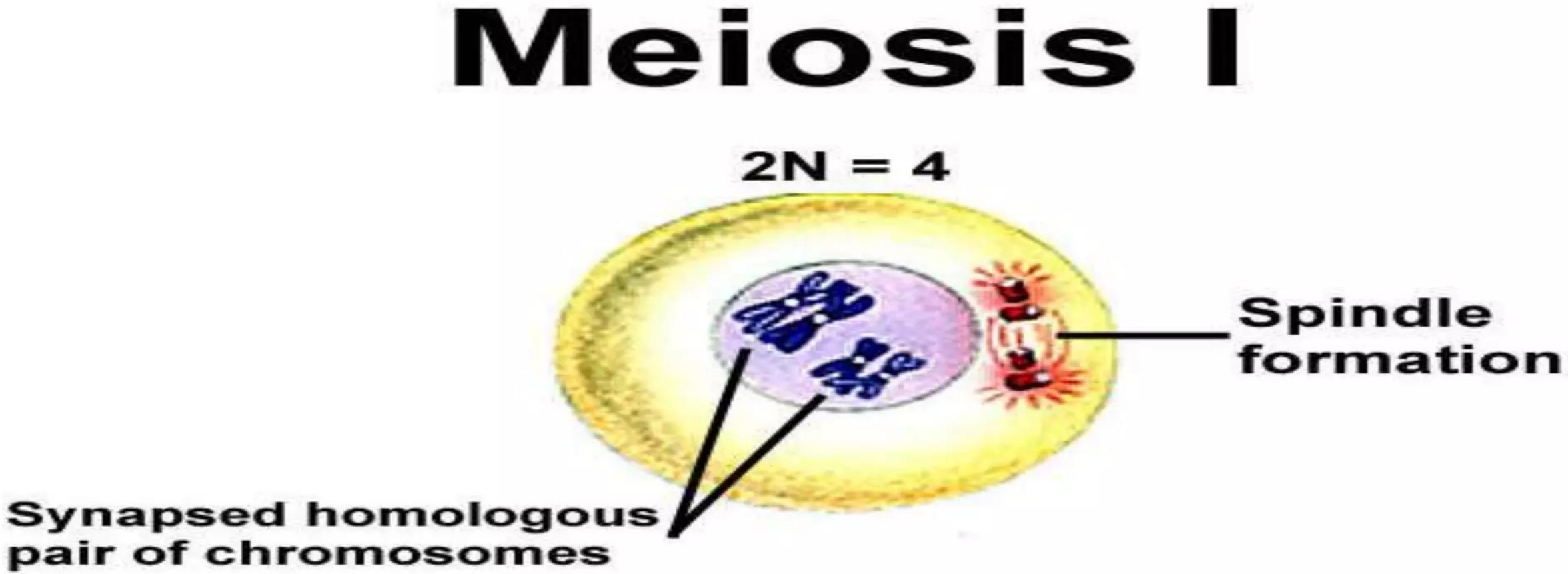
PHASES OF MEIOSIS I

- PROPHASE I
- METAPHASE I
- ANAPHASE I
- TELOPHASE I

PROPHASE I

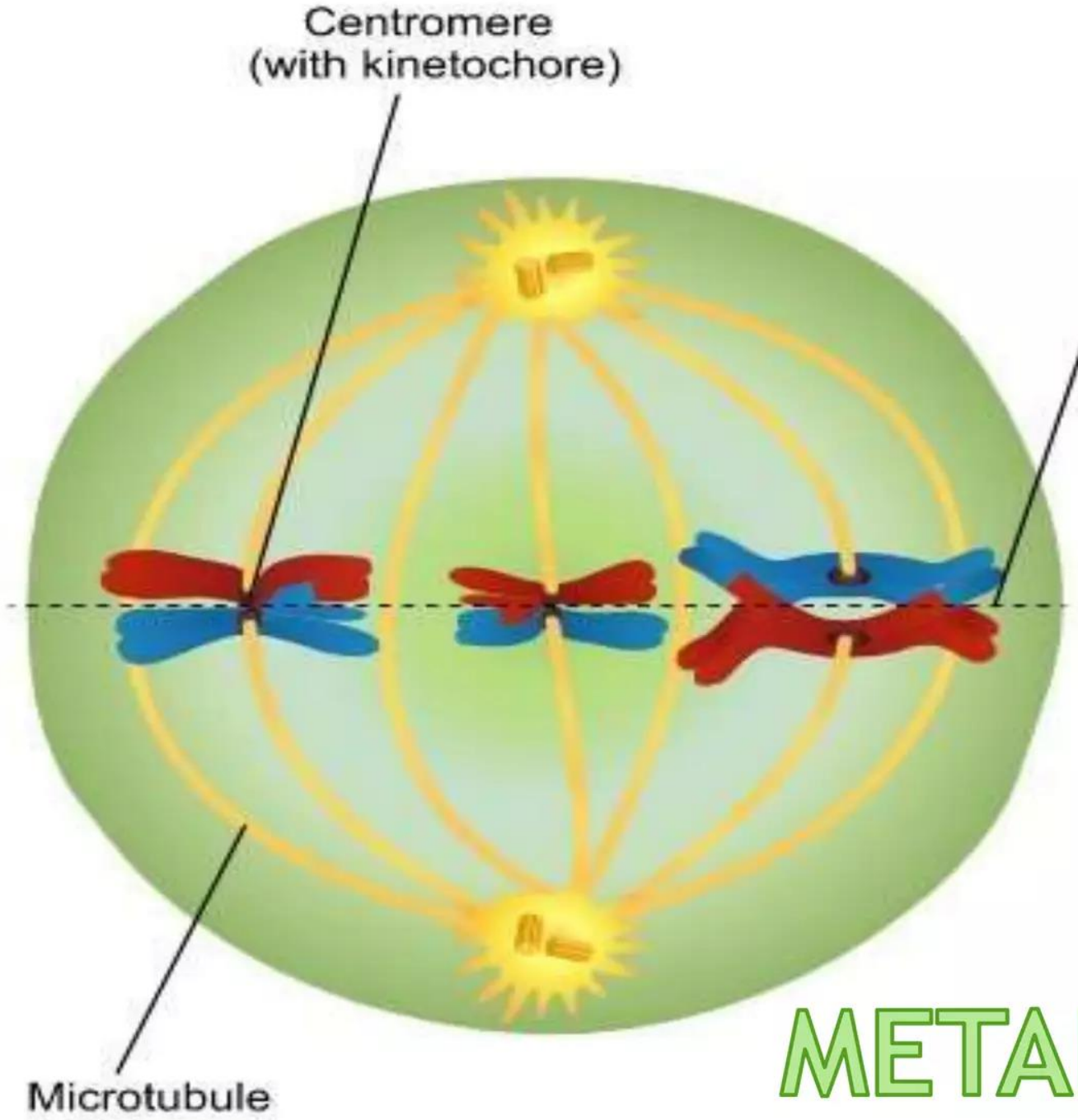
- During prophase I, DNA is exchanged between homologous chromosomes in a process called homologous recombination. This often results in chromosomal crossover.
- The paired and replicated chromosomes are called bivalents or tetrads.
- The process of pairing the homologous chromosomes is called synopsis.
- At this stage, non-sister chromatids may cross-over at points called chiasmata

PROPHASE I


Meiosis I
2N = 4
Spindle formation
Synapsed homologous pair of chromosomes
Prophase I

METAPHASE I

- Metaphase 1 is the second phase of Meiosis
- The tetrads from prophase I line up in the middle of the dividing cell randomly
- Spindle fibers attach to the tetrads from both ends of the cell 24

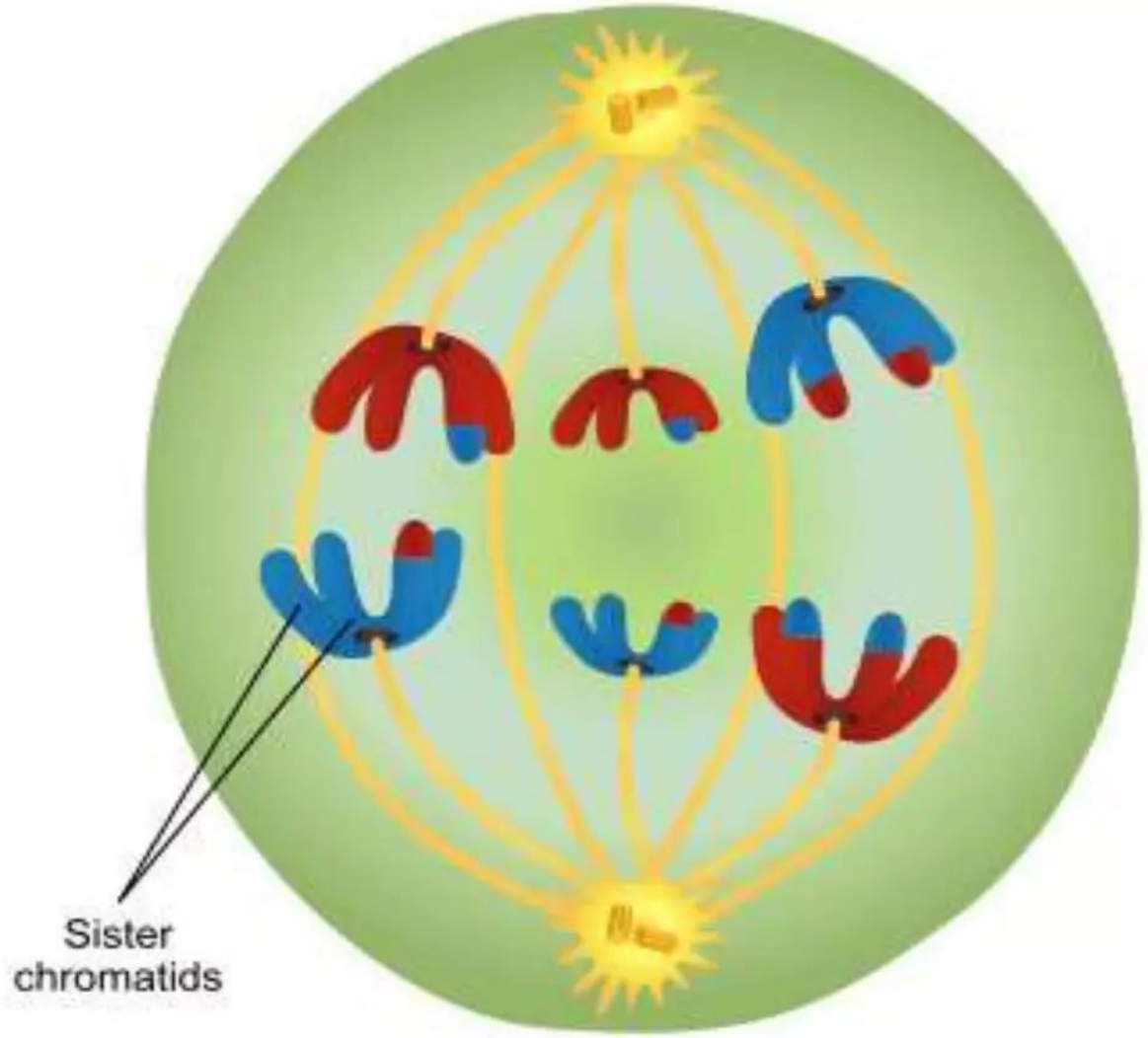

Centromere
(with kinetochore)
Metaphase
plate
Microtubule

METAPHASE I

ANAPHASE I

- Anaphase I begins when the two chromosomes of each bivalent separate and start moving toward opposite poles of the.

- In anaphase I the sister chromatids remain attached at their centromeres and move together toward the poles.

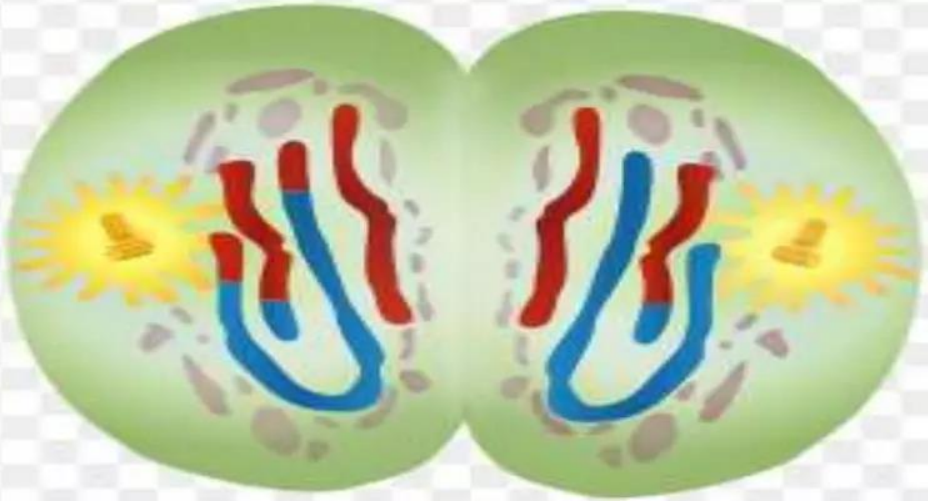


ANAPHASE I

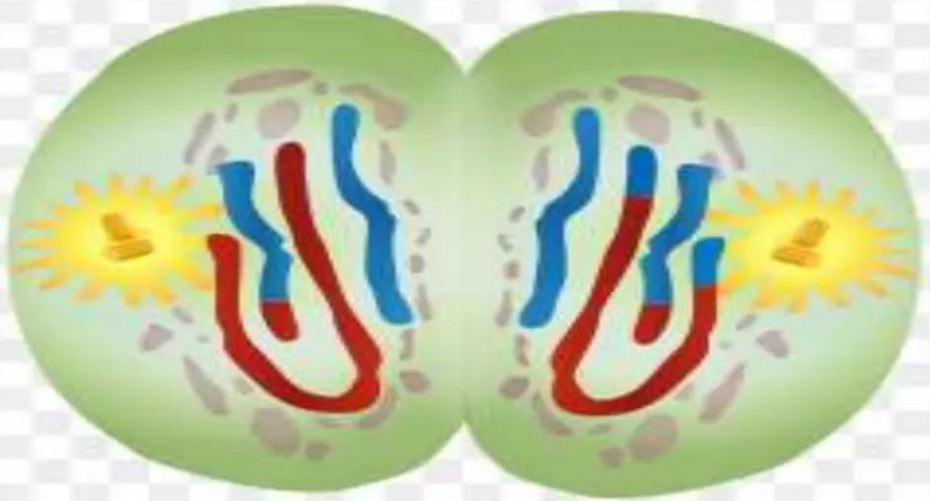
Homologous chromosomes move to the opposite poles of the cell.

TELOPHASE I

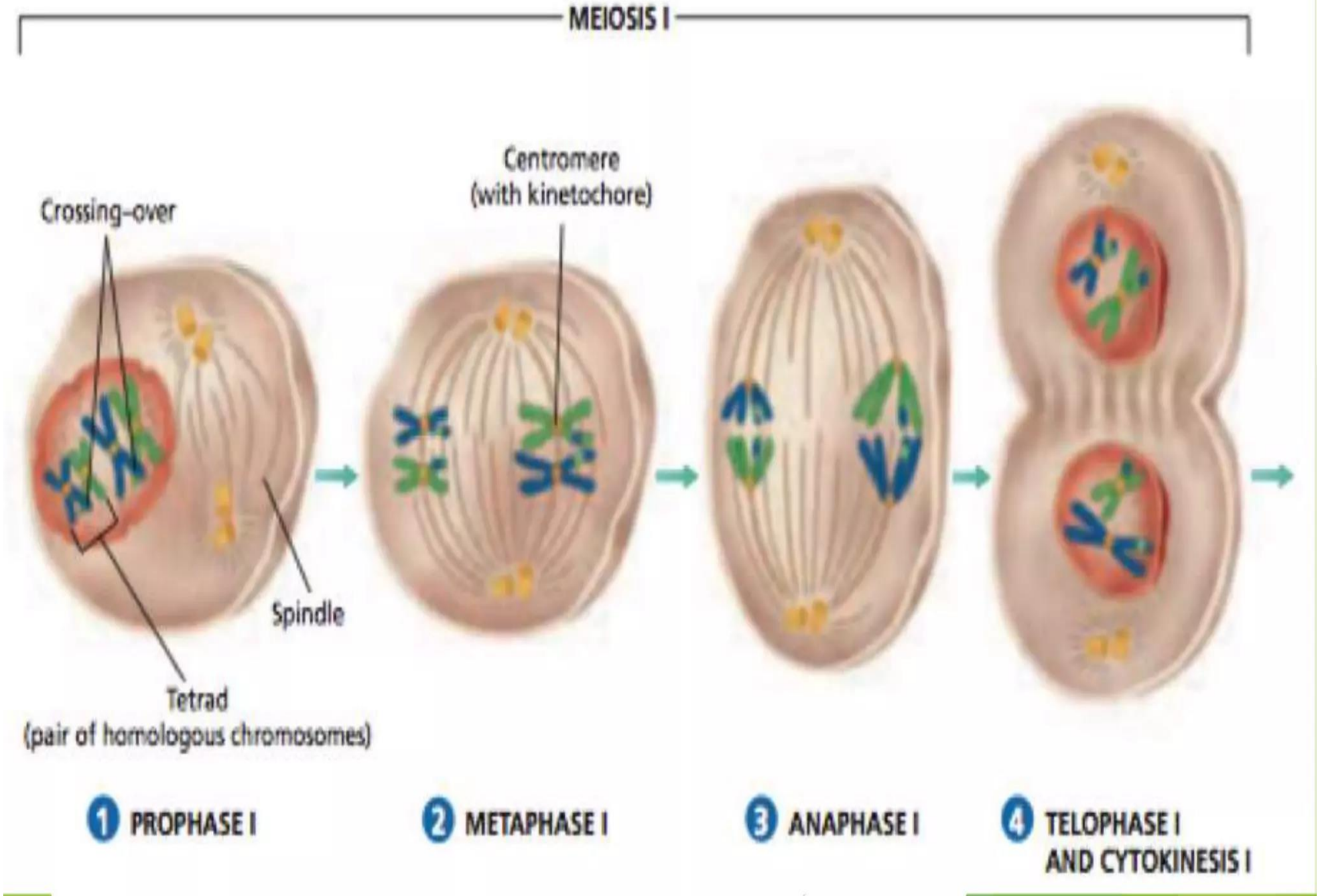
- The homologous chromosome pairs reach the poles of the cell.
- The homologous chromosome pairs complete their migration to the two poles
- A nuclear envelope reforms around each chromosome set, the spindle disappears, and cytokinesis follows



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



TELOPHASE I


MEIOSIS I
Crossing-over
Centromere
(with kinetochore)
Spindle
Tetrad
(pair of homologous chromosomes)
1 PROPHASE I
2 METAPHASE I
3 ANAPHASE I
4 TELOPHASE I
AND CYTOKINESIS I

MEIOSIS II

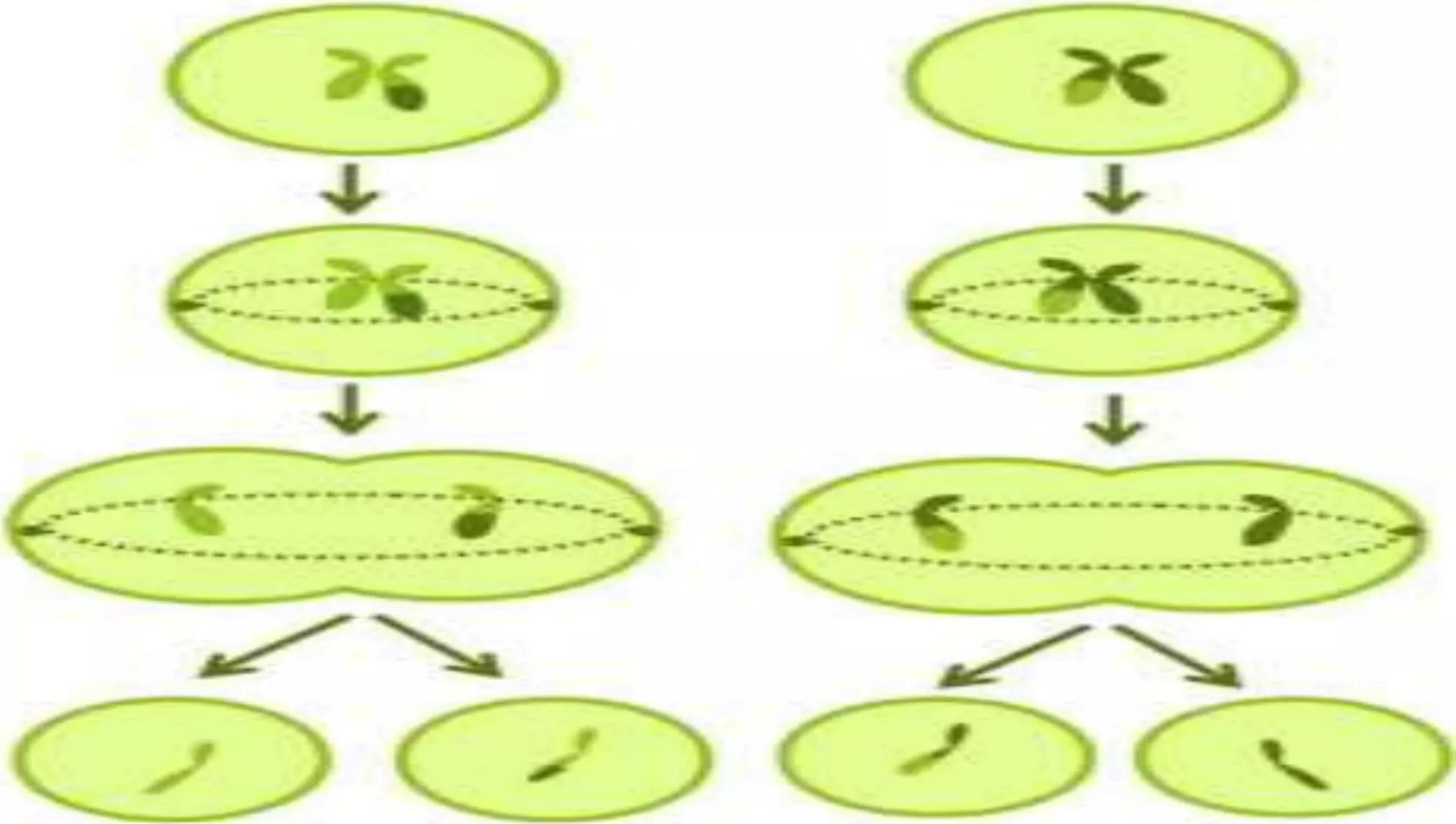
- The Second division in the meiotic process is termed as equational division because events in this phase are similar to those of mitosis.
- Meiosis II Differs from mitosis how ?
- Answer - Number of Chromosomes has already been halved in Meiosis I and the cell does not begin with the same number of chromosomes as it does in Mitosis

PHASES OF MEIOSIS II

- Mitotic division of 2 haploid cells to produce 4 haploid daughter cells.

- Prophase -2
- Metaphase -2
- Anaphase 2
- Telophase

Meiosis II



Difference Between Mitosis & Meiosis

Mitosis	Meiosis
Occurs in body cells	Occurs in reproductive cells
Number of chromosomes remains the same in the daughter cells	Number of chromosomes is halved in the daughter cells
Daughter cells are identical to parent cells and each other	Daughter cells are genetically different to the parent cells and each other
Two daughter cells are formed	Four daughter cells are formed
Homologous chromosomes do not come together	Homologous chromosomes come together
There is no exchange of genetic material between Chromosomes	There is exchange of genetic material between chromosomes