Cell Division

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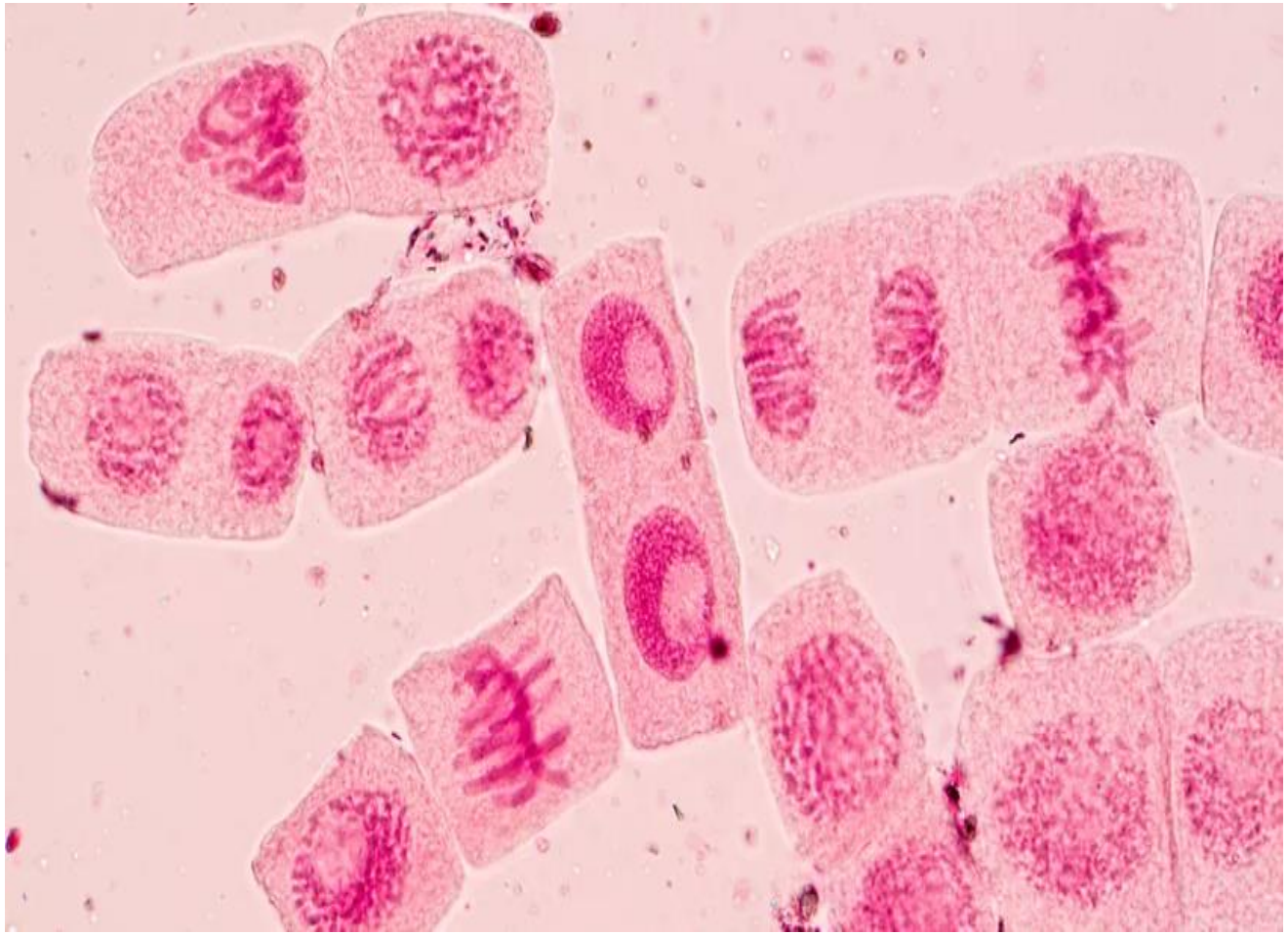
Cell Division

Cell division happens when a parent cell divides into two or more cells called daughter cells. Cell division usually occurs as part of a larger cell cycle. All cells reproduce by splitting into two, where each parental cell gives rise to two daughter cells.



Types of cell division

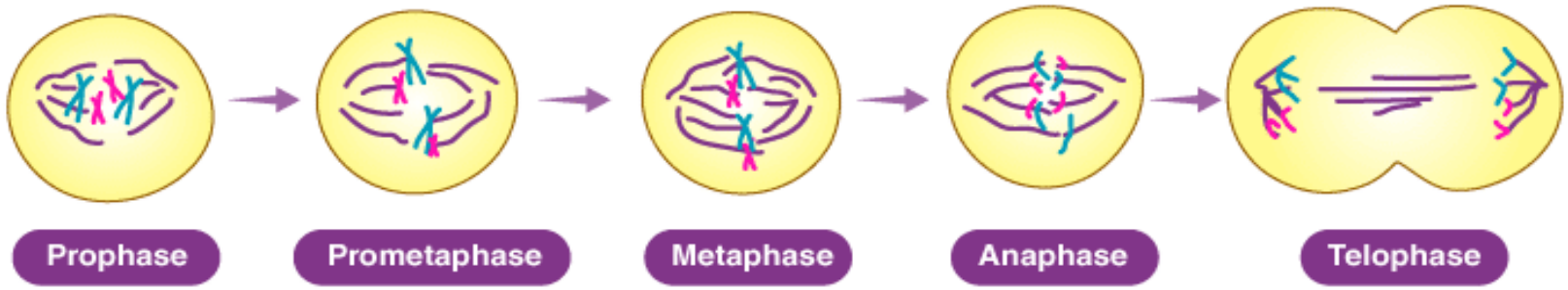
1. **Mitosis:** The process cells use to make exact replicas of themselves. Mitosis occurs in somatic cells. Mitosis is observed in almost all the body's cells, including eyes, skin, hair, and muscle cells. The resultant number of cells in mitosis is twice the number of original cells. The number of chromosomes in the daughter cells is the same as that of the parent cell.

2. **Meiosis:** In this type of cell division, meiosis occurs in gametes. sperm or egg cells are produced instead of identical daughter cells as in mitosis. The resultant number of cells is Meiosis is four times the number of original cells. This results in cells with half the number of chromosomes present in the parent cell. A diploid cell duplicates itself, then undergoes two divisions, in the process forming four haploid cells. This process occurs in two phases, meiosis I and meiosis II.

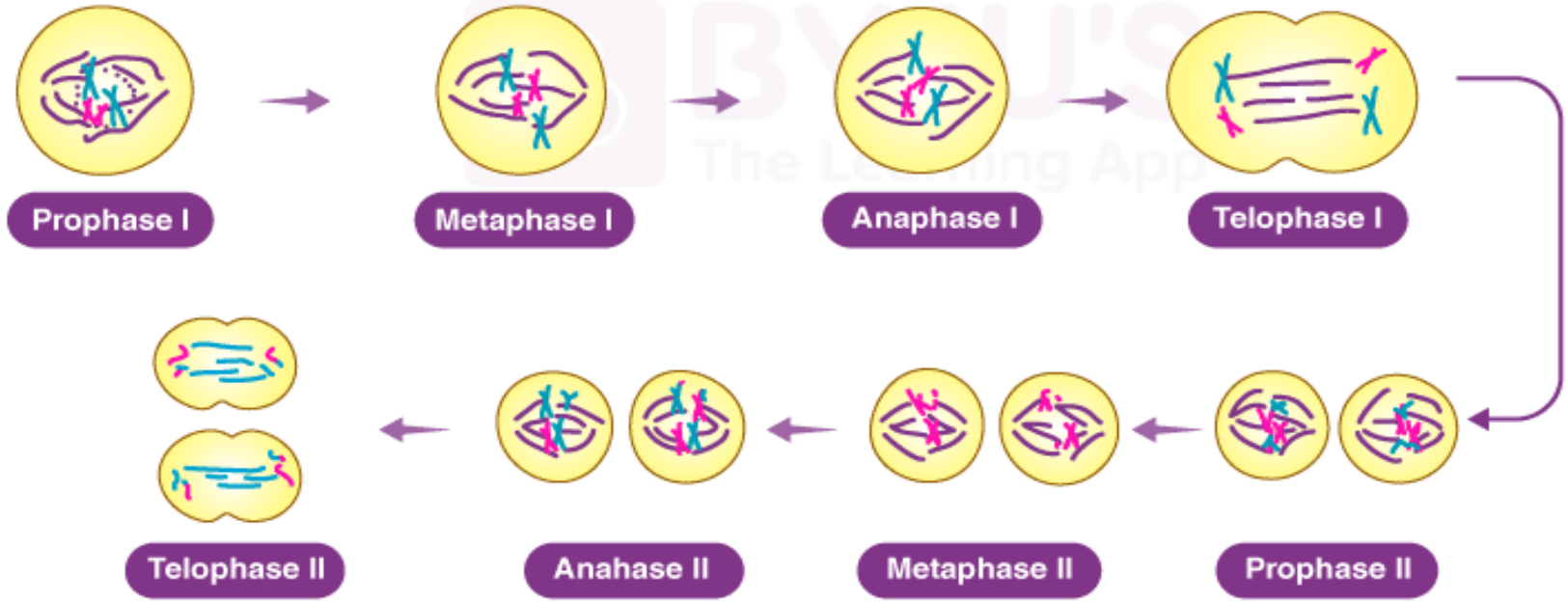
Mitosis and meiosis are an integral part of cell division. Mitosis occurs in somatic cells, while meiosis occurs in gametes.

TYPES OF CELL DIVISION

MITOSIS



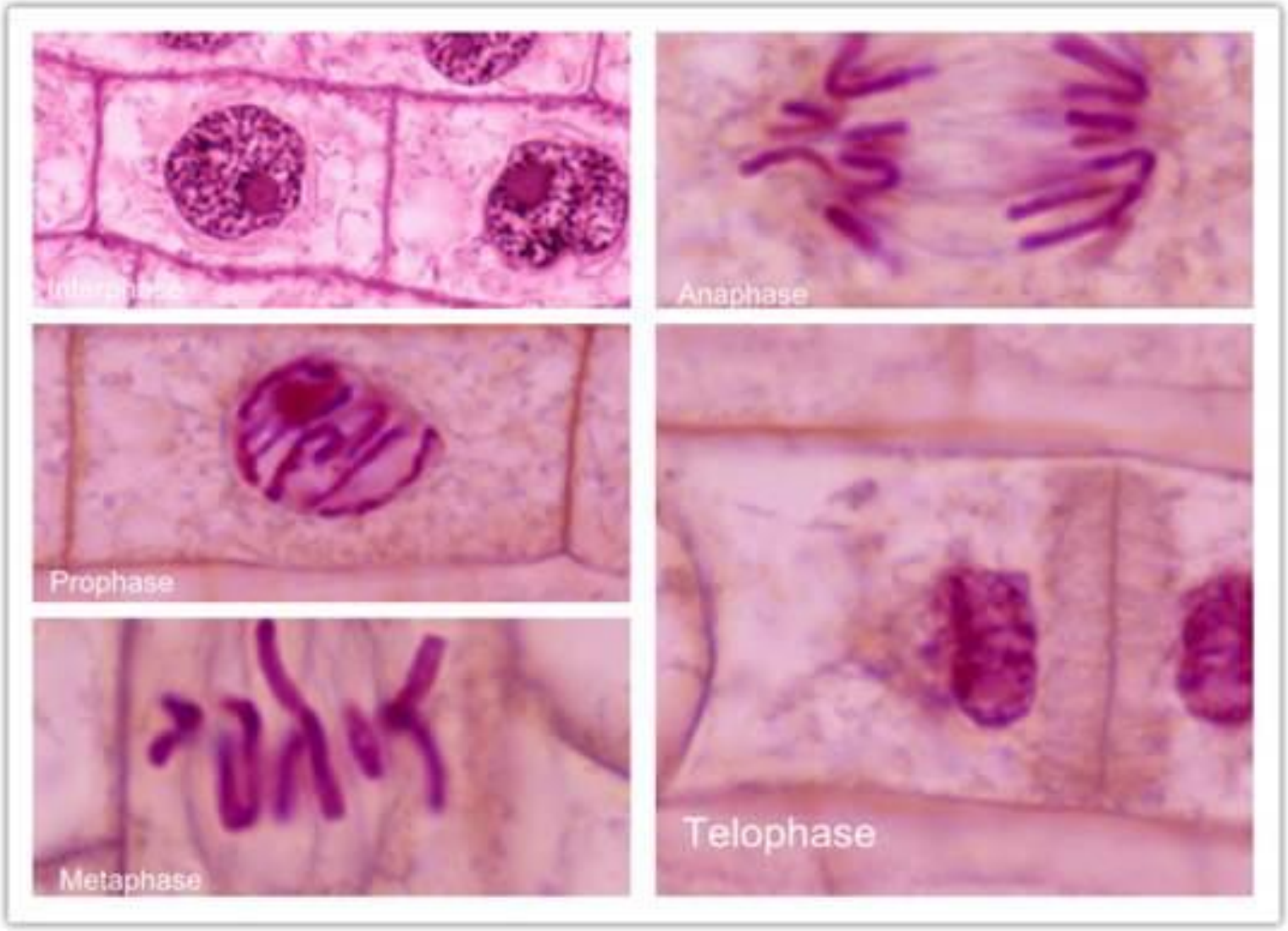
MEIOSIS



A. Mitosis

The Stages of Mitosis

1. **Interphase**
2. **Prophase**
3. **Metaphase**
4. **Anaphase**
5. **Telophase**
6. **Cytokinesis**

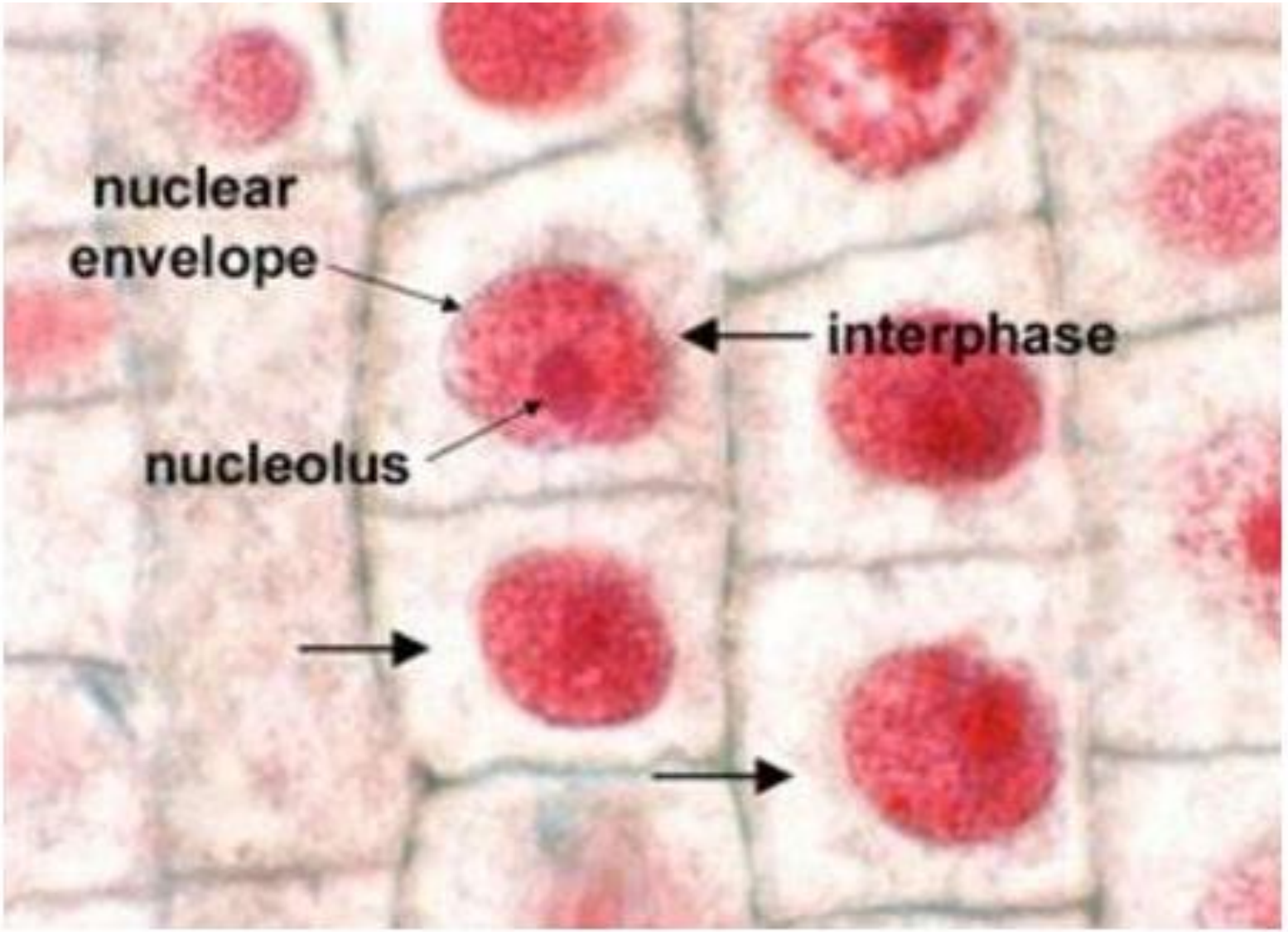


1. Interphase

Before entering mitosis, a cell spends a period of its growth under interphase. It undergoes the following phases when in interphase:

- **G1 Phase:** This is the period before the synthesis of DNA.
- **S Phase:** This is the phase during which DNA synthesis takes place.
- **G2 Phase:** This is the phase between the end of DNA synthesis and the beginning of the prophase.

Interphase

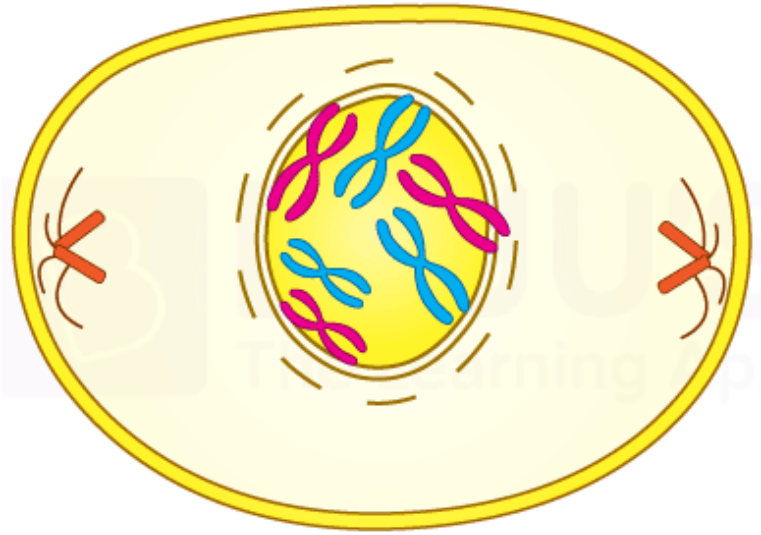


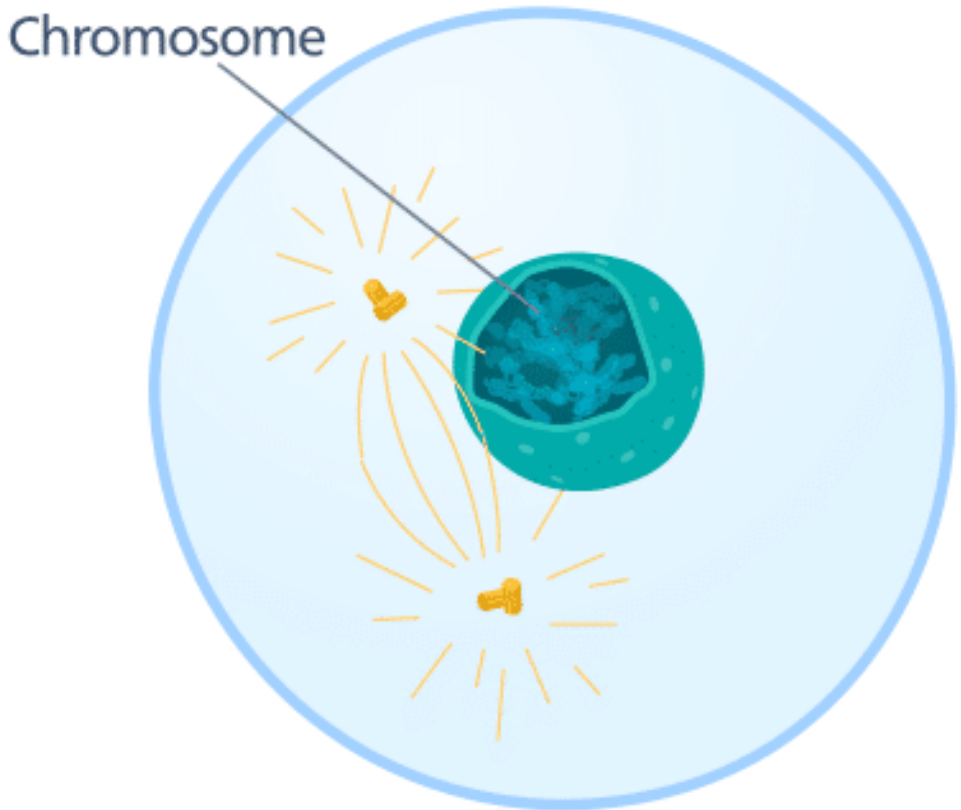
2. Prophase

- **Prophase immediately follows the S and G2 phases of the cycle and is marked by condensation of the genetic material to form compact mitotic chromosomes composed of two chromatids attached at the centromere.**

- **The completion of the prophase is characterized by the initiation of the assembly of the mitotic spindle, the microtubules and the proteinaceous components of the cytoplasm that help in the process. The nuclear envelope starts disintegrating.**

- **The longest phase of mitosis is prophase. During prophase chromatin shorten & condenses into chromosomes, the centrioles near the nucleus begin to separate and move to opposite poles (sides) of the cell.**





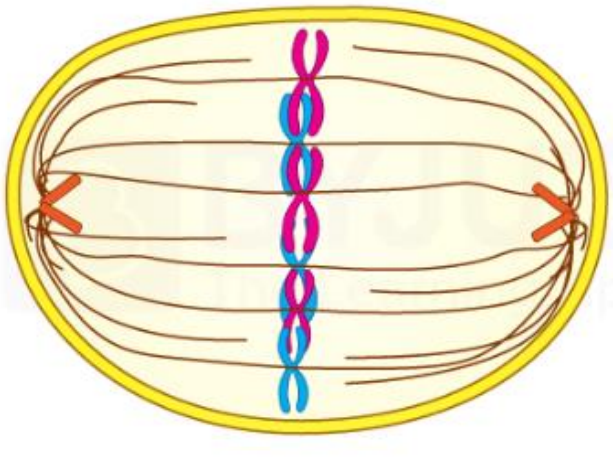
Prophase

Chromatin condenses into **chromosomes**

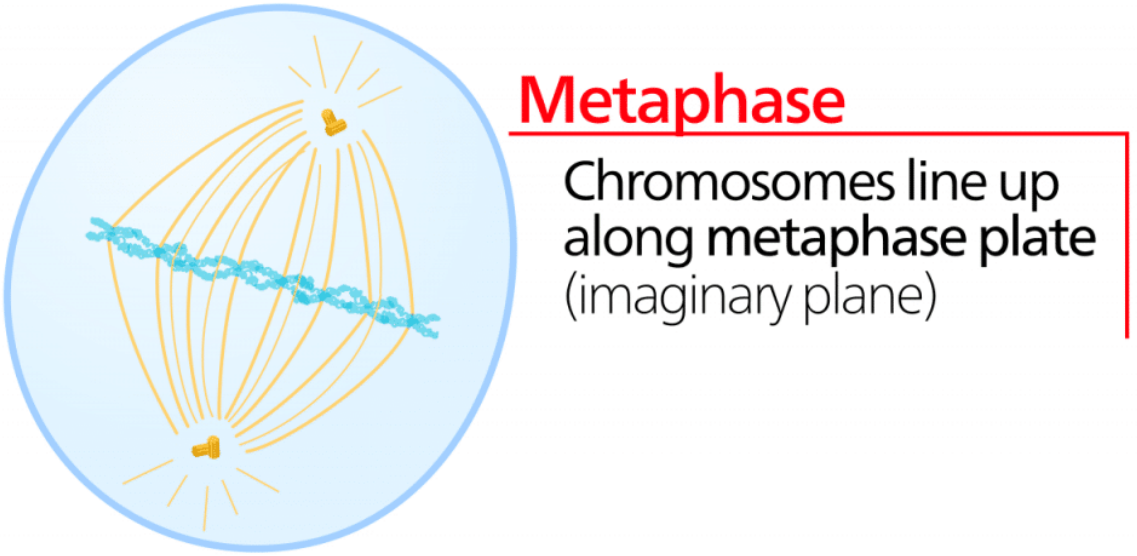
Nucleolus disappears

3. Metaphase

At this stage, the microtubules start pulling the chromosomes with equal force and the chromosome ends up in the middle of the cell. This region is known as the metaphase plate. Thus, each cell gets an entire functioning genome.

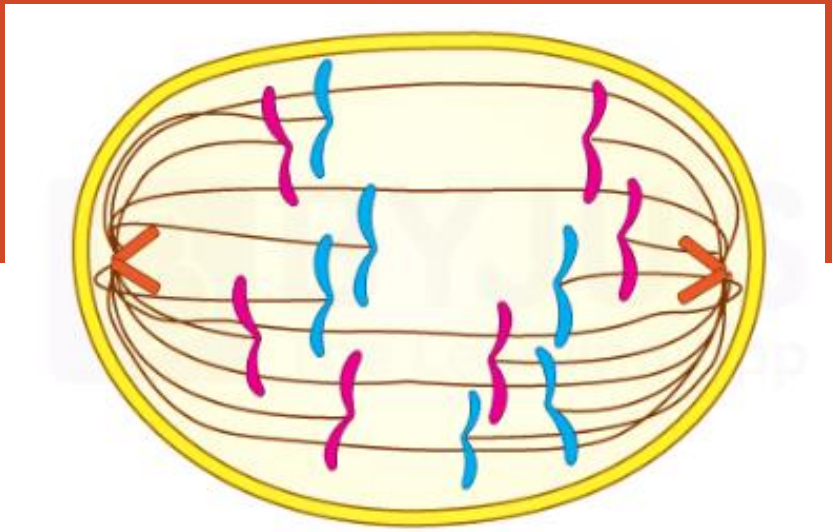


Metaphase

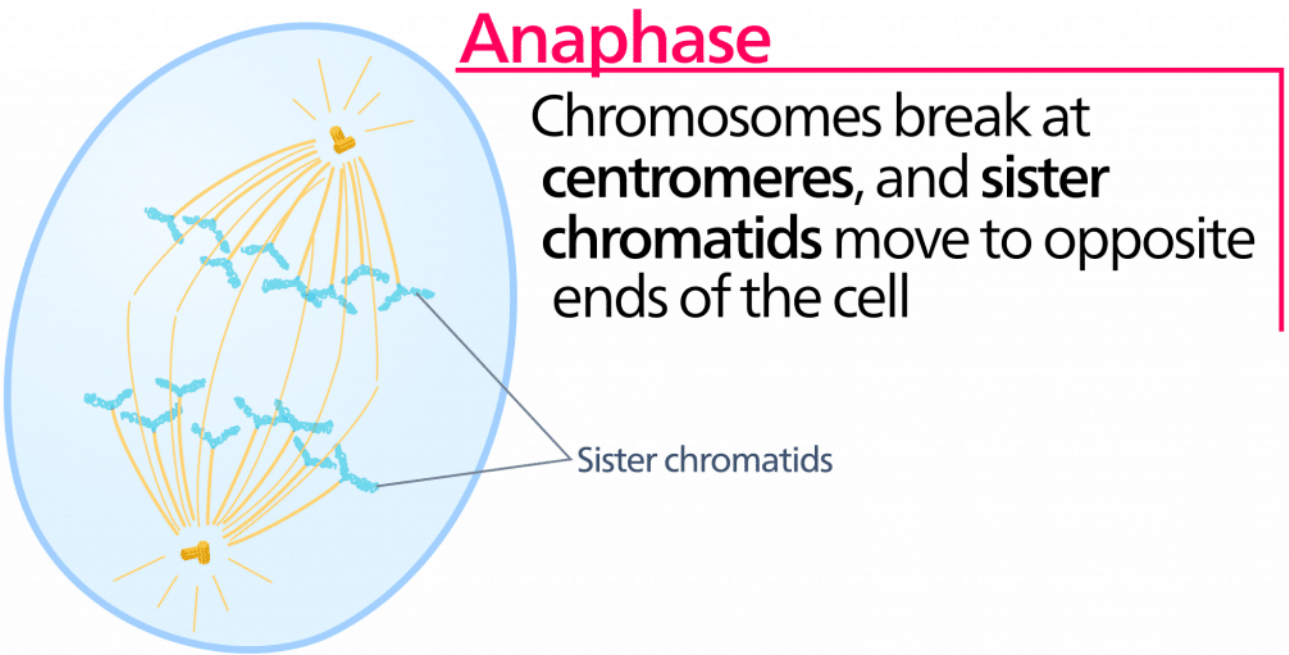


4. Anaphase

The splitting of the sister chromatids marks the onset of anaphase. These sister chromatids become the chromosome of the daughter nuclei. The chromosomes are then pulled towards the pole by the fibres attached to the kinetochores of each chromosome. The centromere of each chromosome leads at the edge while the arms trail behind it.

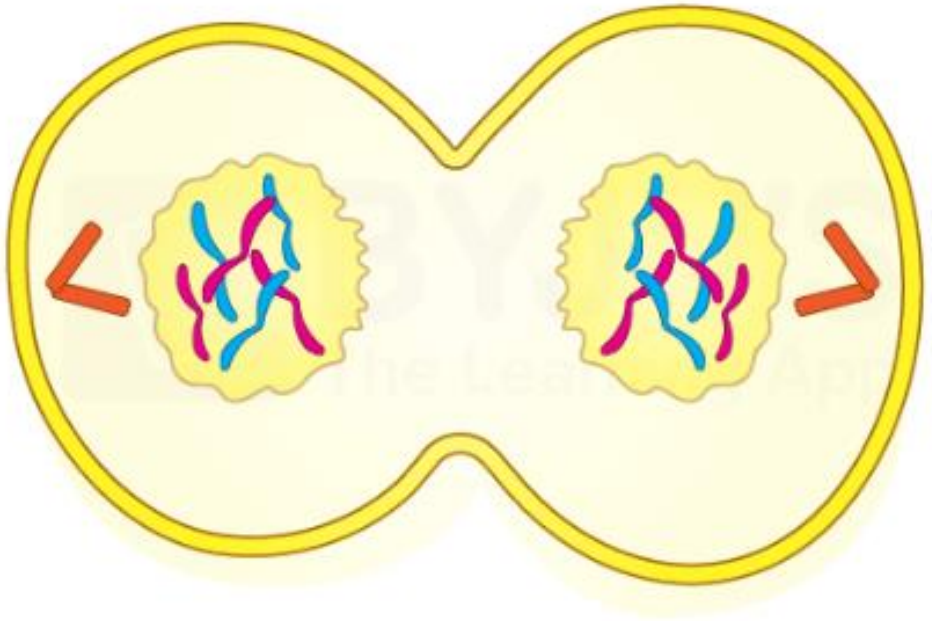


Anaphase



5. Telophase

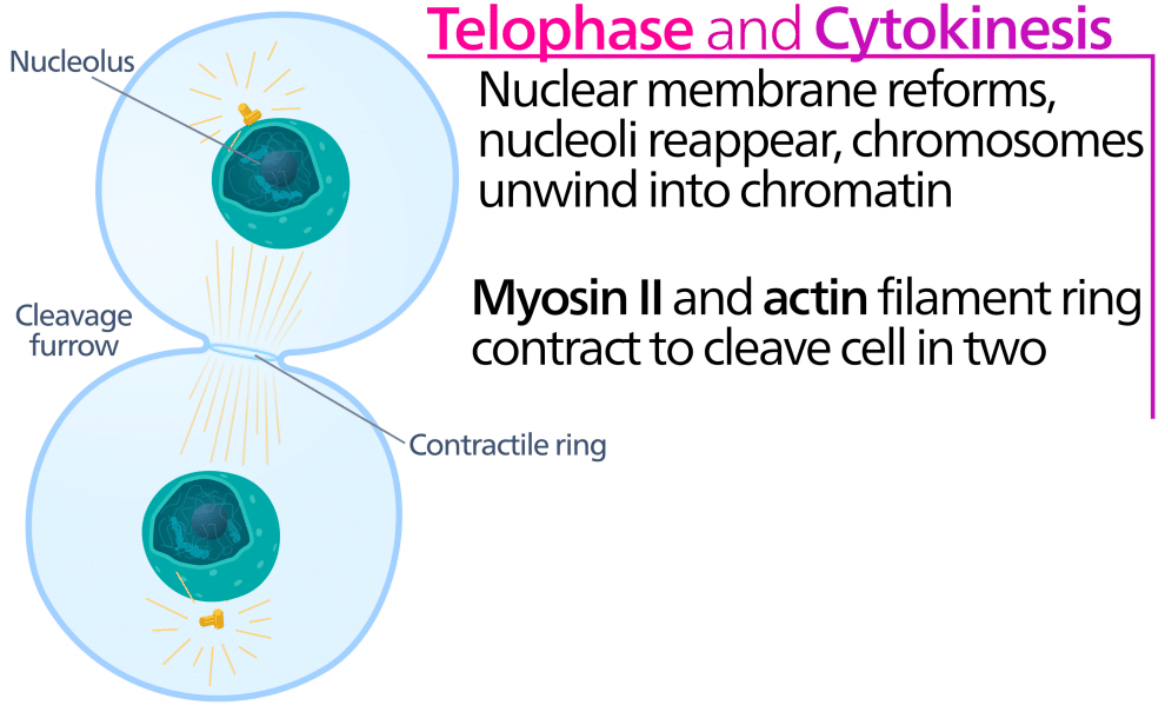
The chromosomes that cluster at the two poles start coalescing into an undifferentiated mass, as the nuclear envelope starts forming around it. The nucleolus, Golgi bodies and ER complex, which had disappeared after prophase start to reappear.



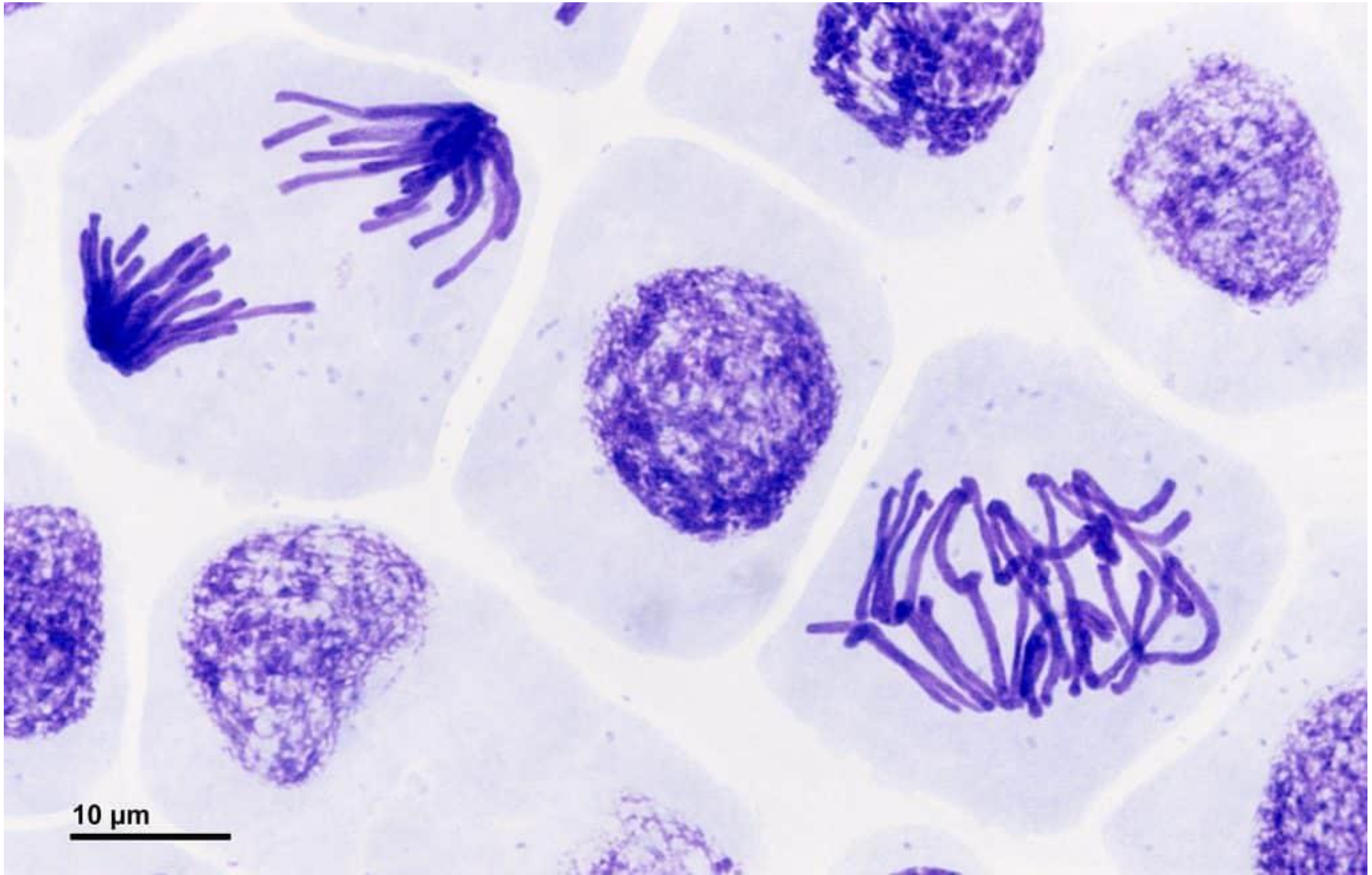
Telophase

6. Cytokinasis

- **This is the last stage of mitosis. It is the process of splitting the daughter cells apart.**
- **Cytokinesis is the division of the cytoplasm to form two new cells.**
- **This stage actually begins between anaphase and telophase, however, doesn't finish until after telophase. To separate the two cells, a ring of protein (actin ring) pinches the cytoplasm along a crease known as a cleavage furrow. This splits the cytoplasm equally between the two cells.**



Microscope image of cells in various stages of mitosis



B. Meiosis

Stages of Meiosis

1. **Meiosis I**

2. **Meiosis II**

Meiosis I

The first meiotic division is a reduction division (diploid → haploid) in which homologous chromosomes are separated

1. **Prophase I** (**P-I):** Chromosomes condense, nuclear membrane dissolves, homologous chromosomes form bivalents, crossing over occurs

2. **Metaphase I (M-I):** Spindle fibres from opposing centrosomes connect to bivalents (at centromeres) and align them along the middle of the cell

3. **Anaphase I** (**A-I):** Spindle fibres contract and split the bivalent, homologous chromosomes move to opposite poles of the cell

4. **Telophase I** (**T-I):** Chromosomes decondense, nuclear membrane *may* reform, cell divides (cytokinesis) to form two haploid daughter cells

Meiosis II

The second division separates sister chromatids (these chromatids may not be identical due to crossing over in prophase I)

1. **Prophase II (P-II):** Chromosomes condense, nuclear membrane dissolves, centrosomes move to opposite poles (perpendicular to before)

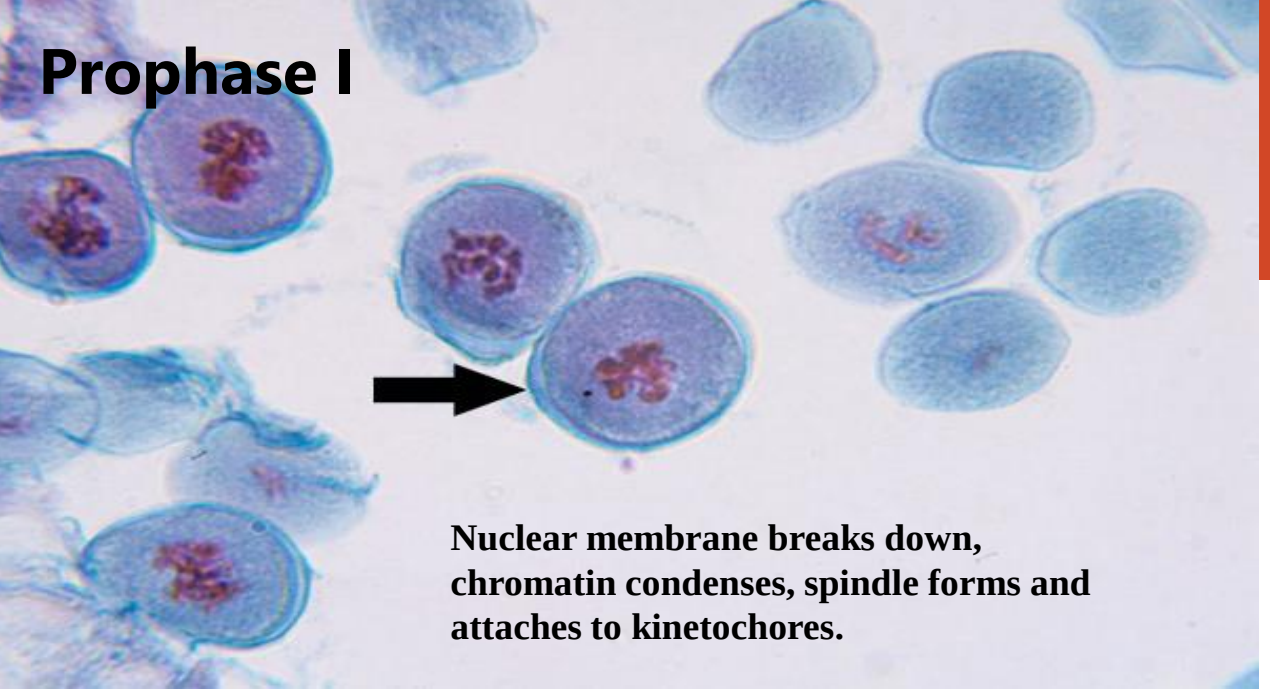
2. **Metaphase II (M-II):** Spindle fibres from opposing centrosomes attach to chromosomes (at centromere) and align them along the cell equator

3. **Anaphase II (A-II):** Spindle fibres contract and separate the sister chromatids, chromatids (now called chromosomes) move to opposite poles

4. **Telophase II (T-II):** Chromosomes decondense, nuclear membrane reforms, cells divide (cytokinesis) to form four haploid daughter cells

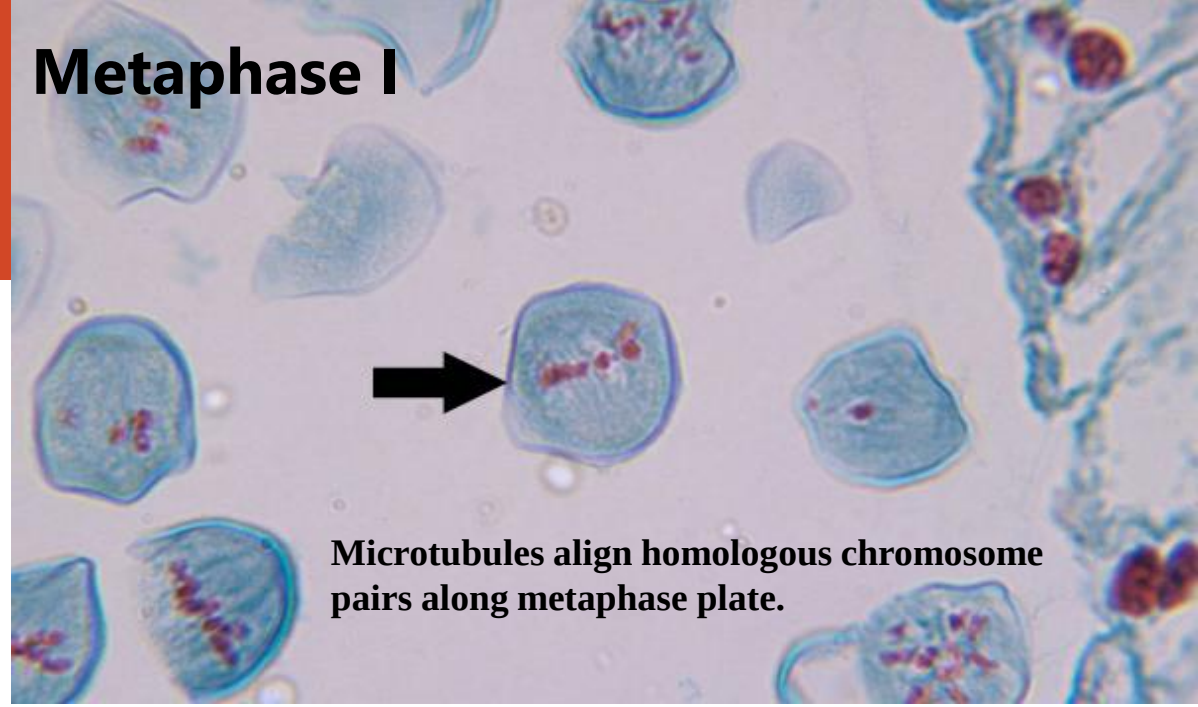
The final outcome of meiosis is the production of four haploid daughter cells

Prophase I



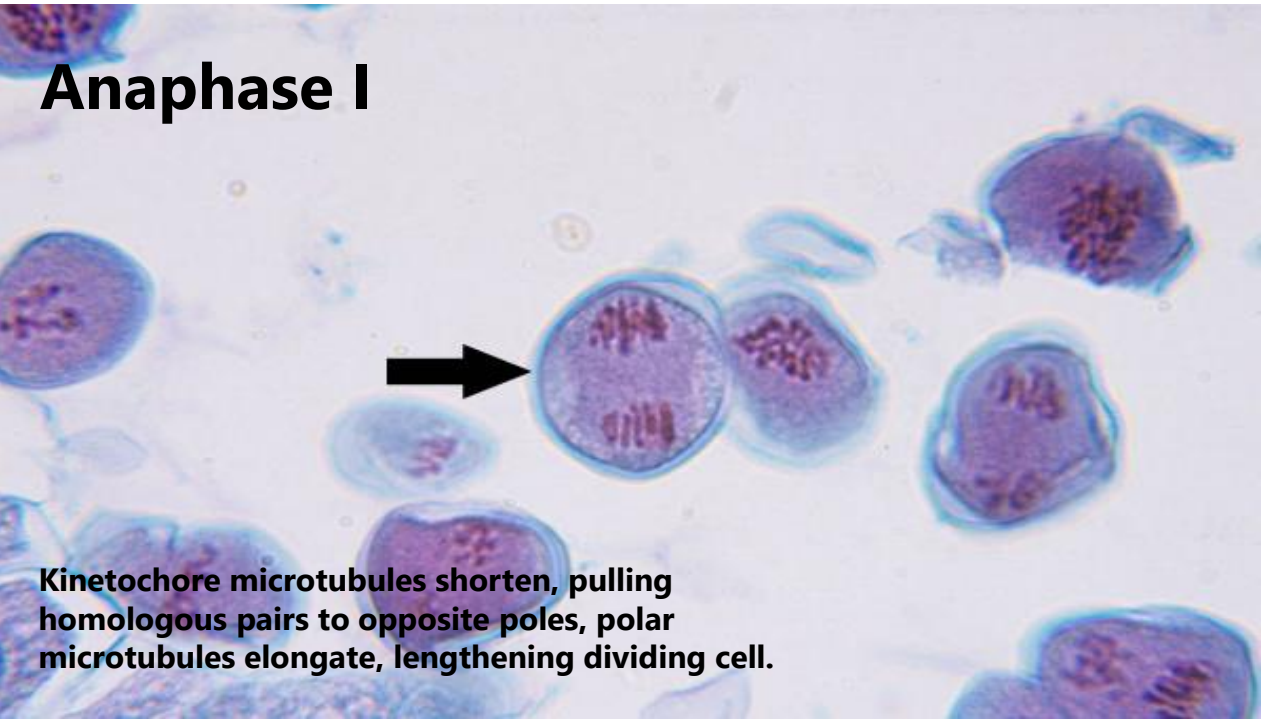
Nuclear membrane breaks down, chromatin condenses, spindle forms and attaches to kinetochores.

Metaphase I



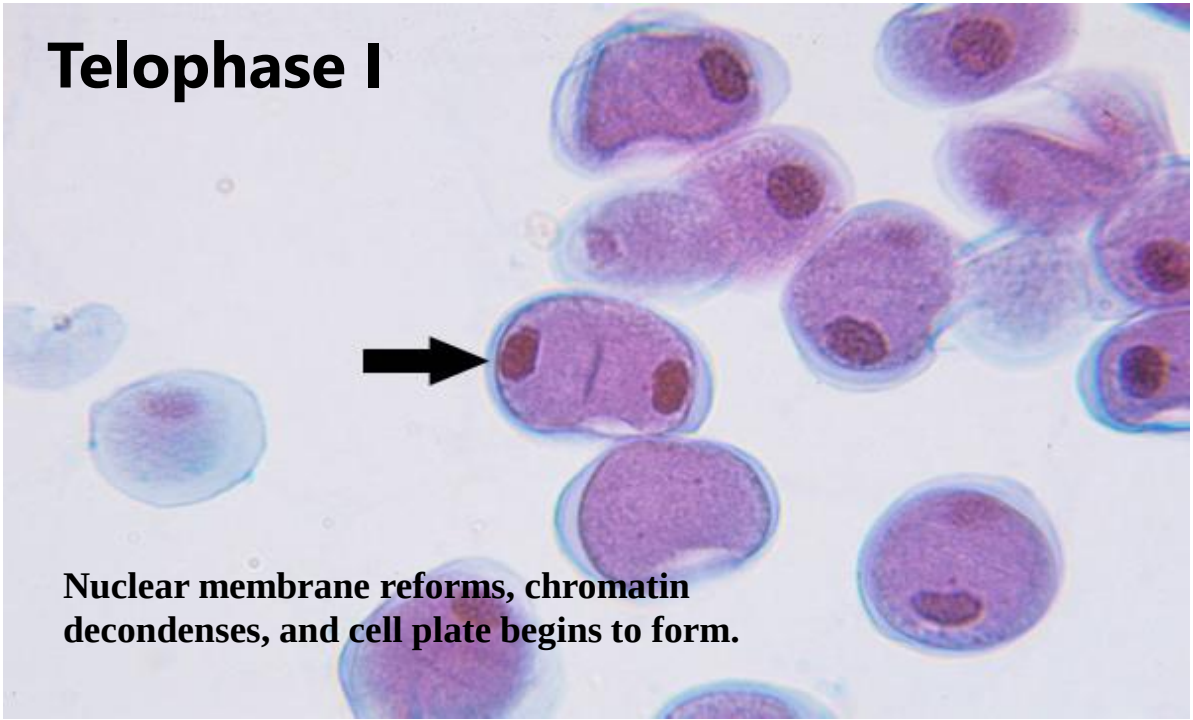
Microtubules align homologous chromosome pairs along metaphase plate.

Anaphase I



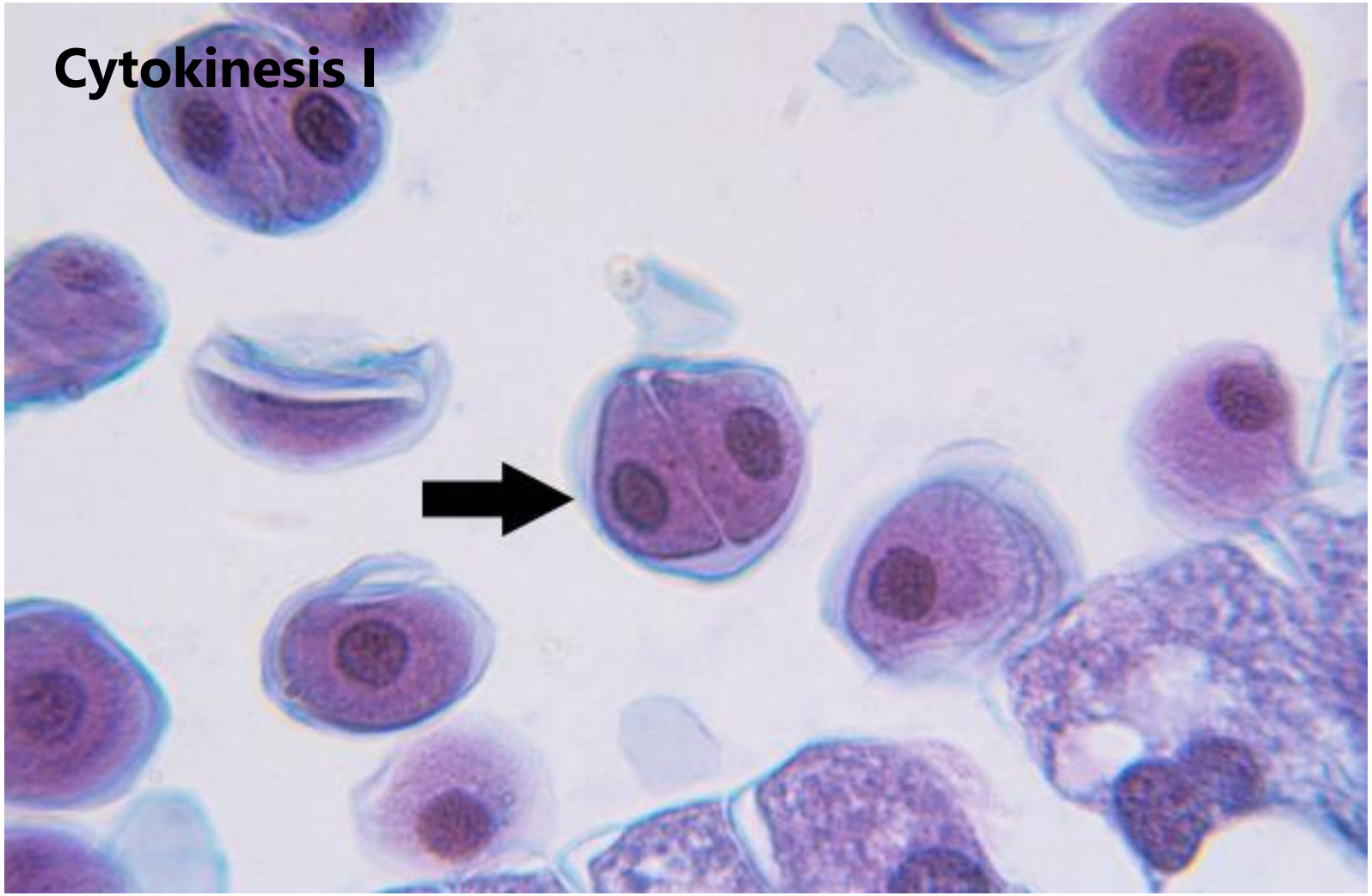
Kinetochore microtubules shorten, pulling homologous pairs to opposite poles, polar microtubules elongate, lengthening dividing cell.

Telophase I



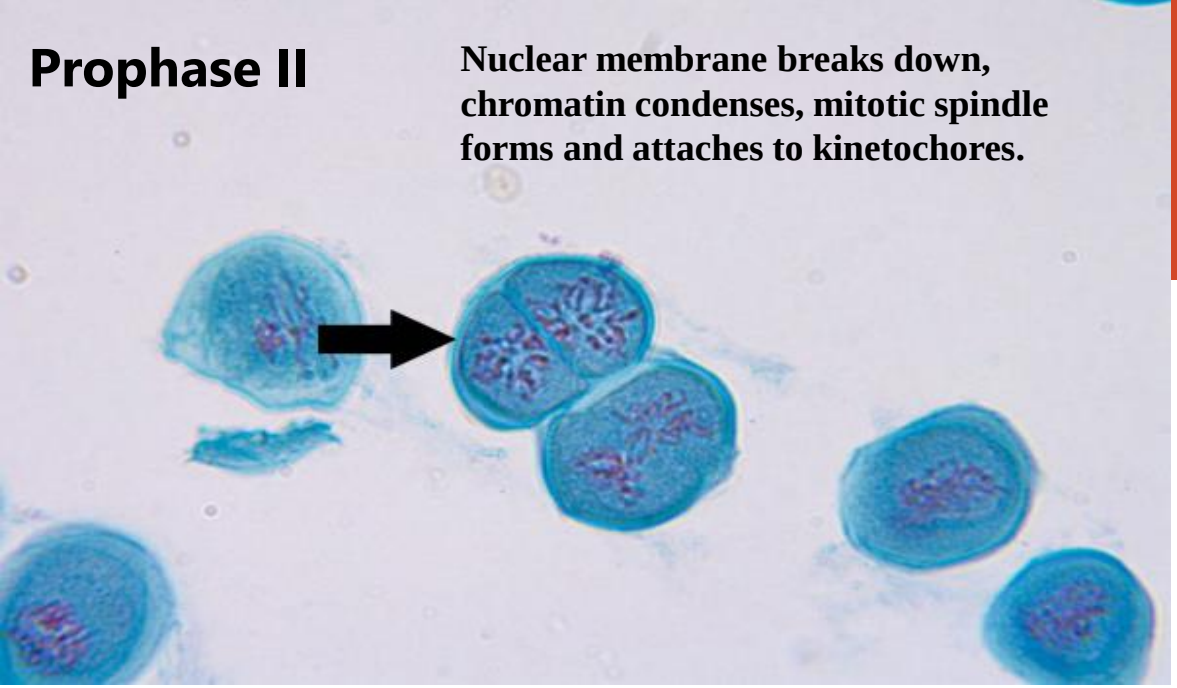
Nuclear membrane reforms, chromatin decondenses, and cell plate begins to form.

Cytokinesis I



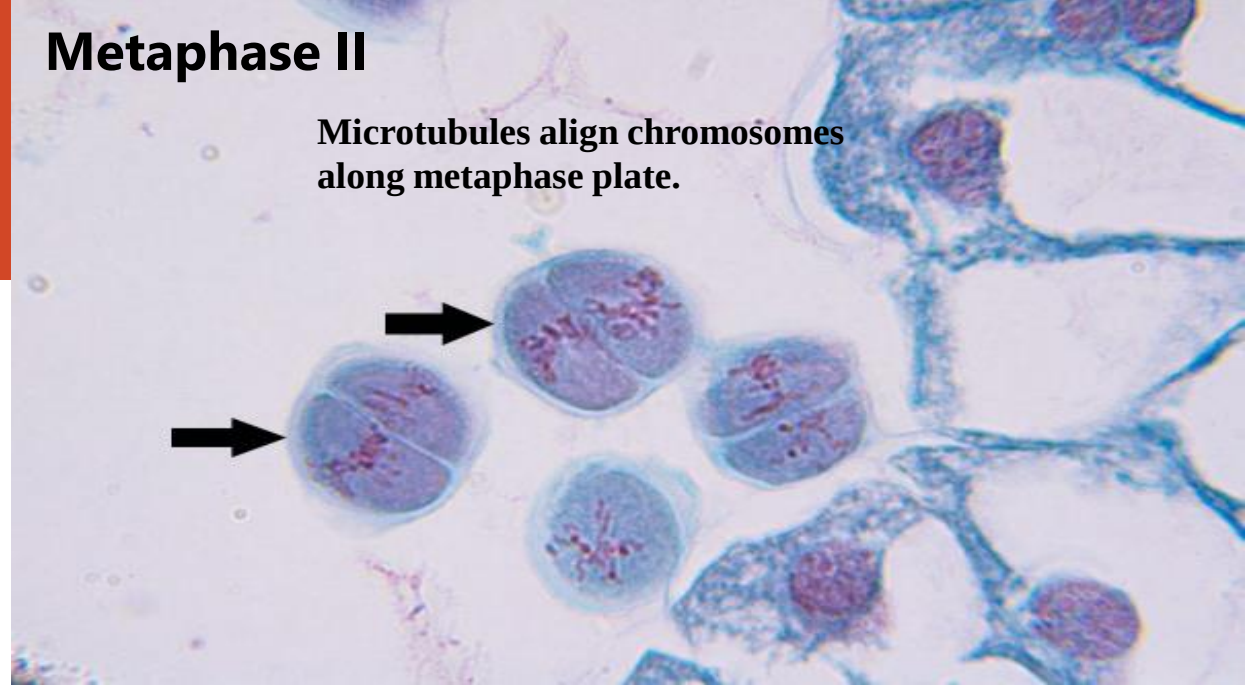
Prophase II

Nuclear membrane breaks down, chromatin condenses, mitotic spindle forms and attaches to kinetochores.



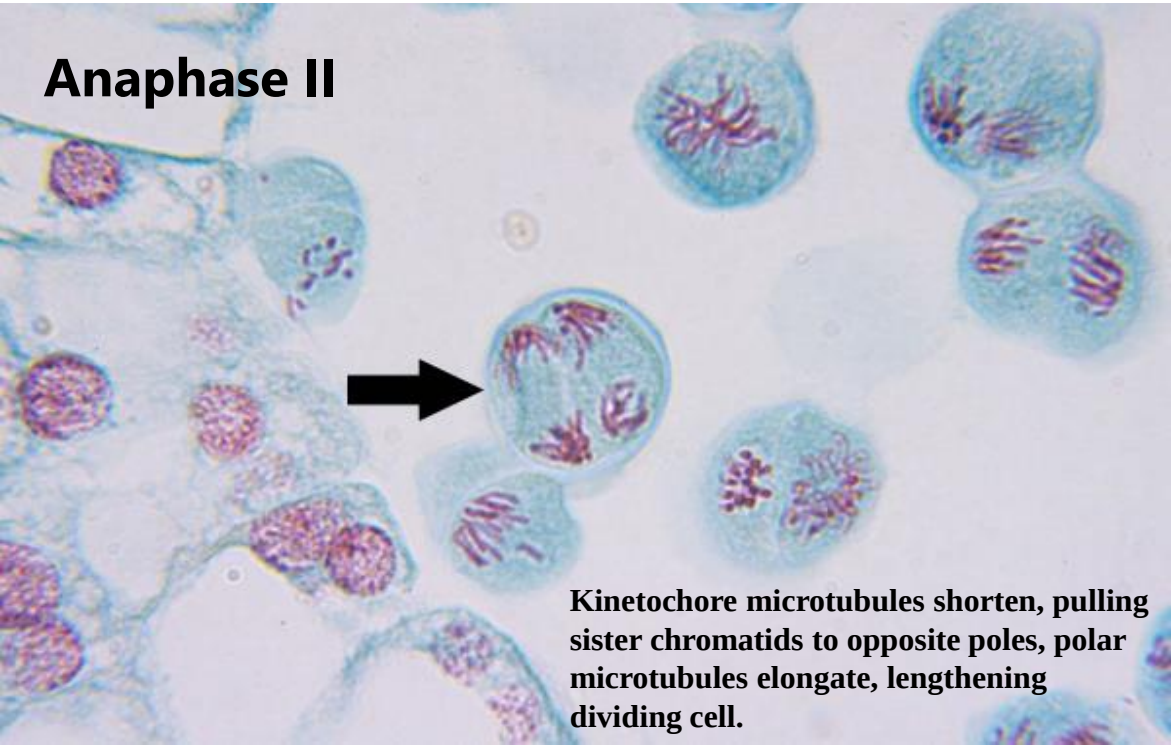
Metaphase II

Microtubules align chromosomes along metaphase plate.



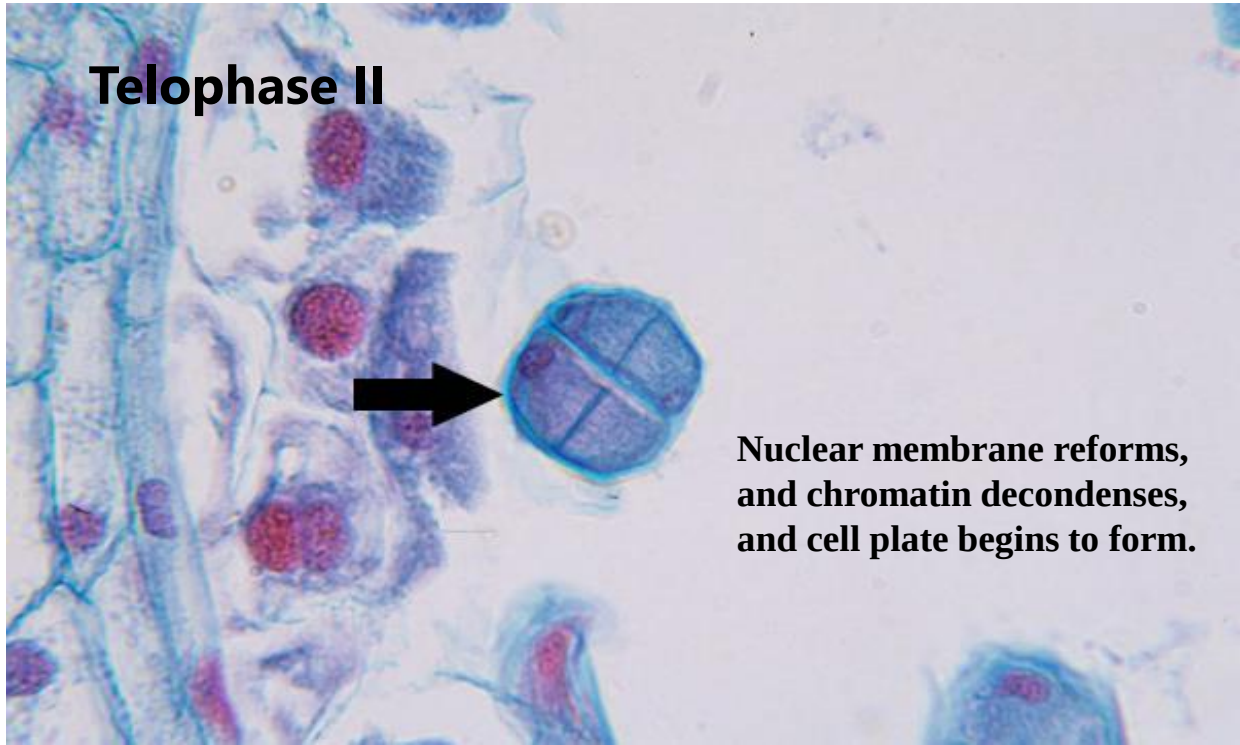
Anaphase II

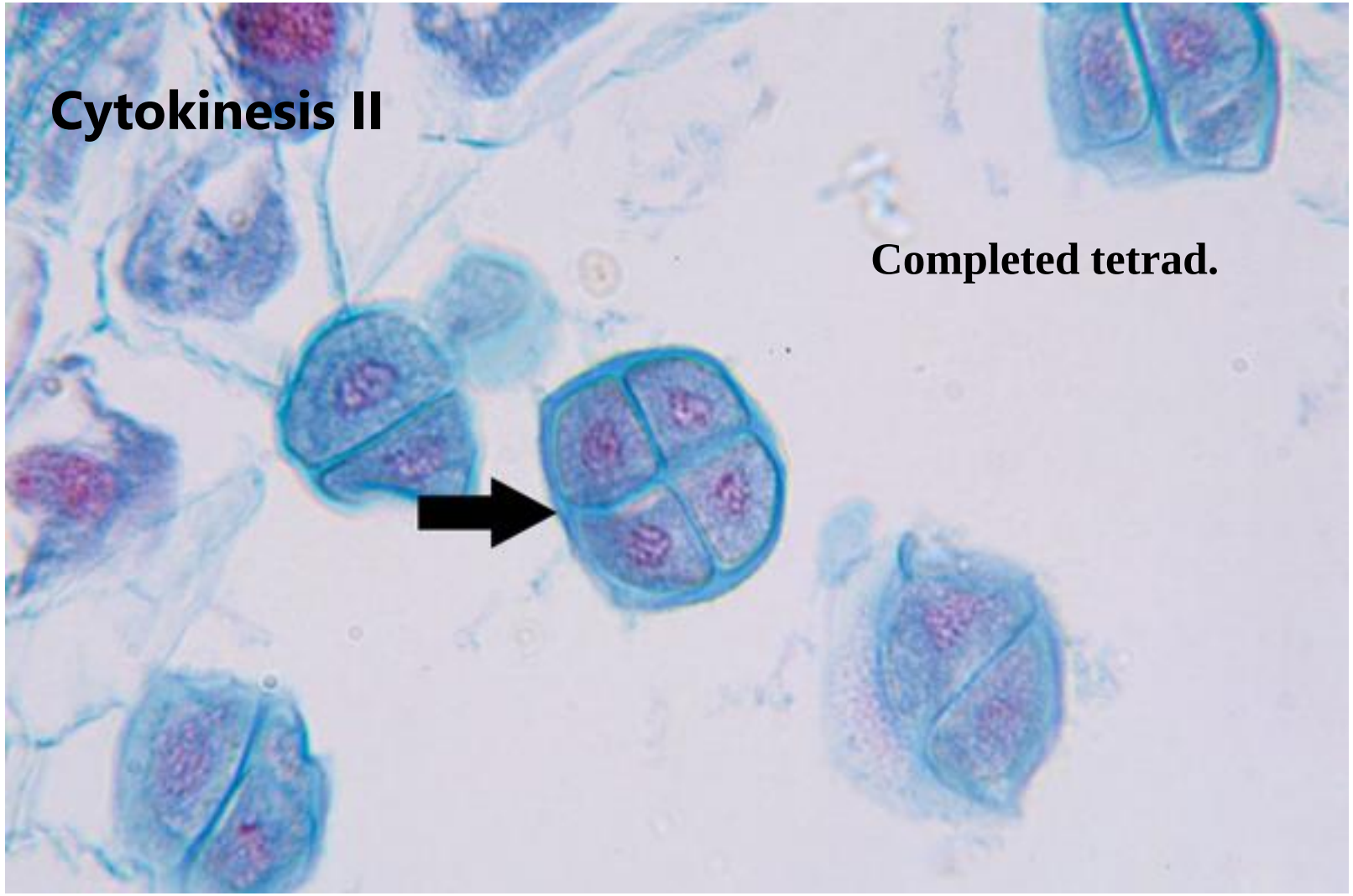
Kinetochore microtubules shorten, pulling sister chromatids to opposite poles, polar microtubules elongate, lengthening dividing cell.

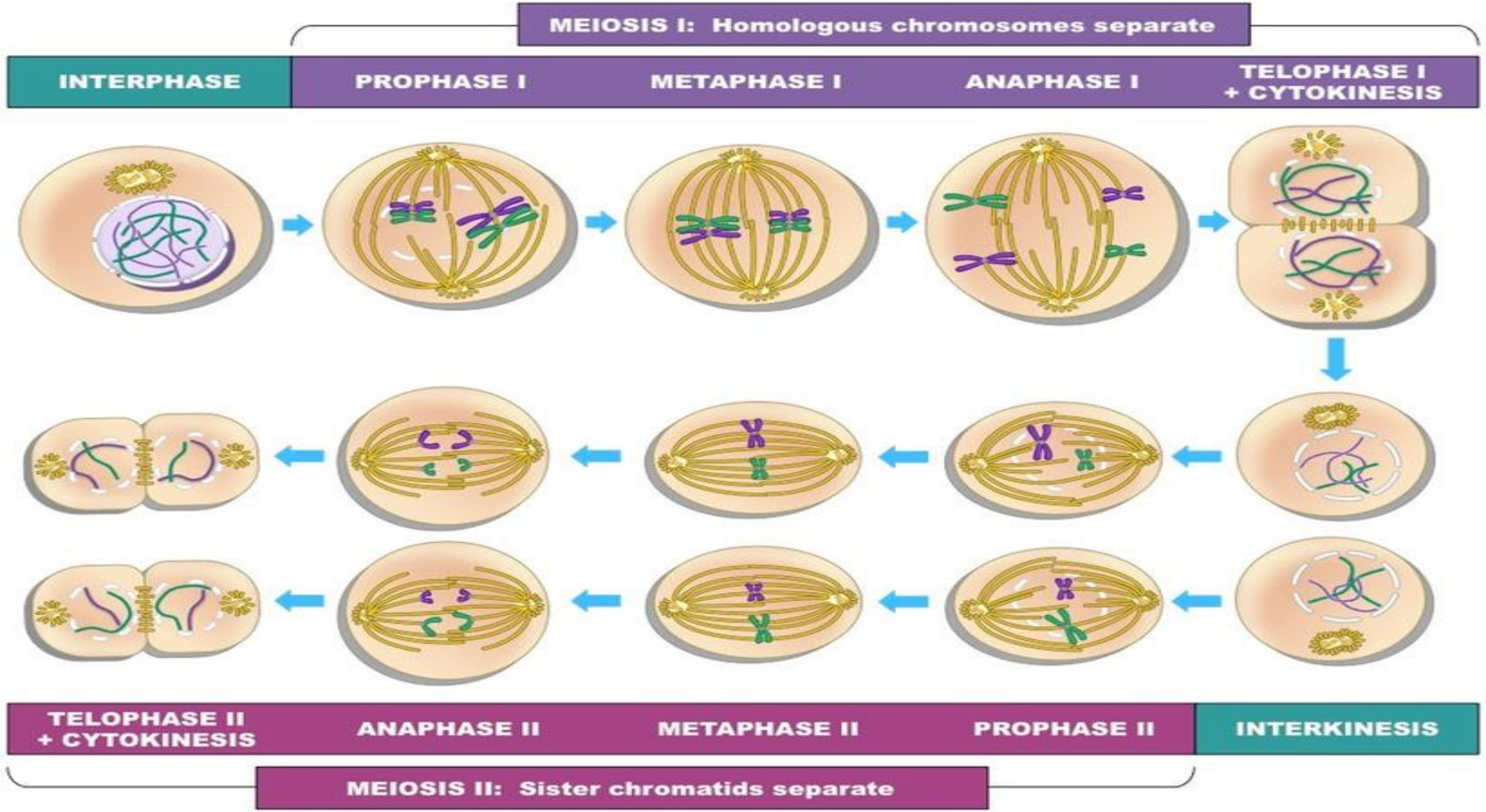


Telophase II

Nuclear membrane reforms, and chromatin decondenses, and cell plate begins to form.




Cytokinesis II
Completed tetrad.


MEIOSIS I: Homologous chromosomes separate
INTERPHASE
PROPHASE I
METAPHASE I
ANAPHASE I
TELOPHASE I + CYTOKINESIS
INTERKINESIS
PROPHASE II
METAPHASE II
ANAPHASE II
TELOPHASE II + CYTOKINESIS
MEIOSIS II: Sister chromatids separate