Keystone Biology Remediation

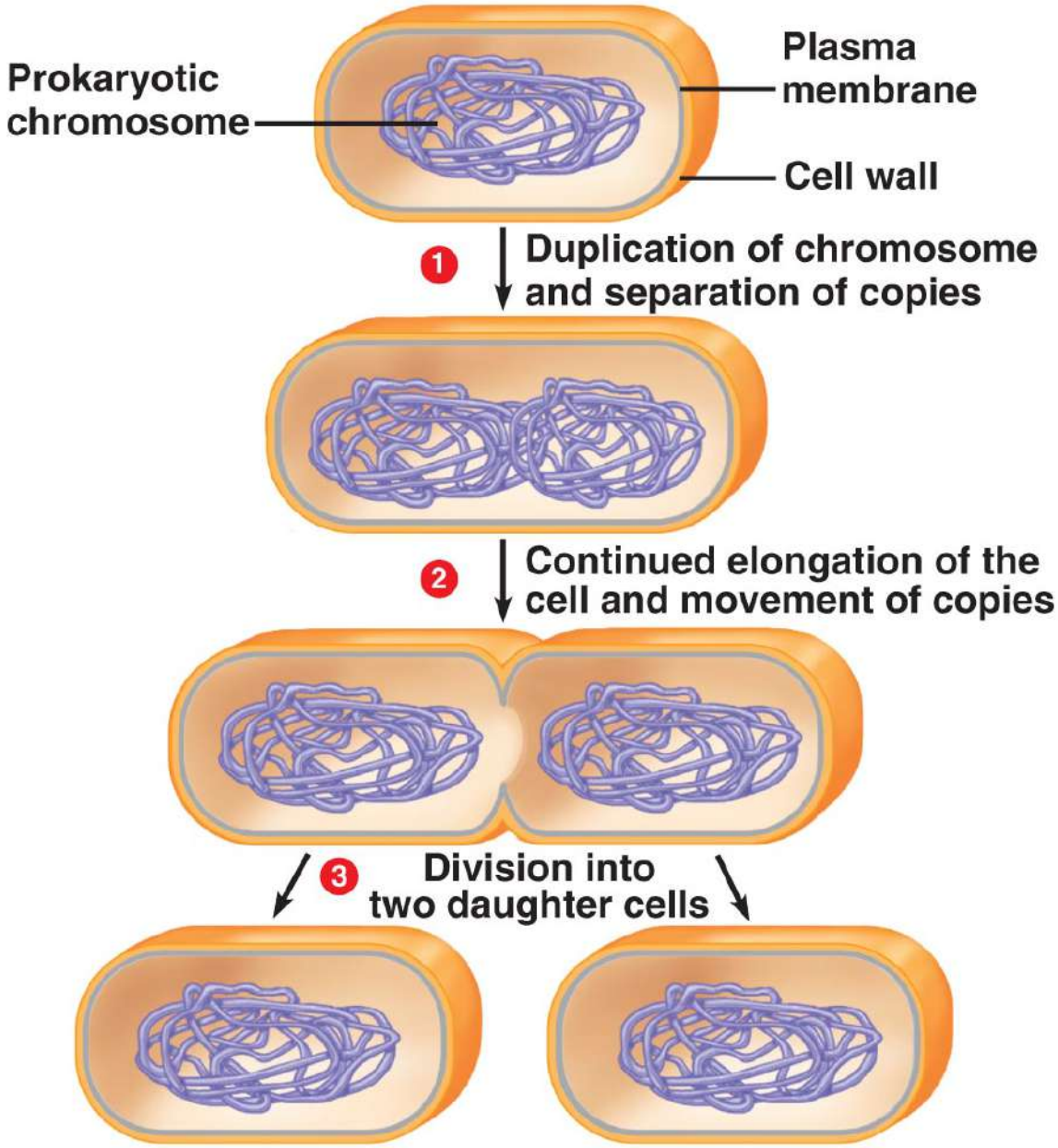
Cell Growth and Reproduction

Cell Division

- The process by which cells produce offspring cells.
  - Prokaryotes
    - Binary Fission
  - Eukaryotes
    - Mitosis and Meiosis

Binary Fission

- The division of a prokaryotic cell into two offspring cells.
  1. The DNA is copied and results in two identical cells.
  2. The cell grows to twice its original size.
  3. The cell membrane grows inward until it meets pinching of and forming two identical cells.



Cell Cycle

- The **cell cycle** involves the growth, replication, and division of a eukaryotic cell.
- The two main phases of the cell cycle are
  - **interphase**
    - During interphase, a cell's chromosomes are duplicated, but no cell division is occurring.
    - Most of a cell's life is spent in interphase
  - **M phase** includes mitosis and cytokinesis.
    - During **mitosis**, the nucleus of a cell divides into two daughter nuclei
      - each contain the same number of chromosomes as the parent nucleus
      - The two nuclei that are formed during mitosis are separated into two identical daughter cells during **cytokinesis**.
      - The end result of M phase are two cells that genetically identical to the parent cell.

Mitosis and Meiosis

- *Mitosis*
  - is directly involved in the division of a cell's nucleus during the cell cycle.
- *Meiosis*
  - is not directly involved in the cell cycle
  - a process in which a cell undergoes two successive nuclear divisions
  - produces haploid daughter cells with half of the species' usual number of chromosomes
  - These resulting daughter cells are called gametes and aid the organism in sexual reproduction

Cell Growth and Reproduction

Cell Division

- All cells come from pre-existing cells.
- Cell division is a key process involved in growth, repair, and reproduction of organisms.
- Most of the cells found in living things are able to reproduce by dividing to form new cells that are identical or genetically similar to themselves.
- Cell division is triggered as cells become too large to efficiently import nutrients and export wastes across their cell membrane.
  - This occurs because as a cell grows larger, its volume grows more rapidly than its surface area.
- As cells continue to divide, they will proliferate to fill whatever medium they are in.
  - Once the cells have spread so much that two cells contact each other, they can signal to each other to stop dividing through a process called inhibition.
- Cellular reproduction in multicellular organisms occurs primarily through the process of **mitosis.**
  - The purpose of mitosis is to form new somatic cells. Somatic cells are those cells that form the body of an organism

Mitosis & Cytokinesis

- Mitosis refers specifically to the division of the cellular nucleus.
  - Therefore, it only occurs in eukaryotes.
  - After the chromosomes are replicated during interphase, the cell enters the first stage of mitosis —prophase.
  - Following the completion of mitosis, the entire cell divides through a process called **cytokinesis**. The result of which are two identical daughter cells.

Interphase

- Interphase occurs before mitosis. During interphase, the chromosomes containing the genetic information of the cell are copied.

Mitosis Begins

Prophase

- Genetic material (chromatin) condenses into rod-like structures called **chromosomes**

Metaphase

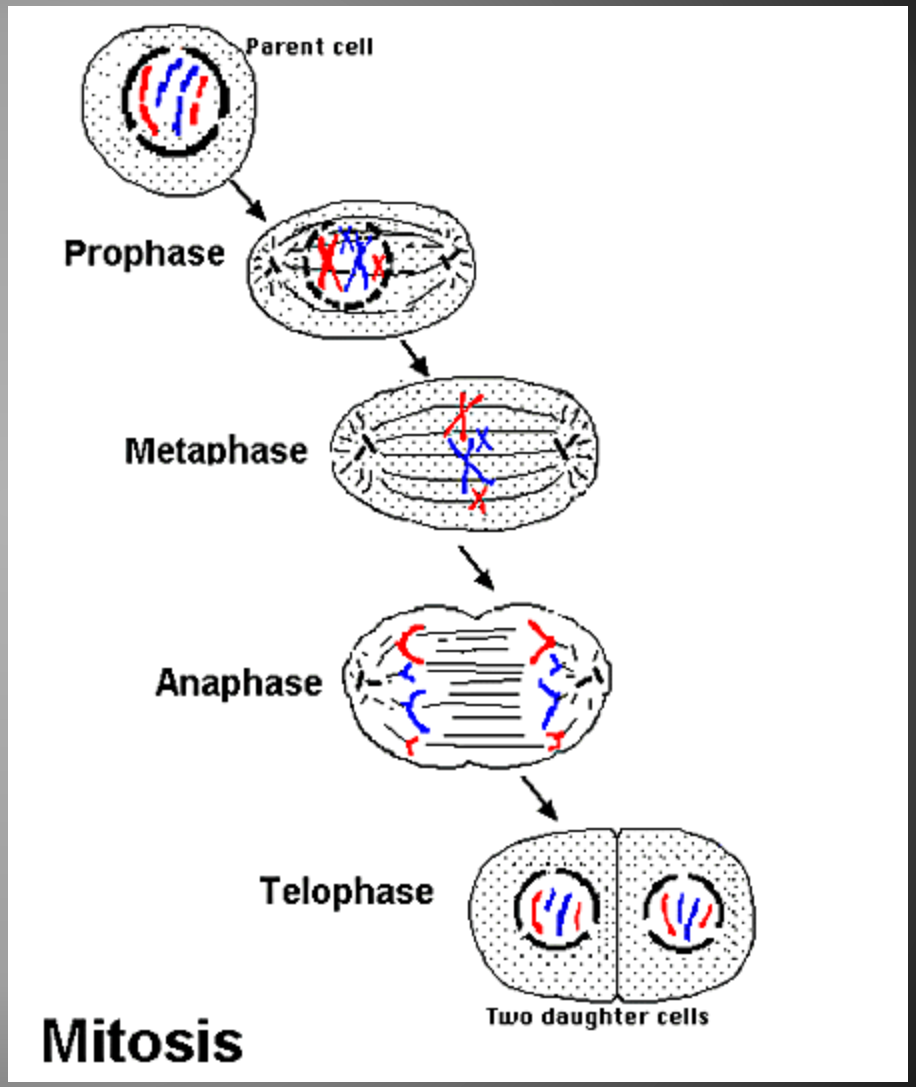
- Chromosomes line-up along the equator of the cell.

Anaphase

- Chromatids separate and move to opposite sides of the cell

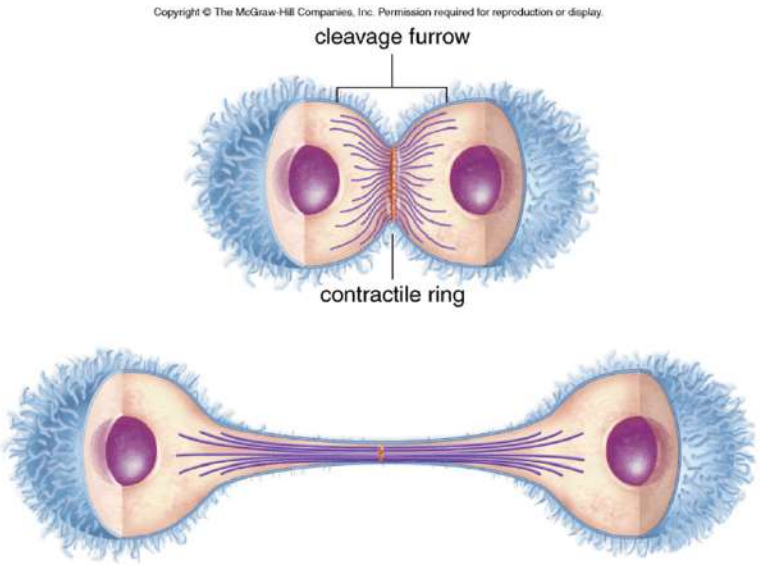
Telophase

- A nuclear membrane forms around each set of chromosomes and mitosis is complete.



Mitosis Ends

- **Cytokinesis**
- After mitosis, cytokinesis takes place. It is during this stage of cell division that the cytoplasm divides. In cells that lack a cell wall, the cell pinches in two. In cells that have a cell wall, a cell plate forms between the two new cells.



Mitosis

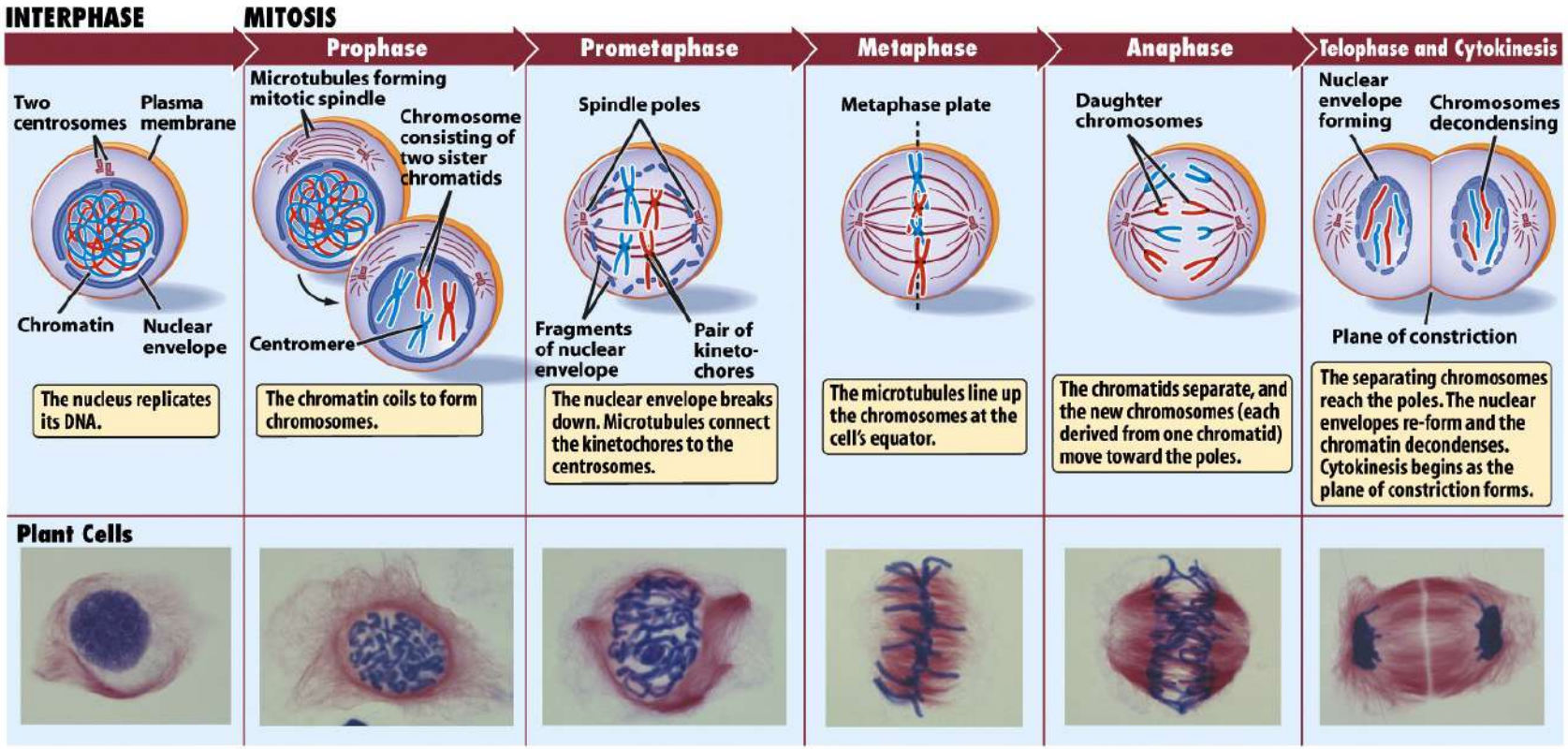


Figure 9-5 Discover Biology 3/e

Meiosis

- **Meiosis** is a kind of eukaryotic cell division that reduces the number of chromosomes in a cell by half.
  - Only *eukaryotic cells* can undergo meiosis.
  - Meiosis is a form of cell division that produces **haploid** (N) daughter cells that contain only half of the species' usual number of chromosomes.
  - These resulting daughter cells are called **gametes** and aid the organism in sexual reproduction.

Stages of Meiosis

- Chromosomes are copied during interphase prior to the start of meiosis. This short period of interphase is known as *S phase* for synthesis. The following stages of meiosis are summarized in order.

Prophase I

- During prophase I, homologous chromosomes pair and become tetrads (two chromosomes or four chromatids). Crossing over between homologous chromosomes occurs at this stage.

Metaphase I

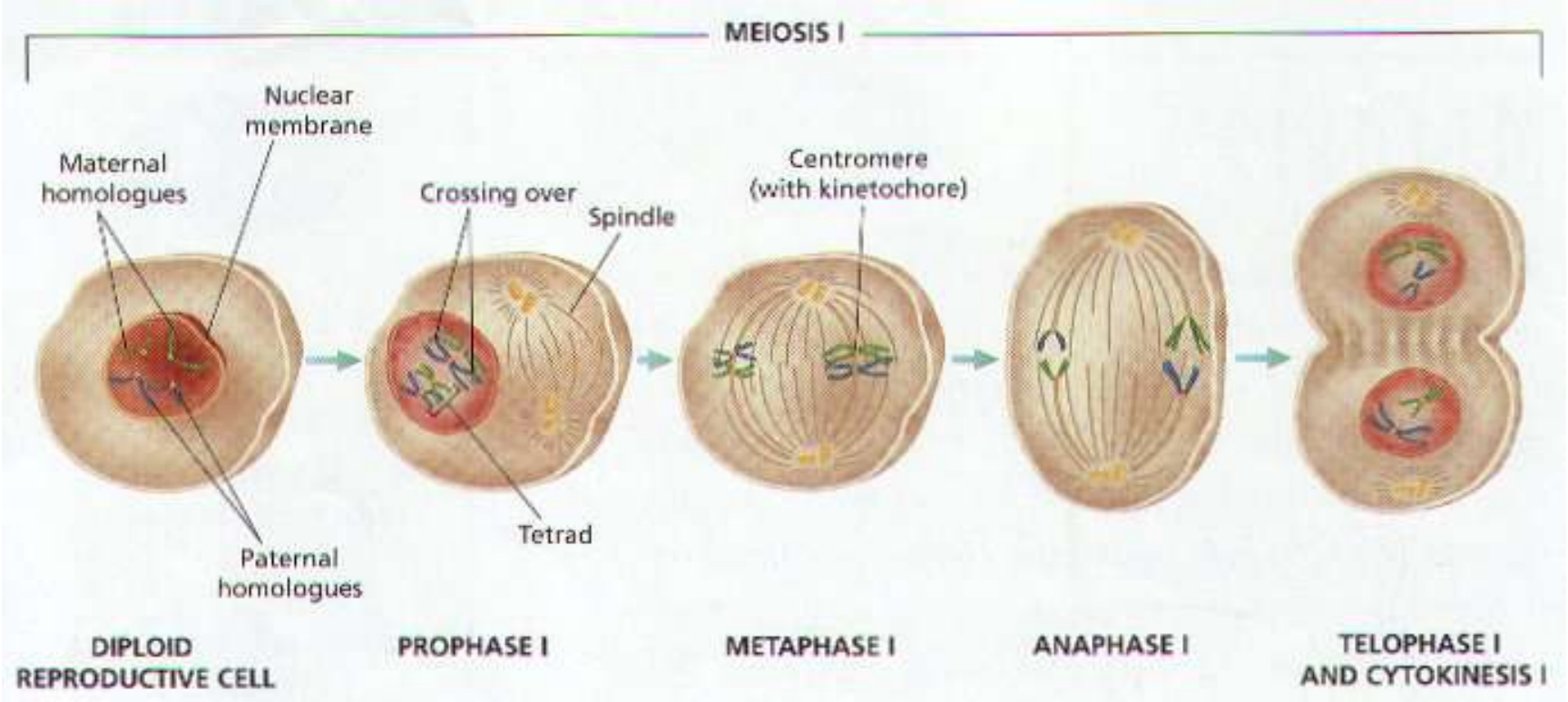
- After crossing over occurs, homologous chromosomes line-up along the equator.

Anaphase I

- Whole chromosomes separate from the tetrad formation and move to opposite sides of the cell. Each chromosome still has two sister chromatids.

Telophase I

- During telophase I, a nuclear membrane forms around each set of chromosomes. Each cell now has one set of chromosomes and is haploid (n).


MEIOSIS I
Nuclear membrane
Maternal homologues
Crossing over
Spindle
Centromere (with kinetochore)
Tetrad
Paternal homologues
DIPLOID REPRODUCTIVE CELL
PROPHASE I
METAPHASE I
ANAPHASE I
TELOPHASE I AND CYTOKINESIS I

Stages of Meiosis

Prophase II

- Sister chromatids become short and thick at the beginning of prophase II.

Metaphase II

- The chromosomes migrate to the center of the nucleus and line-up along the equator by the end of metaphase II.

Anaphase II

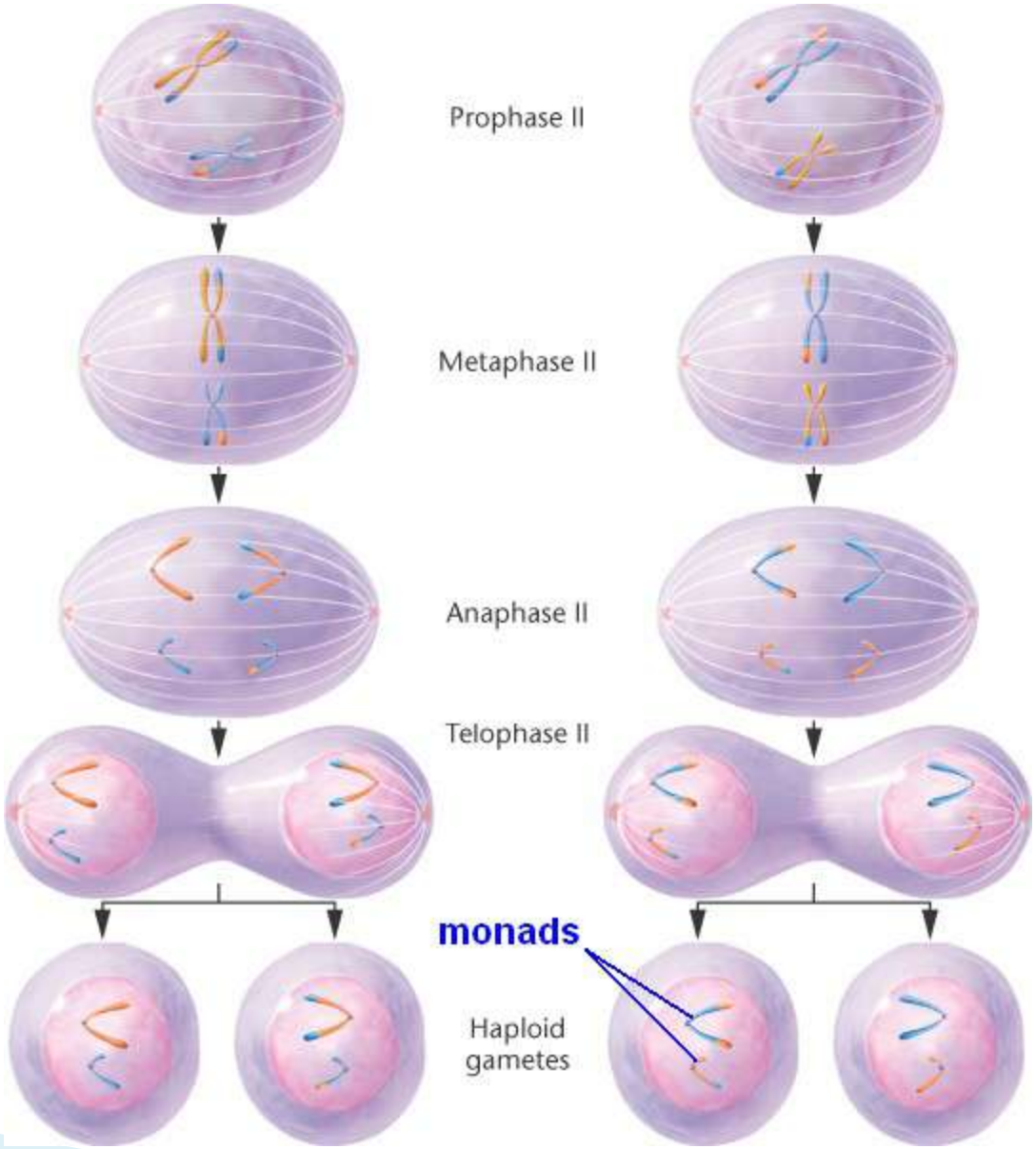
- During anaphase II, sister chromatids are pulled apart by microtubules to opposite poles.

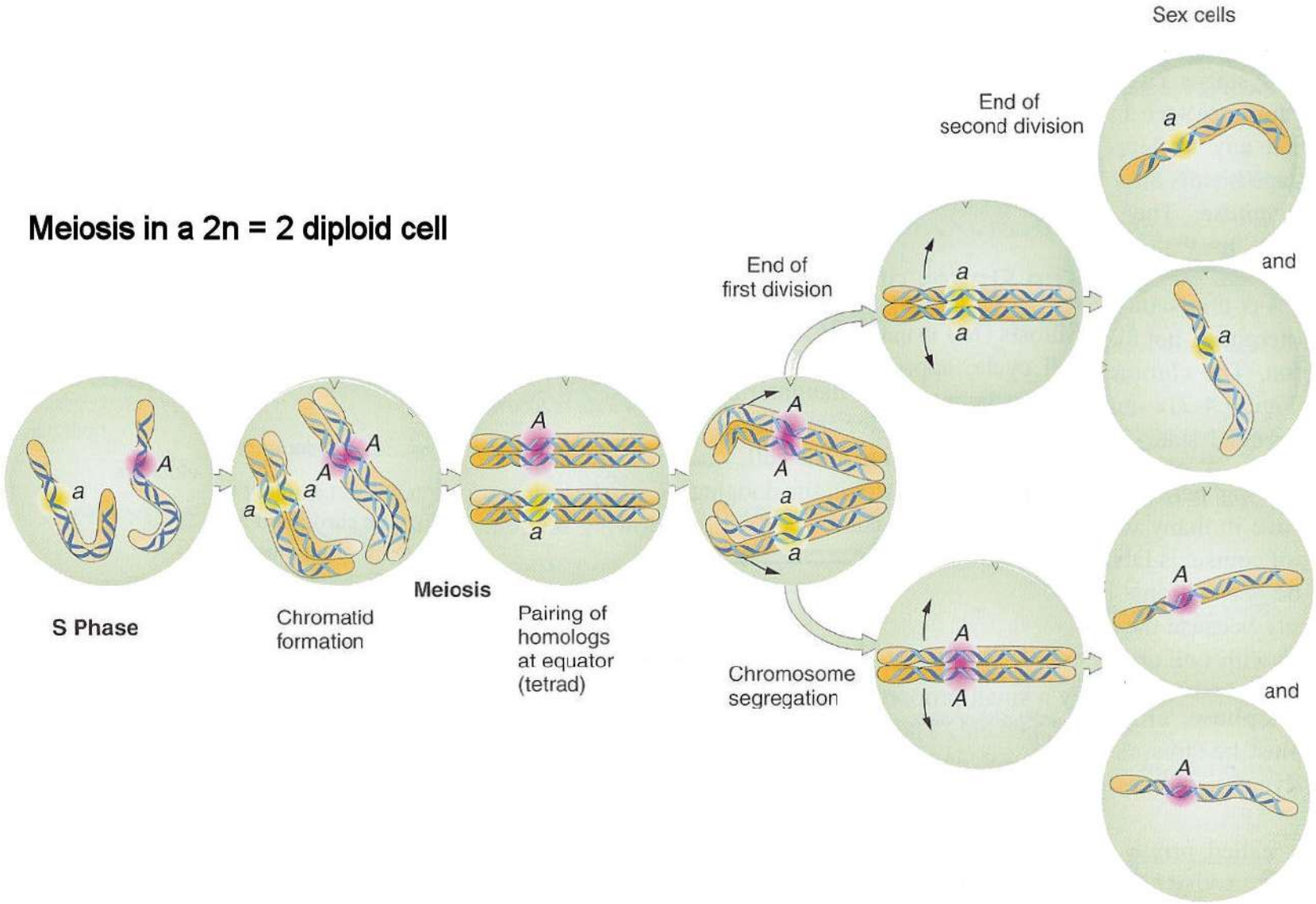
Telophase II

- A nuclear envelope forms around each set of chromosomes and meiosis II is complete.

Cytokinesis

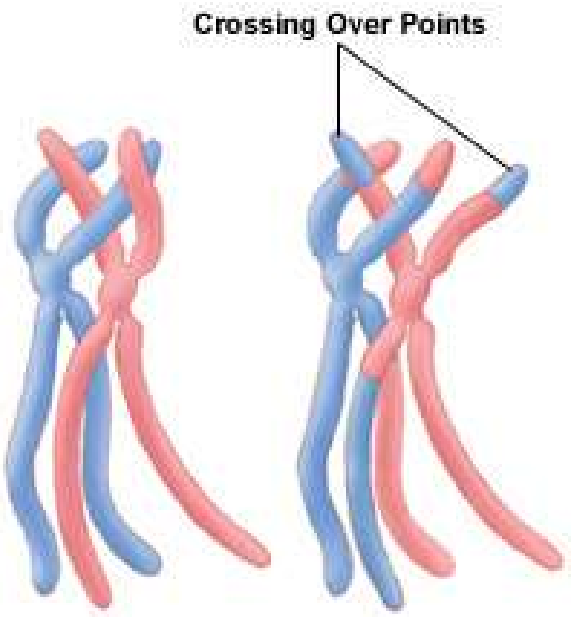
- The cells divide to create four haploid cells


Prophase II
Metaphase II
Anaphase II
Telophase II
monads
Haploid gametes


Meiosis in a 2n = 2 diploid cell
Sex cells
End of second division
End of first division
Meiosis
S Phase
Chromatid formation
Pairing of homologs at equator (tetrad)
Chromosome segregation
and
and
a
A

Genetic Variation

- During meiosis, **crossing over**—a process unique to meiosis—can occur.
  - Crossing over occurs during prophase I when two chromosomes pair up and *exchange parts of their DNA*.
  - Crossing over provides genetic diversity between the parents and their offspring.



Genetic Variation

- **Genetic variation** can also occur when alleles are randomly sorted during meiosis.
  - Since each offspring receives a different combination of alleles from the parent organisms, phenotypic diversity results.