Republic of Iraq Ministry of Higher Education
and Scientific Research
Al-Zahraa University for Women
College of Pharmacy

Human Biology

First semester/ Lab.5

Chromosome and Cell Division

By:

Asst. Lec. Nabaa Faiz Abbas

What is a chromosome?

Chromosomes are thread-like structures located inside the nucleus of animal and plant cells. Each chromosome is made of protein and a single molecule of deoxyribonucleic acid (DNA). Passed from parents to daughter, DNA contains the specific instructions that make each type of living creature unique.

Do all living organisms have the same types of chromosomes?

Chromosomes vary in number and shape among living things. Most bacteria have one or two circular chromosomes. Humans, along with other animals and plants, have linear chromosomes that are arranged in pairs within the nucleus of the cell.

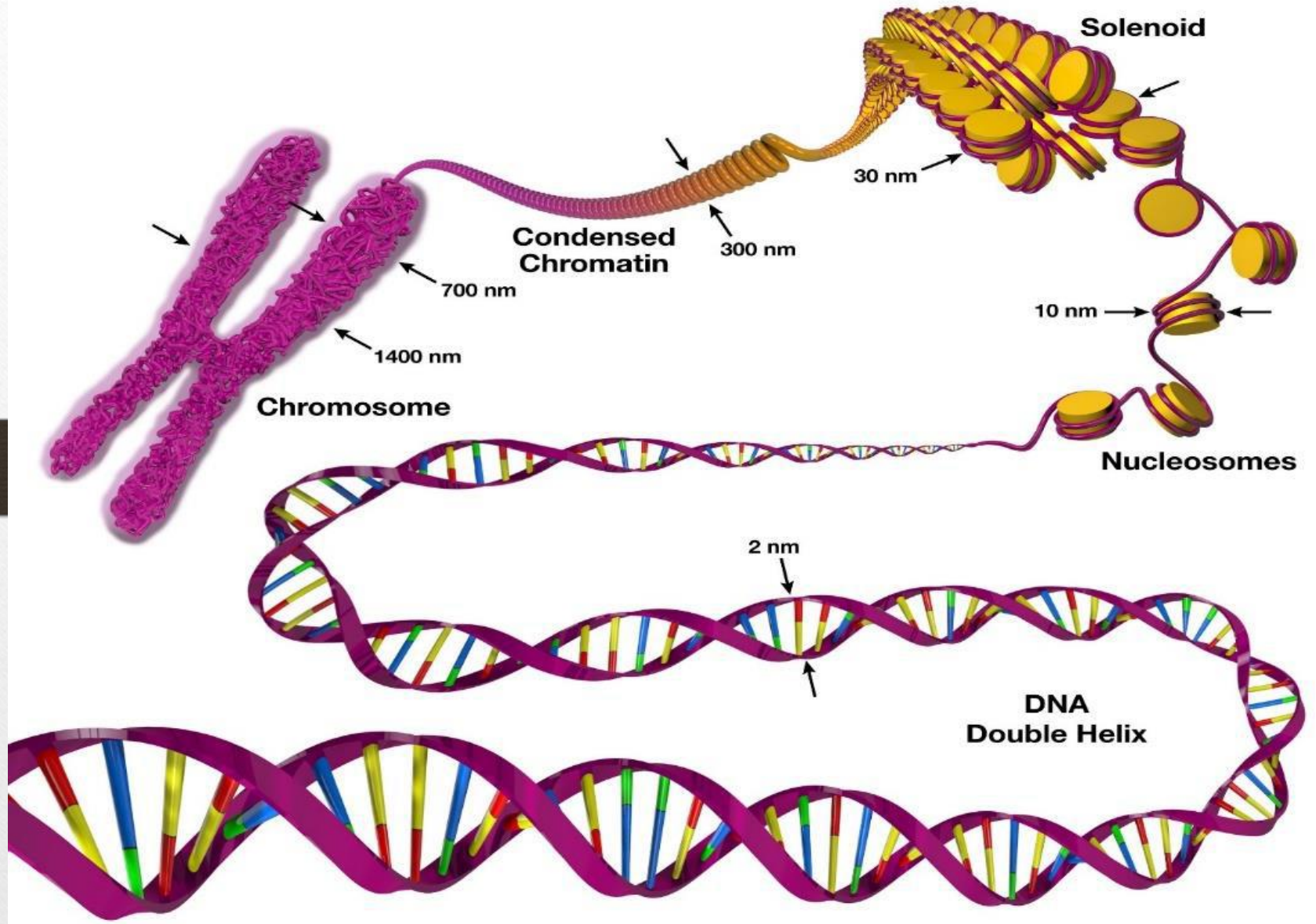
Chromosome Structure:

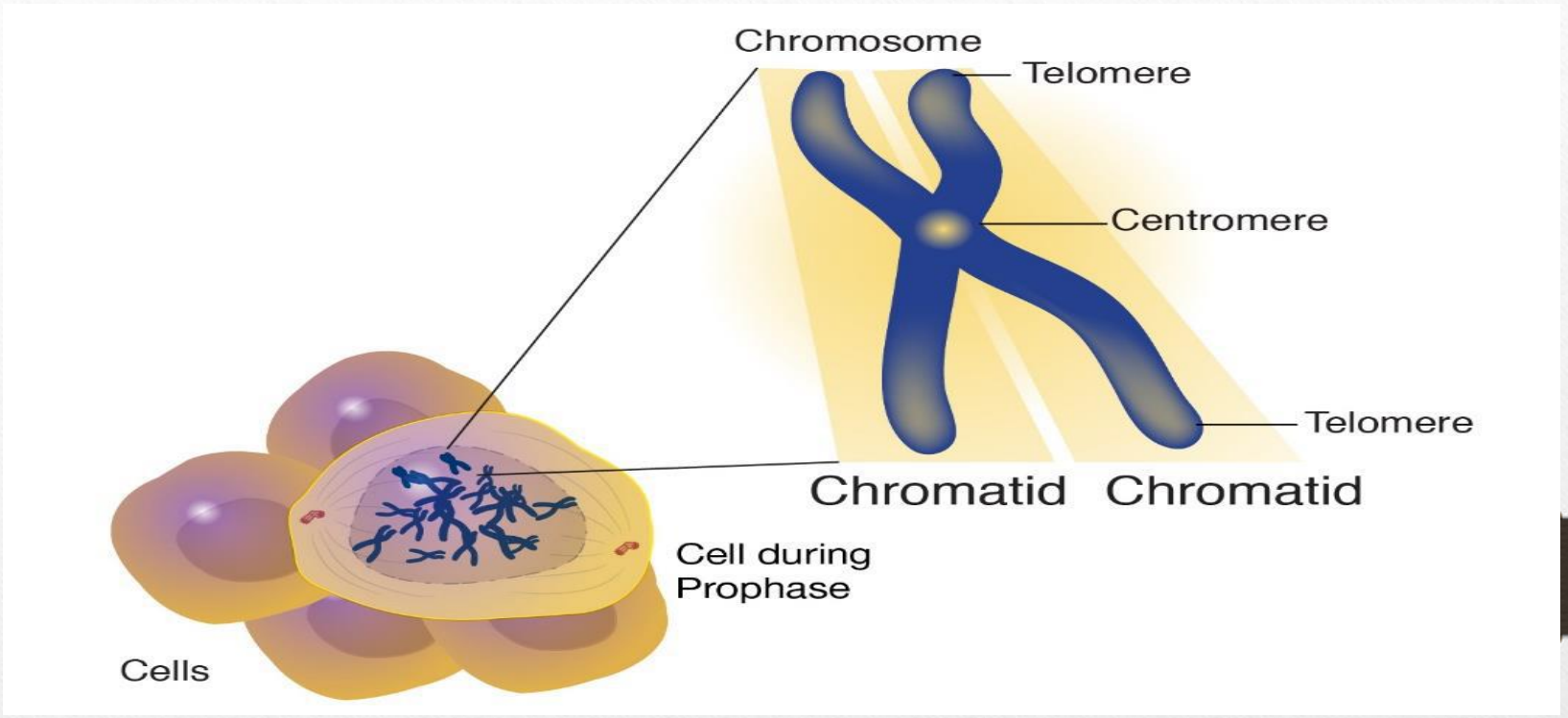
It consists of:

- **Chromatid**: Each chromosome has two symmetrical structures called chromatids or sister chromatids which is visible in mitotic metaphase .
- **Centromere and kinetochore**: Sister chromatids are joined by the centromere.
- **Telomere**: Terminal part of a chromosome is known as a telomere .

How many chromosomes are there in humans?

The chromosome number in humans is 23 pairs. Normally, there are 46 chromosomes in total in each cell in humans. Twenty-two of these 23 pairs are referred to as autosomes and are the same in both females and males. However, the difference is in the last pair of chromosomes - 23rd pair. It differs in females and males.


Solenoid
30 nm
Condensed
Chromatin
300 nm
700 nm
1400 nm
Chromosome
10 nm
Nucleosomes
2 nm
DNA
Double Helix



Chromosome and Chromatid

CELL REPRODUCTION

• **Cell Division:** process by which a cell divides to form two new cells (daughter cells)

- Three types of cell division, or cell reproduction

– Prokaryotes (bacteria)

• **Amitosis (Binary fission):** divides forming two new identical cells

– Eukaryotes

• **Mitosis:** whenever more cells are needed

• **Meiosis**: formation of sex cells or gametes

Significance of Cell Division

Cell division plays an important role in all living organisms, as it is essential for growth, repair and reproduction.

This process helps in:

1. Renewing of damaged cells.
2. Production of new cells from older ones.
3. Maintains the total number of chromosomes.
4. Provides more cells for growth and development.

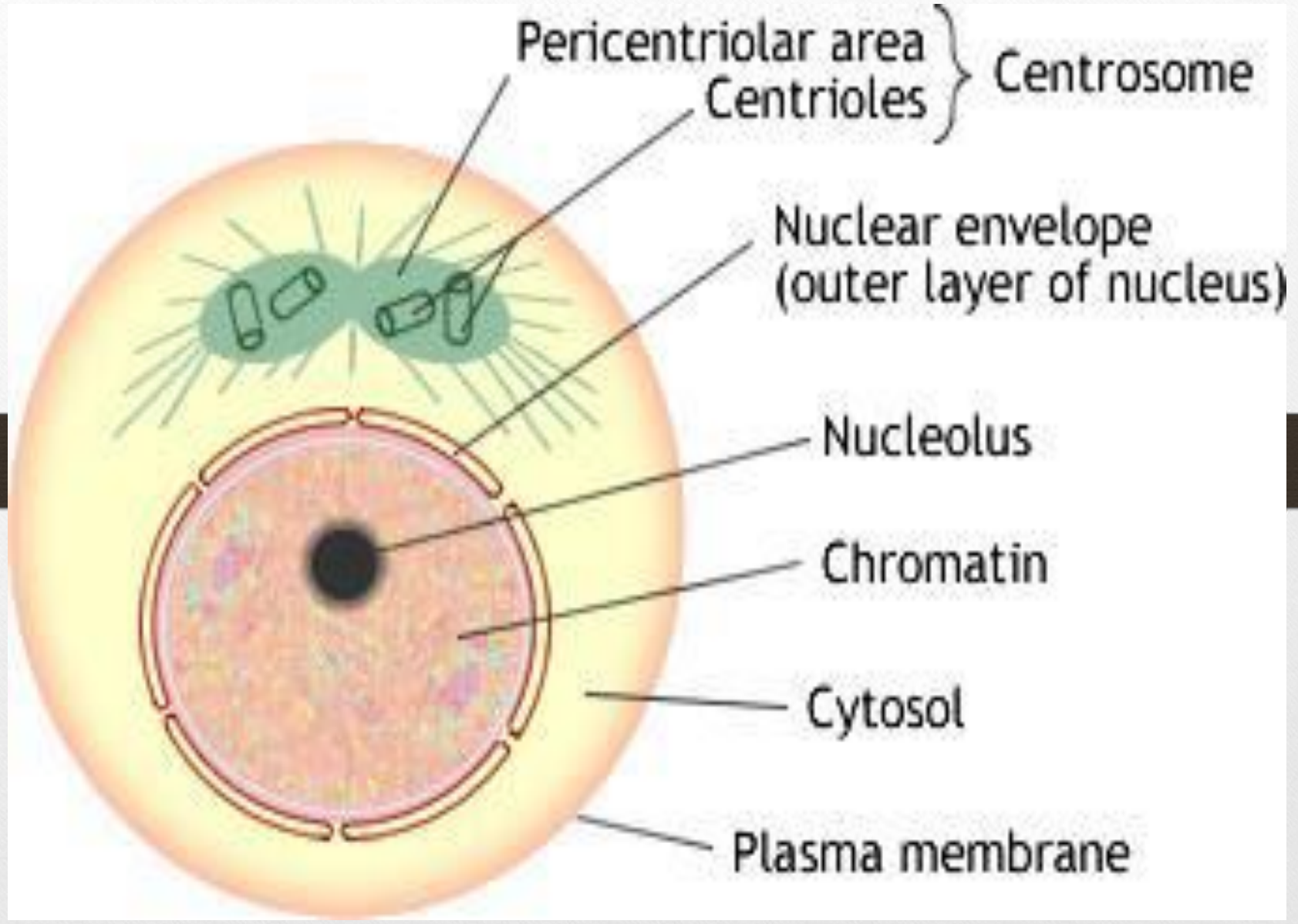
Main steps:

1: Mitosis (4 steps—Prophase, Metaphase, Anaphase, Telophase)

Nucleus divides

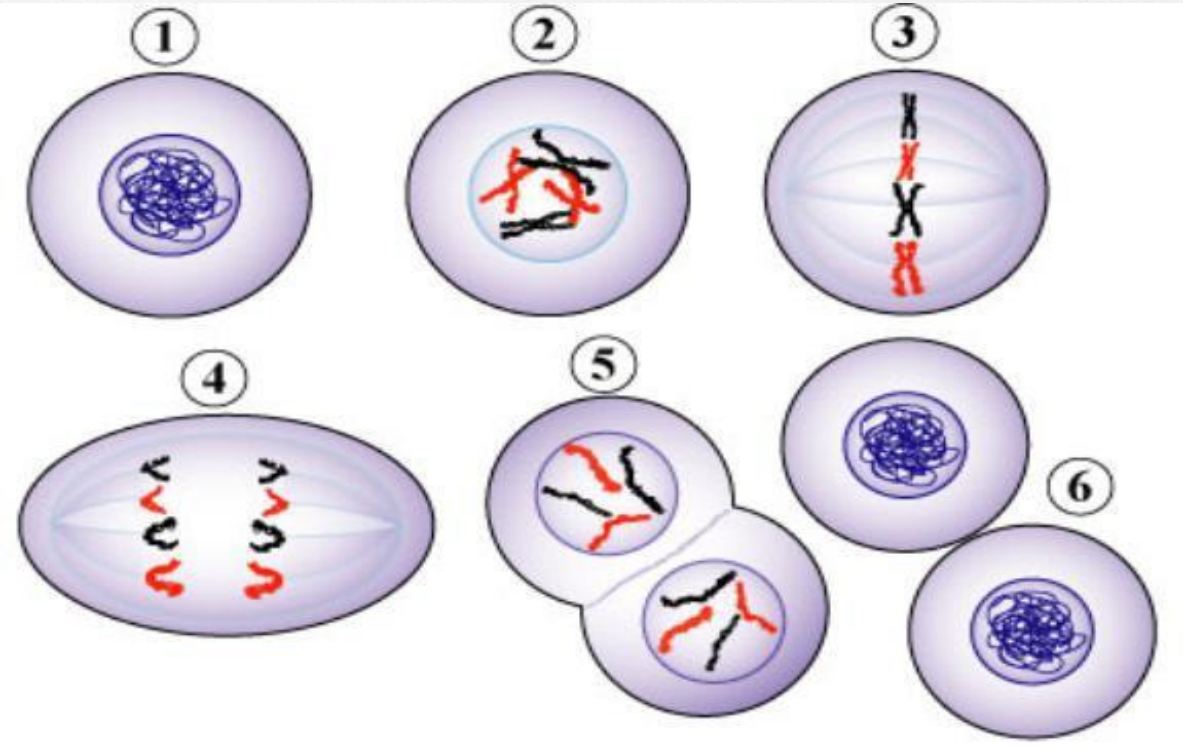
2: Cytokinesis—Cytoplasm divide , forming 2 cells

Each new daughter cell is genetically identical to parent cell


Pericentriolar area
Centrioles
Centrosome
Nuclear envelope
(outer layer of nucleus)
Nucleolus
Chromatin
Cytosol
Plasma membrane

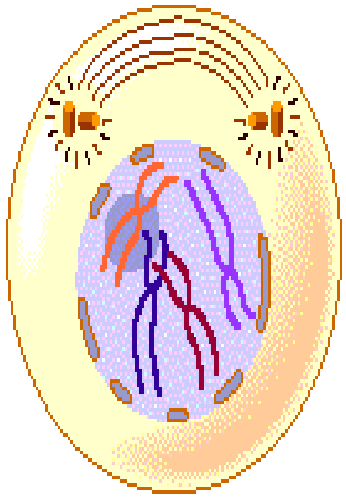
Life cycle of the cell

- Mitosis = nuclear division
- Mitosis is followed by cytokinesis (cell division)
- The steps of mitosis ensure that each new cell has the exact same number of chromosomes as the original



Prophase

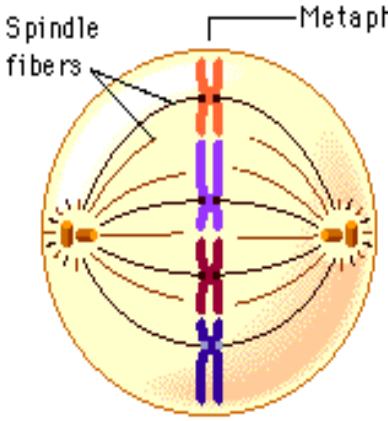
1. chromosomes visible (sister chromatids)
2. centrioles migrate to the poles (only in animals)
3. nuclear membrane disappears
4. spindle forms



Prophase
The chromosomes appear condensed, and the nuclear envelope is not apparent.

Metaphase

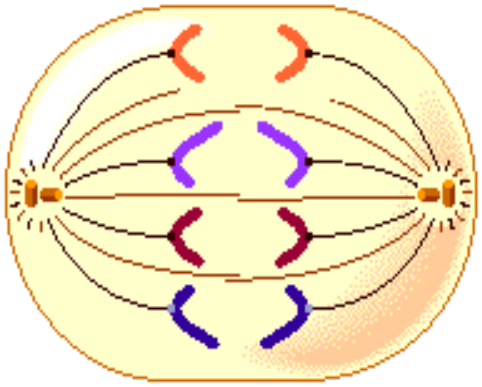
1. chromosomes line up on the equator of the cell
2. spindles attach to centromeres



Metaphase
Thick, coiled chromosomes are lined up in the center of the cell on the metaphase plate. Spindle fibers are attached to the chromosomes.

Anaphase

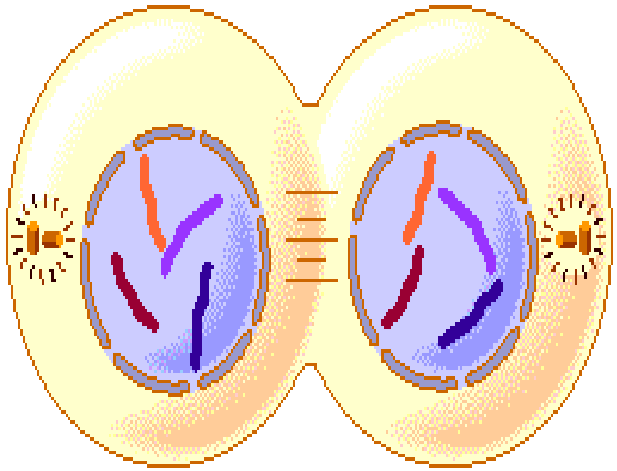
1. sister chromatids separate
2. centromeres divide
3. sister chromatids move to opposite poles



Anaphase
The chromosomes have separated and are moving toward the poles.

Telophase

1. chromosomes uncoil • now chromatin
2. nuclear membranes reform
3. spindle disappears



Telophase
The chromosomes are at the poles, and are becoming more difuse. The nuclear envelope is reforming. The cytoplasm may be dividing.

Cytokinesis

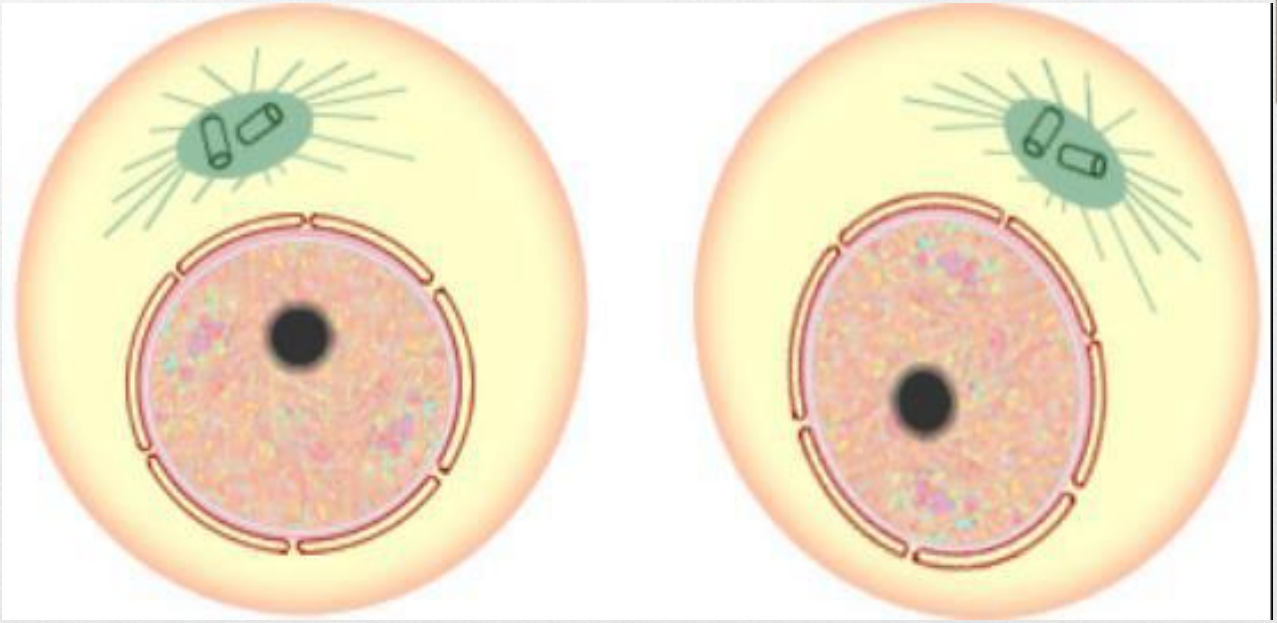
– Occurs at end of Mitosis

– division of the cytoplasm to form 2 new daughter cells

– organelles are divided

– Daughter cells are genetically identical

– Cells return to interface



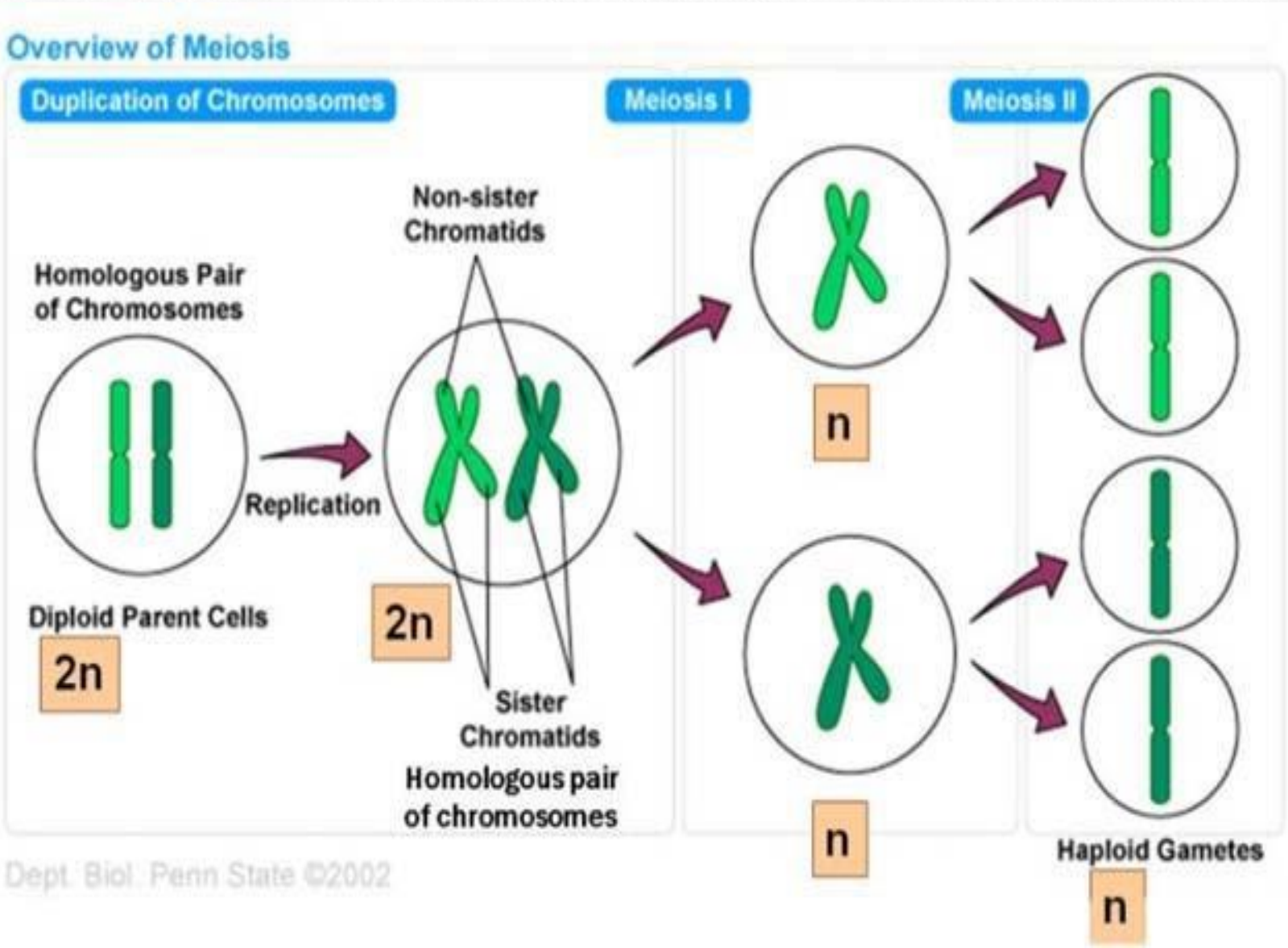
Meiosis

Meiosis functions to reduce the number of chromosomes to one half. Each daughter cell that is produced will have one half as many chromosomes as the parent cell. Meiosis is part of the sexual process because gametes (sperm, eggs) have one half the chromosomes as diploid (2N) individuals.

Phases of Meiosis

There are two divisions in meiosis; the first division is meiosis I: the number of cells is doubled but the number of chromosomes is not. This results in 1/2 as many chromosomes per cell. The second division is meiosis II: this division is like mitosis; the number of chromosomes does not get reduced. The phases have the same names as those of mitosis.

- **Meiosis I: prophase I (2N), metaphase I (2N), anaphase I (N+N), and telophase I (N+N)**
- **Meiosis II: prophase II (N+N), metaphase II (N+N), anaphase II (N+N+N+N), and telophase II (N+N+N+N).**


Overview of Meiosis
Duplication of Chromosomes
Meiosis I
Meiosis II
Non-sister Chromatids
Homologous Pair of Chromosomes
Replication
Diploid Parent Cells
2n
2n
Sister Chromatids
Homologous pair of chromosomes
n
n
Haploid Gametes
n
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Prophase I

Events that occur during prophase of mitosis also occur during prophase I of meiosis. The chromosomes coil up, the nuclear membrane begins to disintegrate, and the centrosomes begin moving apart.

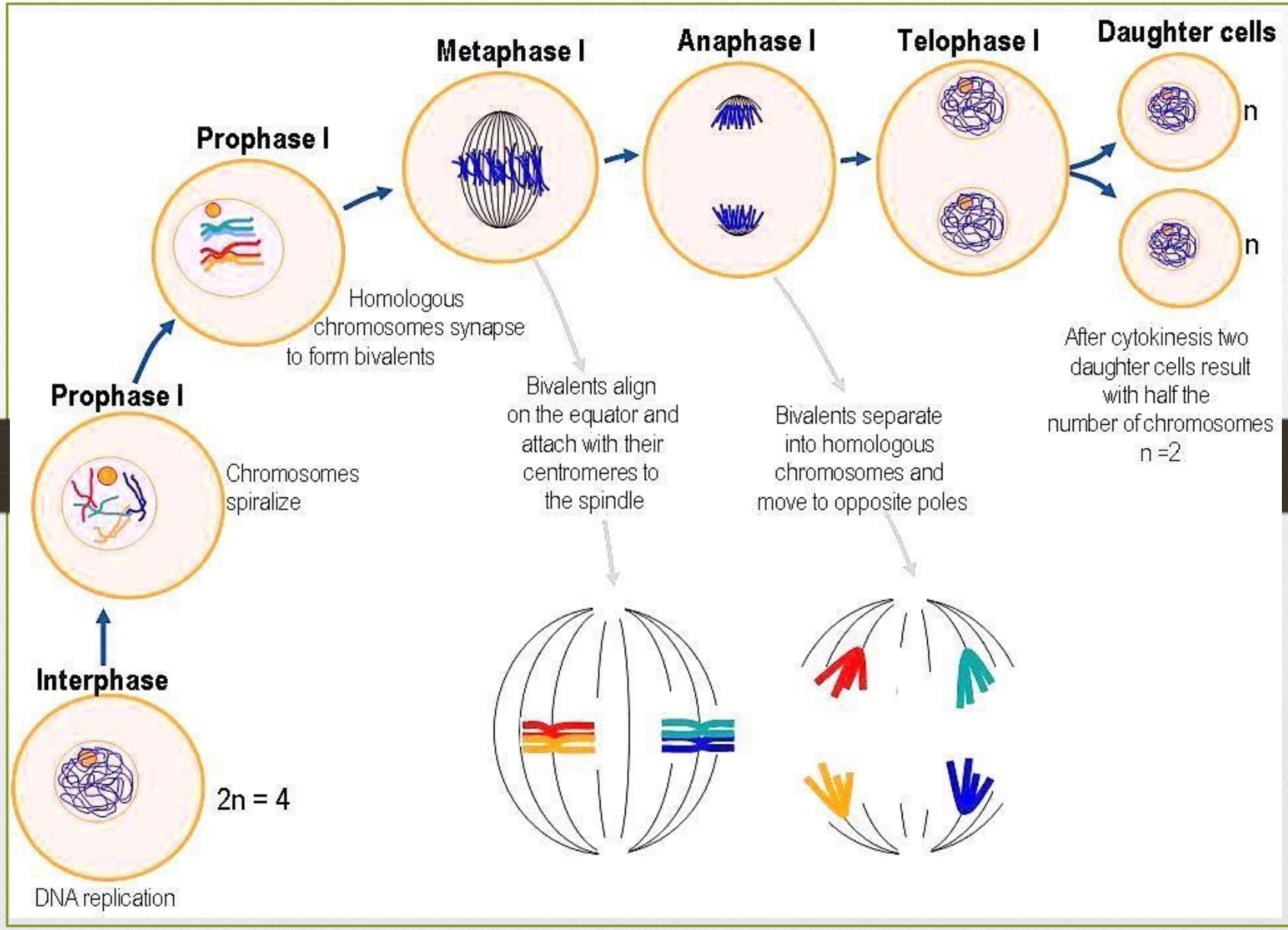
The two chromosomes may exchange fragments by a process called **crossing over**.

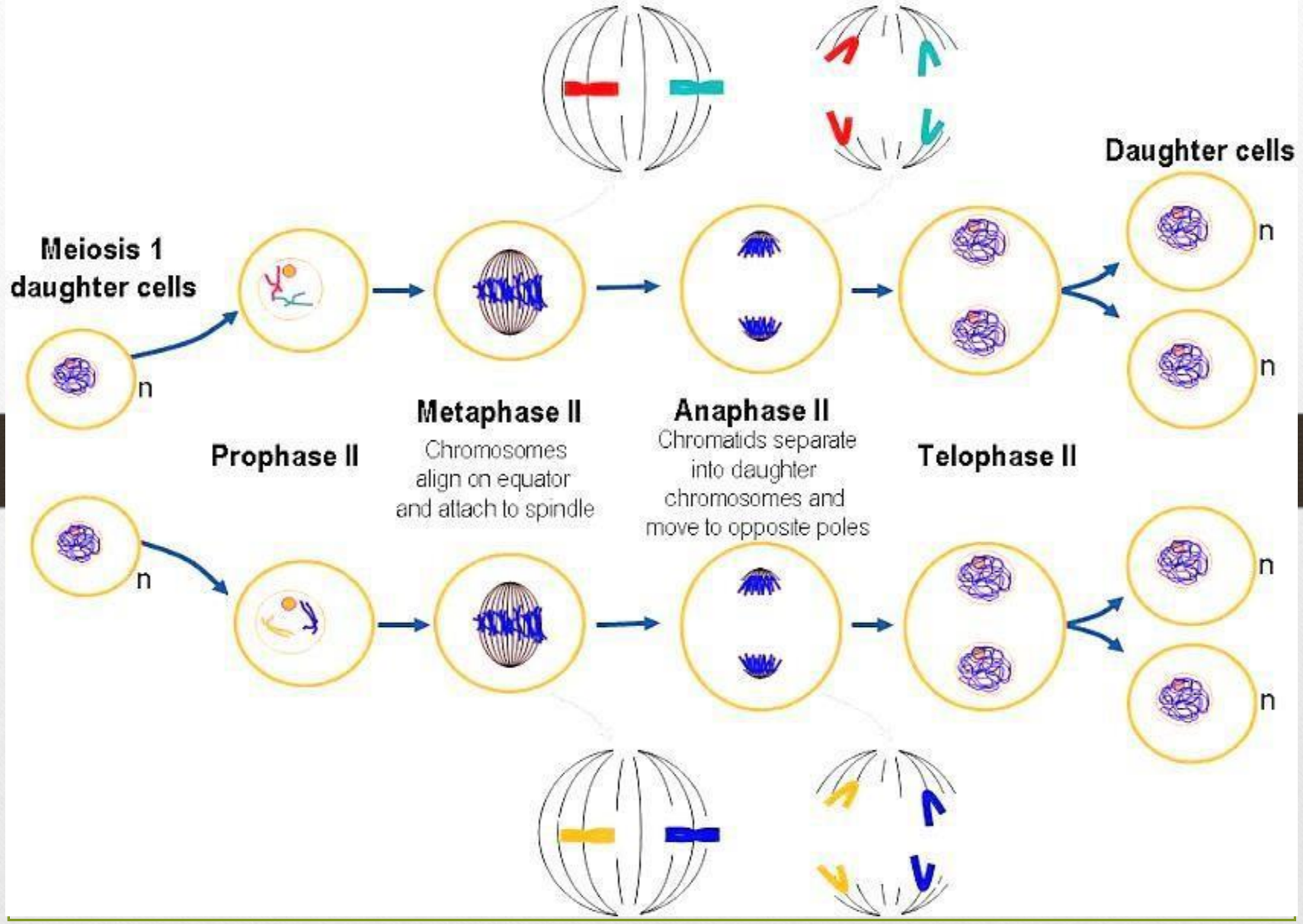
When the chromosomes partially separate in late prophase, until they separate during anaphase resulting in chromosomes that are mixtures of the original two chromosome

Metaphase I: Bivalents (tetrads) become aligned in the center of the cell and are attached to spindle fibers. Independent assortment refers to the random arrangement of pairs of chromosomes.

Anaphase I: begin when homologous chromosomes separate.

Telophase I: The nuclear envelope reforms and nucleoli reappear**.**


Interphase
2n = 4
DNA replication
Prophase I
Chromosomes spiralize
Prophase I
Homologous chromosomes synapse to form bivalents
Metaphase I
Bivalents align on the equator and attach with their centromeres to the spindle
Anaphase I
Bivalents separate into homologous chromosomes and move to opposite poles
Telophase I
Daughter cells
n
n
After cytokinesis two daughter cells result with half the number of chromosomes n =2


Meiosis 1 daughter cells
n
Prophase II
Metaphase II
Chromosomes align on equator and attach to spindle
Anaphase II
Chromatids separate into daughter chromosomes and move to opposite poles
Telophase II
Daughter cells
n
n
n
n
n
n

Meosis II

1. Prophase II

The chromosomes coil up, the nuclear membrane begins to disintegrate, and the centrosomes begin moving apart.

2. Metaphase II

Spindle fibers form and sister chromatids align to the equator of the cell.

3. Anaphase II

Sister chromatids separate.

4. Telophase II & Cytokinesis II

The chromatids reach the poles, and uncoil into thin threadlike chromatin. The nuclear membrane reforms from 2 diploid (2n) cells into 4 haploid (n) Daughter cells.

THANK YOU

Nabaa Faiz Abbas