



الوراثة الطبية 1 / الكورس الاول

Meiosis

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Third Stage

المرحلة الثالثة

محاضرة رقم 4

الجانب النظري : الوراثة الطبية

Lecture No. 4

Theoretical : Medical Genetics

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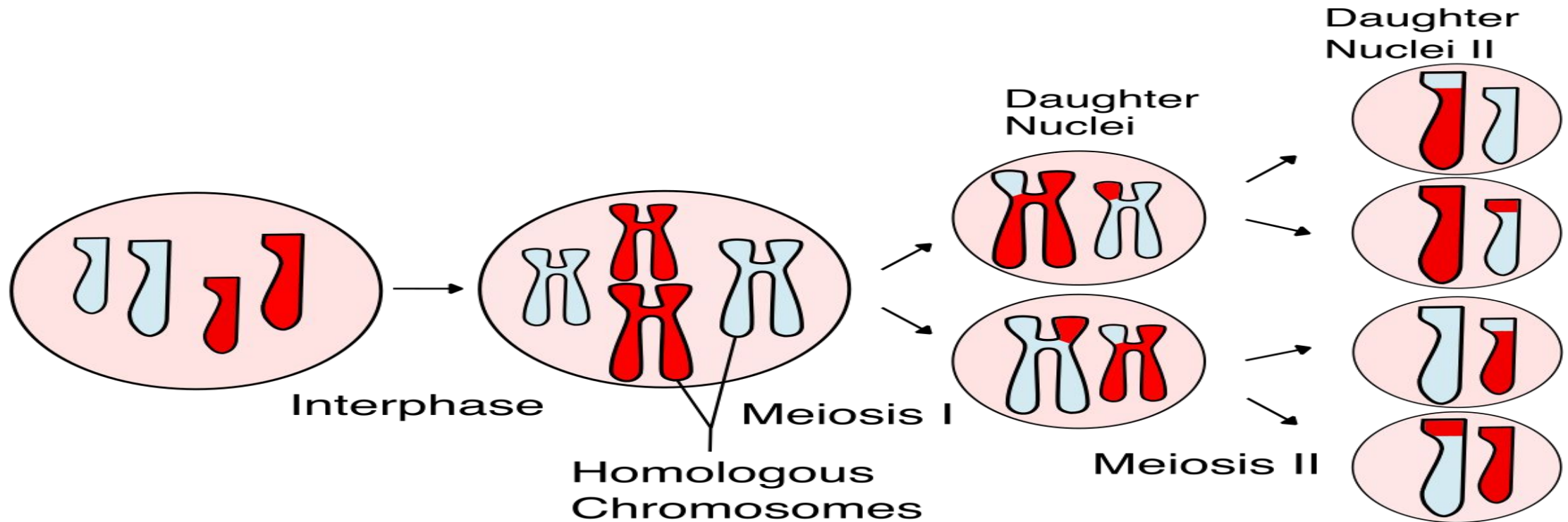
Learning Objectives

By the end of this lecture, you will be able to:

- Defines the concept of meiosis and its biological importance.
- Describes the main stages of meiosis in the correct sequence.
- Identifies the most important changes that occur to the nucleus and chromosomes during each stage.
- Explains the final outcome of meiosis and its impact on gamete formation.

Meiosis

- **Meiosis** or **Reduction cell division** is a process where a single cell divides twice to produce **four** daughter cells containing **half** the original amount of genetic material.
- **The function or purpose of meiosis?**
- To produce sexual cells are called as gametes (sperm in males, eggs in females).



Genetics Terminology

Ploidy refers to the number of sets of chromosomes in cells.

Haploid: It contains only one copy of chromosome, It is designated as "**n**"

Diploid: It contains two sets of chromosomes, It is designated as "**2n**"

Notes

1- Diploid organisms receive one of each type of chromosome from female parent and one of each type of chromosome from male

2- Chromosomes exist in **homologous pairs** in all diploid (2n) cells except in **Sex Chromosomes in male (XY) hetero chromosome**

There are two type of chromosome

1-Sex chromosomes

2- Autosomes chromosomes

Meiosis occurs in **two divisions**, known as **Meiosis I** and **Meiosis II**, each with its own stages of nuclear division

Meiosis I has following four sub stages :

- Prophase 1 Metaphase 1 Anaphase 1 Telophase 1
- Prophase 1 is **longer than the mitotic prophase** and is further subdivided into 5 sub stages, they are :

1-Leptotene

2-Zygotene

3-Pachytene

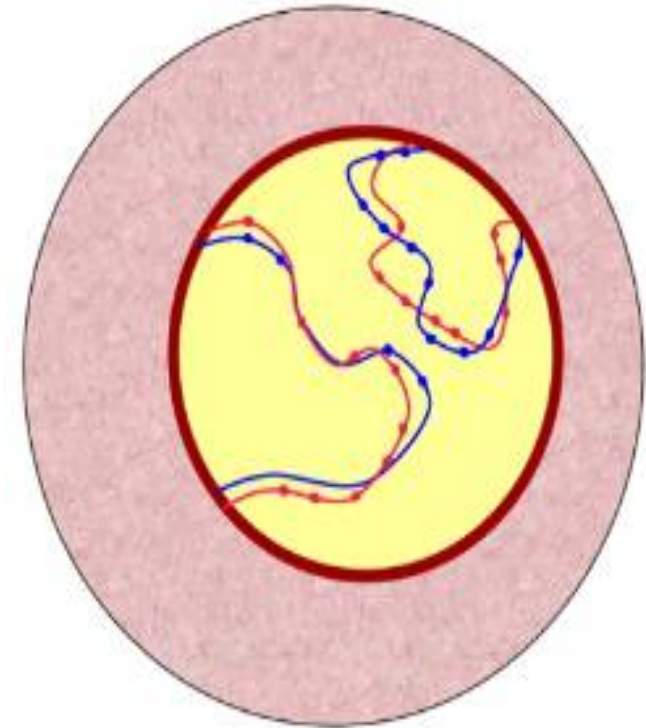
4-Diplotene

5-Diakinesis

Prophase1

Leptotene :

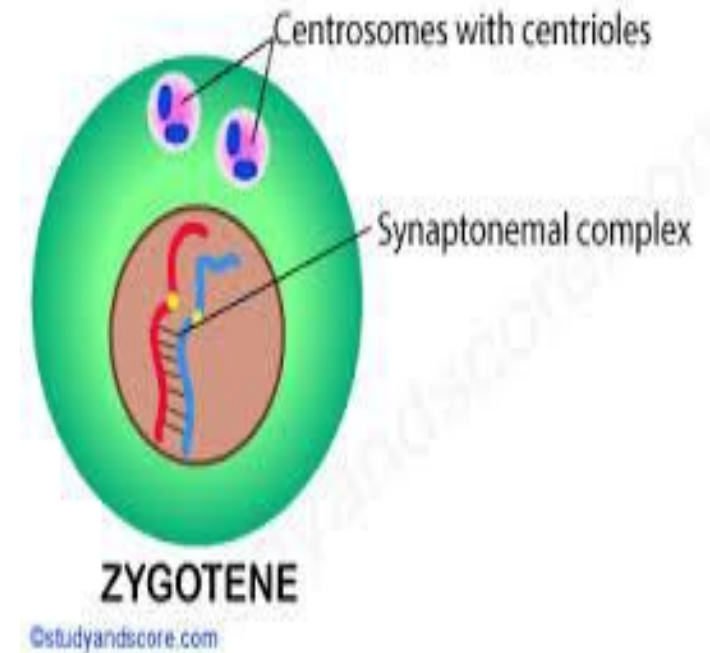
- 1- Leptotene is the first of five stages of Prophase - I
- 2-The chromosomes become visible and now they can be distinguished easily.
- 3-The chromosomes at this stage are likened to a string (DNA) with beads (Nucleosomes) called **chromomeres**.



Prophase1

Zygotene

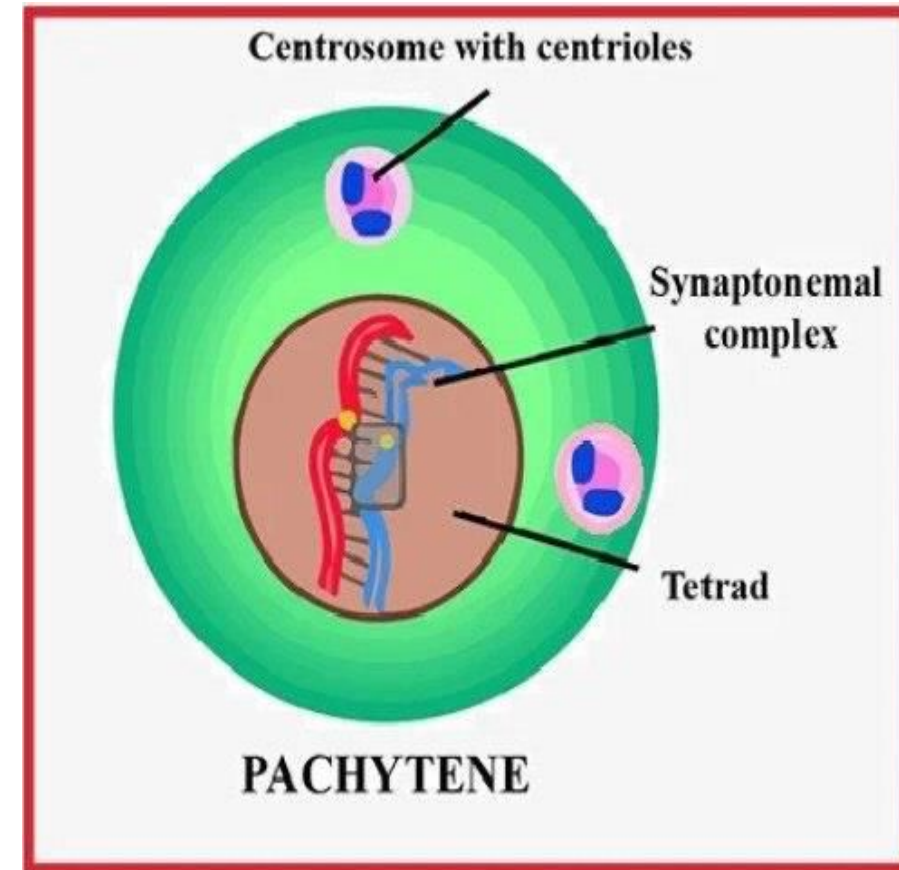
- In this stage, the homologous chromosomes begin to pair. This process is also known as **zygonema (Synapsis)**.
- These synapses can form along the entire length of the chromosomes, allowing numerous points of contact called '**synaptonemal complex**'.
- The synaptonemal complex facilitates synapsis by holding the chromosomes together along the entire length.
- After the homologous pairs synapse they are called **bivalents**.



Prophase1

PACHYTENE

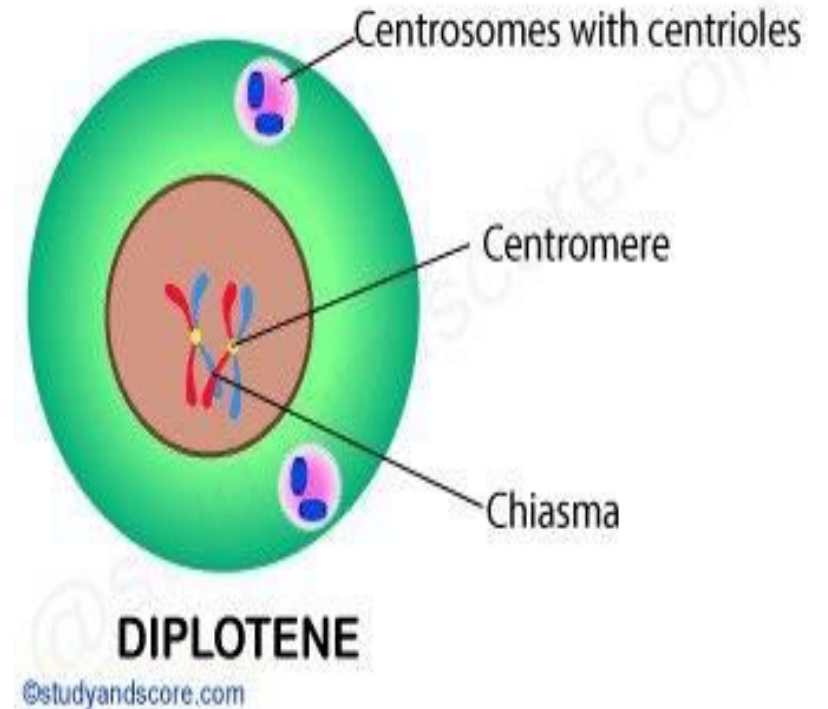
- Once the synapse is formed, the cell is ready for **crossing over**.
- At this stage, further **thickening and shortening** of the chromosomes occur.
- During this stage, **exchanges of chromosome material (gene)** between maternal and paternal homologous chromosomes occur by crossing over.
- At the points of crossing over, **X-shaped chiasmata** are seen in variable numbers.
- **Tetrad**: the pair of homologous chromosomes by non-sister chromatid by point contact, called x chiasmata, by which exchange genetic material (gene)



Prophase1

DIPLLOTENE

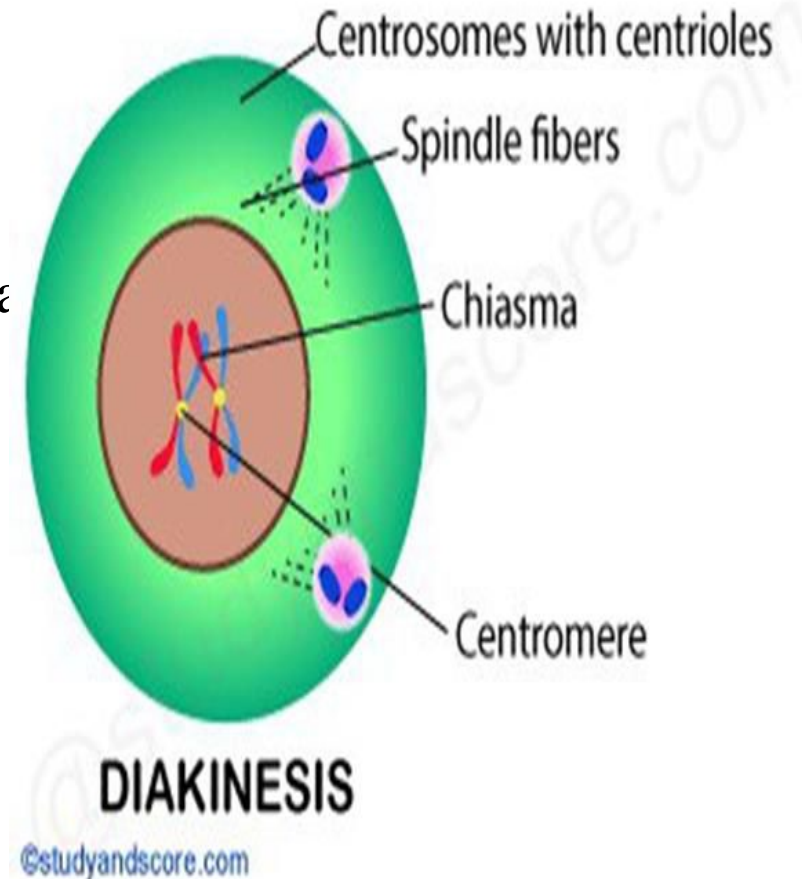
- In the "Diplotene" stage, the paired chromosomes begin to **get separated** from each other.
- While getting separated, the homologous chromosomes, **remain united at the points** of interchange of "Chiasmata".



Prophase1

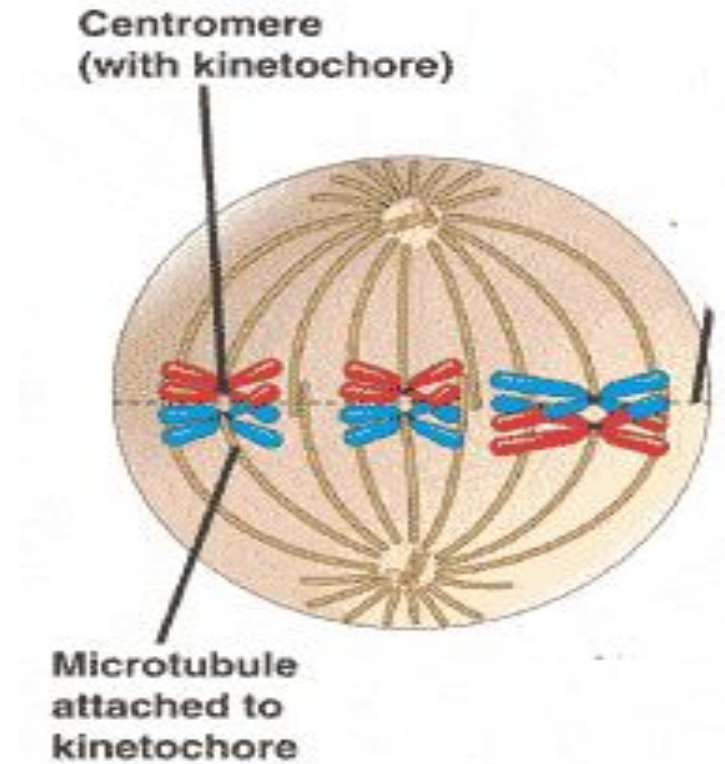
DIAKINESIS

- 1-In this stage, bivalents get **distributed** in the nucleus.
- 2-The nuclear membrane breaks down and the nucleolus disappears.
- 3- Chiasmata move towards the end, and this process is called **terminalization**.
- 4- Chromatids remain attached only at the terminal chiasmata and enter the metaphase1 stage.
- 4- **Tetrad** moves towards equatorial plate
- 5- spindle formation is initiated in this stage



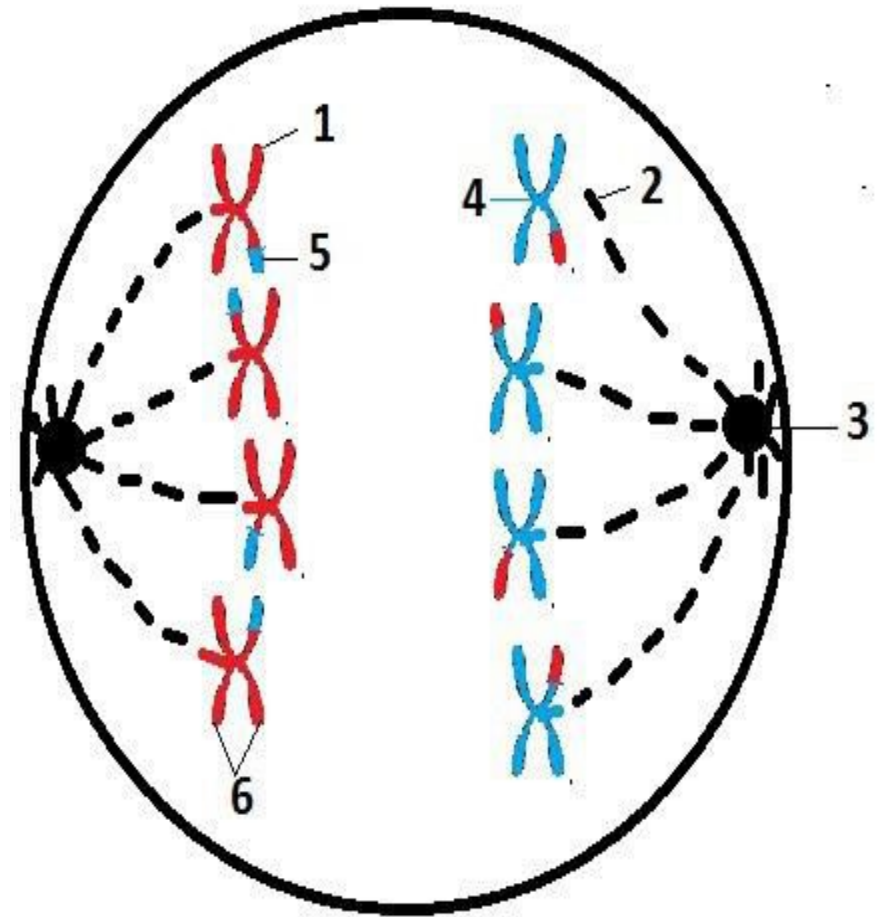
METAPHASE I

- In Metaphase I of meiosis homologous chromosomes align along the equator of the cell.
- Each chromosome in the pair is attached to the mitotic spindle by its own kinetochore.



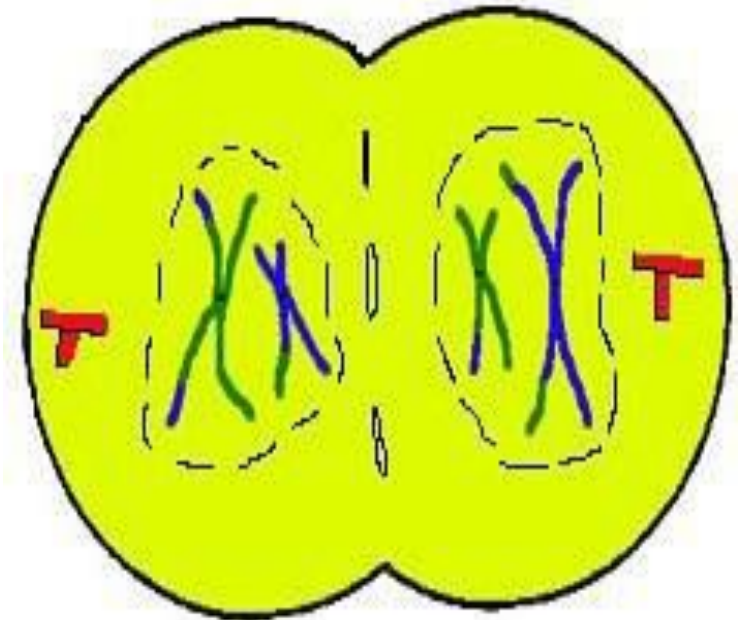
ANAPHASE 1

- microtubules **shorten** and **pull** the homologous chromosomes to opposite poles.
- The sister chromatids **remain tightly bound** together at the centromere.
- The points where chromosomes crossed (chiasmata) break when the spindle fibers pull the homologous chromosomes to opposite poles.



TELOPHASE 1

- This is the end of the first division (meiosis 1).
- Each daughter cell now has half the number of chromosomes but **each chromosome consists of a pair of chromatids**.
- The microtubules that make up the spindle network disappear, and a new nuclear membrane surrounds each haploid set.
- The chromosomes **back** into chromatin.
- **Cytokinesis** occurs, completing the creating of two daughter cells



MEIOSIS II

MEIOSIS II

- Meiosis II initiates immediately after cytokinesis.
- interphase **lacks an S phase**, so chromosomes are not duplicated.
- The two cells produced in meiosis I go through the events of meiosis II together.
- During meiosis II, the sister chromatids within the two daughter cells separate, **forming four new haploid gametes.**
- The mechanics of meiosis II is similar to mitosis, **except that each dividing cell has only one set of homologous chromosomes.**

The key features of meiosis in a structured format:

- **Main purpose:** To produce gametes (sperm and egg cells) with half the number of chromosomes, ensuring genetic diversity through recombination.
- **Number of divisions:** Two nuclear divisions (Meiosis I and Meiosis II).
- **Number of resulting cells:** Four haploid daughter cells.
- **Chromosome number:** Reduced by half (from 46 to 23 chromosomes in humans).
- **Genetic variation:** Occurs due to crossing-over (recombination) and independent assortment, producing genetically unique daughter cells.
- **Phases:**
 - **Meiosis I:** Prophase I → Metaphase I → Anaphase I → Telophase I (followed by Cytokinesis).
 - **Meiosis II:** Prophase II → Metaphase II → Anaphase II → Telophase II (followed by Cytokinesis).
- **Function:** Formation of gametes for sexual reproduction and maintenance of chromosome number across generations.

Any questions?

*Thank
You*