

# **Cell-division- Meiosis**

**Prepared b: Prof Fardous Karoya**

<https://youtu.be/Outf9puEPXs>

# Comparison of Divisions

## Mitosis

## Meiosis

**Number of divisions**

**1**

**2**

**Number of daughter cells**

**2**

**4**

**Genetically identical?**

**Yes**

**No**

**Chromosome**

**Same as parent**

**Half of parent**

**Where**

**Somatic cells**

**Germ cells**

**When**

**Throughout life**

**At maturity**      **sexual**

**Role**

**Growth and repair**

**Sexual reproduction**

# The Stages of Meiosis

## Interphase

- ❑ Similar to **mitosis** interphase.(G1,S,G2)
- ❑ **Chromosomes = DNA** replicate (**S- phase**).
- ❑ **Centriole** also replicate
- ❑ Each duplicated **chromosome** consist of two identical sister **chromatids** attached at their **centromeres**
- ❑ After chromosomes duplicate, two divisions follow
  - ❑ Meiosis **I** (reductional division): homologs pair up and separate, resulting in two haploid daughter cells with replicated chromosomes
  - ❑ Meiosis **II** (equational division) sister chromatids separate
- ❑ The result is four haploid daughter cells with unreplicated chromosomes

- ❑ Meiosis I is preceded by interphase, when the chromosomes are duplicated to form sister chromatids
- ❑ The sister chromatids are genetically identical and joined at the centromere
- ❑ The single centrosome replicates, forming two centrosomes
- ❑ Division in meiosis I occurs in four phases
  - ❖ Prophase I
  - ❖ Metaphase I
  - ❖ Anaphase I
  - ❖ Telophase I and cytokinesis

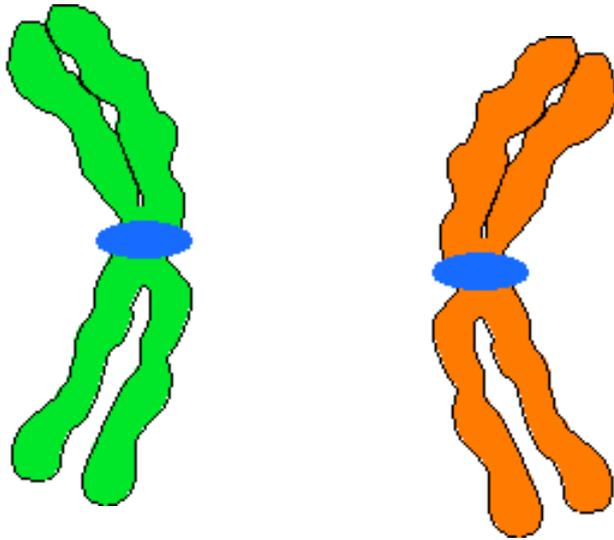
<https://youtu.be/BVO-Ram1L2M>

# Prophase I

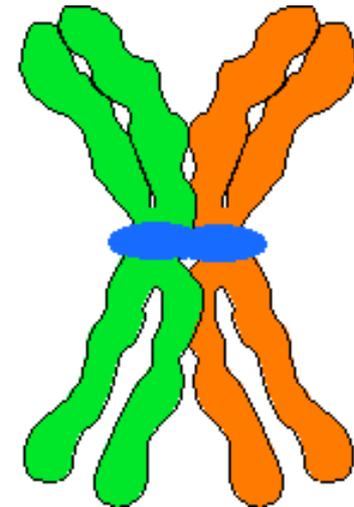
- Longest and most complex phase
- 90% of the meiotic process is spent in Prophase I
- This stage is composed of **5 stages:**
  - 1- Leptotene (thin threads )
  - 2- Zygotene (Homologous bivalent = **synapsis** )
  - 3- Pachytene (condense short & thick)
  - 4- Diplotene (**crossing –over**)
  - 5- Diakinesis + (nuclear memb & nucleoles disappear)
- **Chromosomes** condense.
- **Synapsis** occurs: **homologous chromosomes** come together to form a **tetrad**.
- **Tetrad** is two **chromosomes** or four **chromatids**

# Tetrads Form in Prophase I

**Homologous chromosomes**  
**(each with sister chromatids)**



**Join to form a**  
**TETRAD**



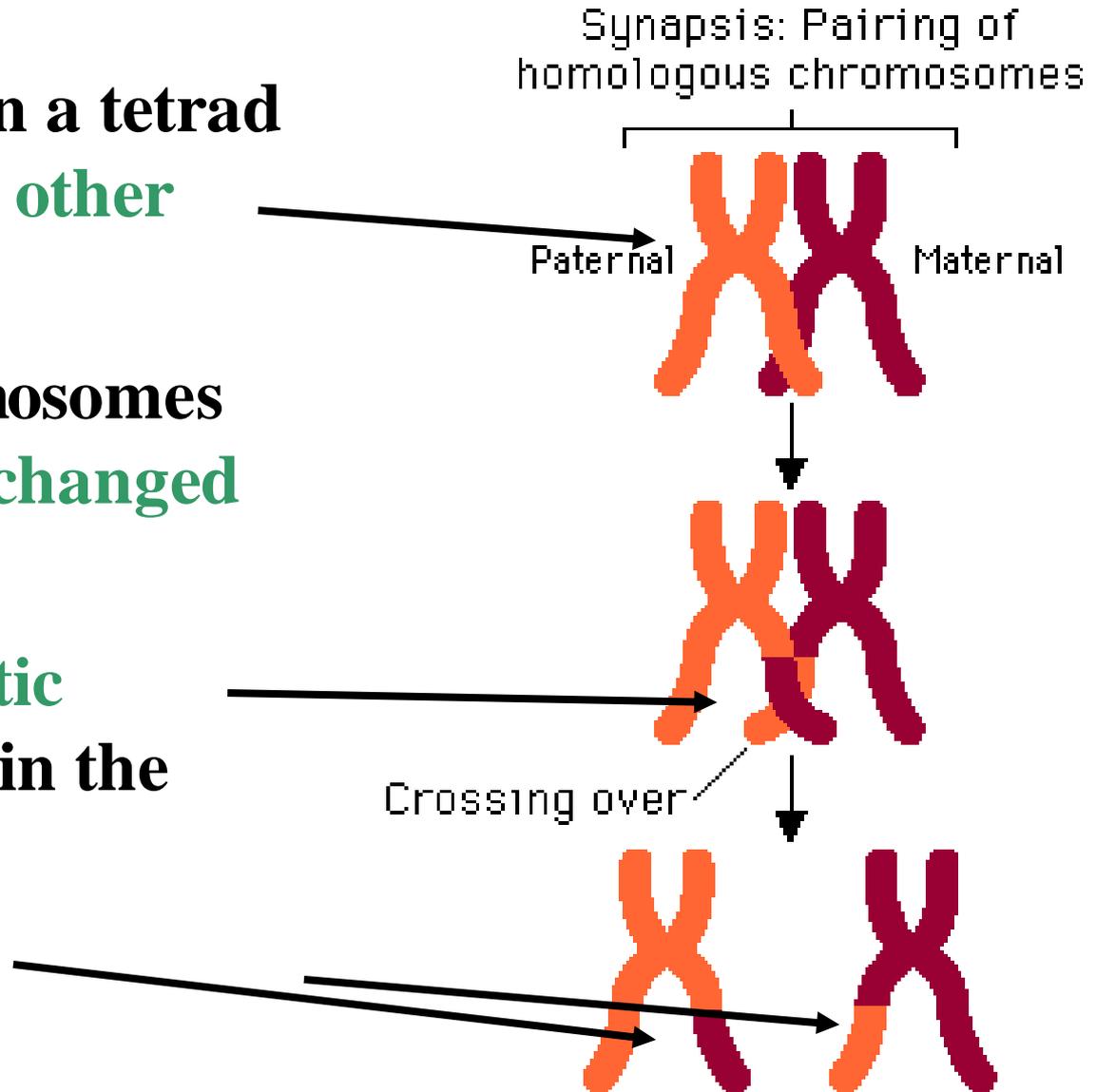
**Called Synapsis**

# Crossing-Over

✓ **Homologous chromosomes in a tetrad cross over each other**

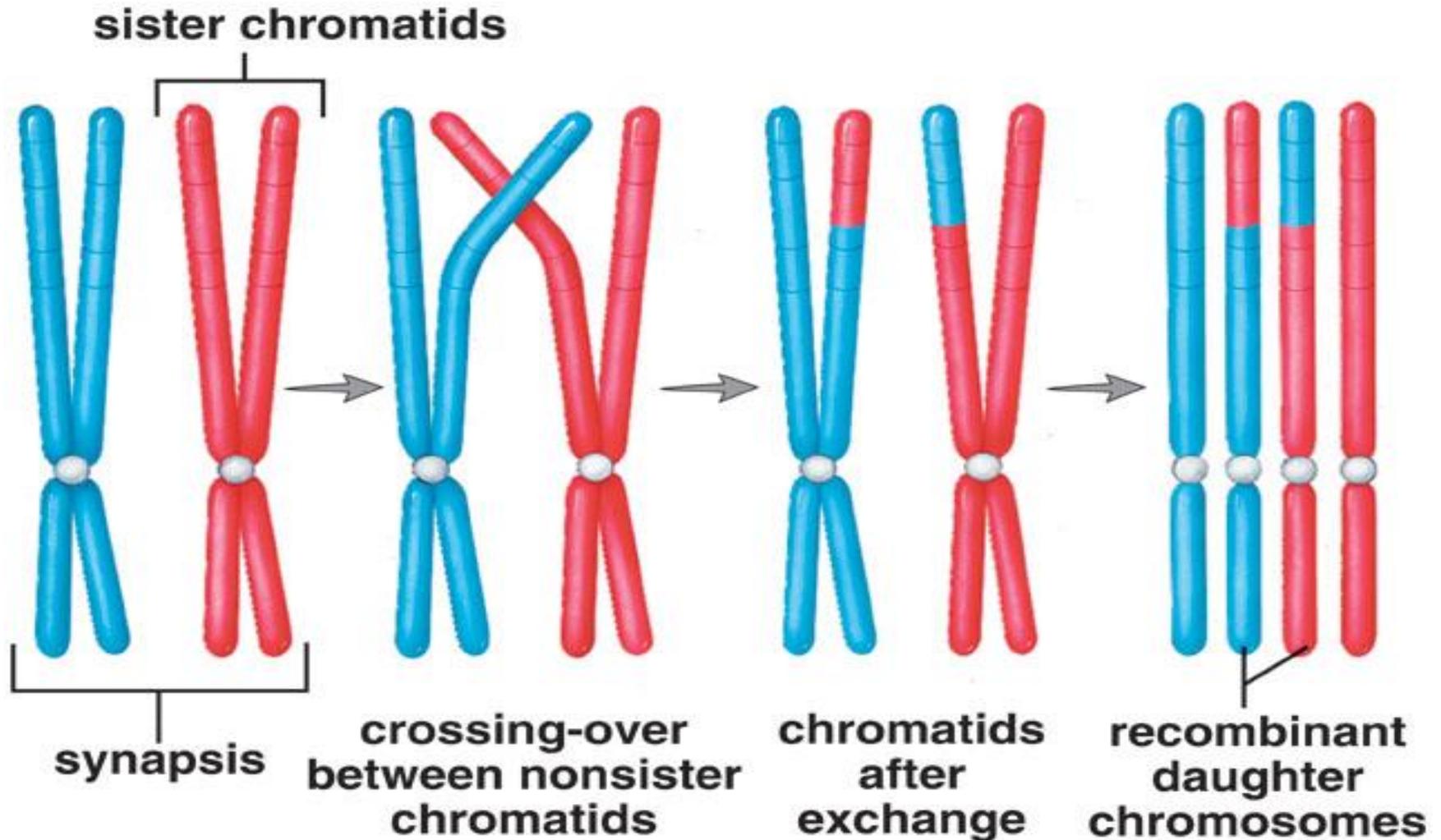
✓ **Pieces of chromosomes or genes are exchanged**

✓ **Produces Genetic recombination in the offspring**



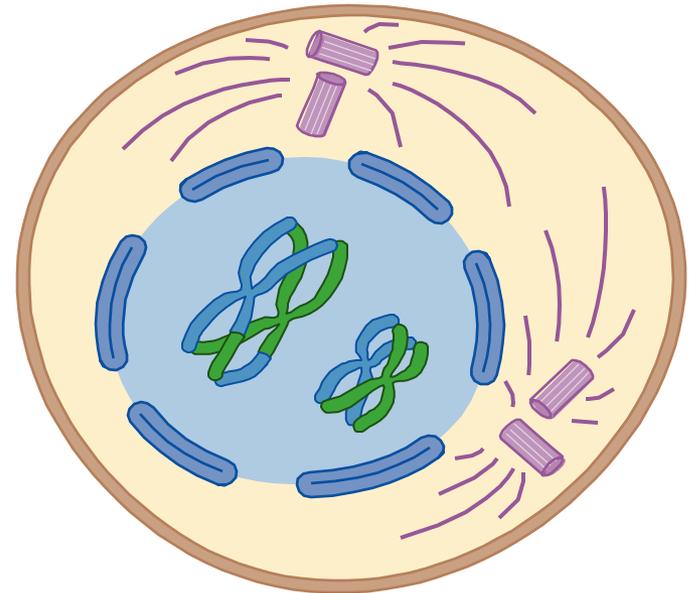
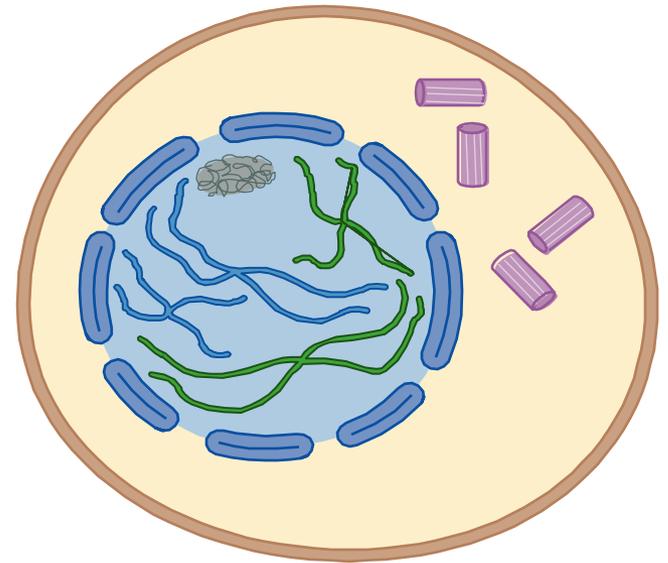
# Synapsis and crossing-over

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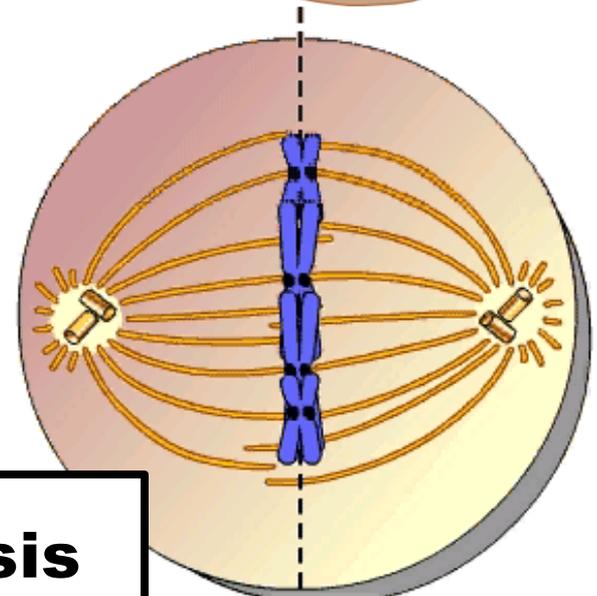
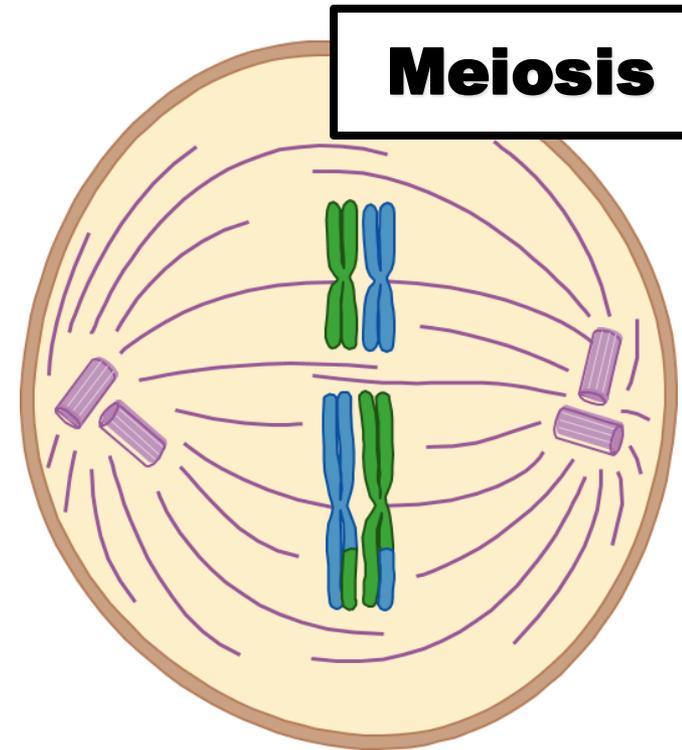
# Prophase I

- ✓ Chromosomes condense.
- ✓ Spindle forms.
- ✓ Nuclear envelope fragments
- ✓ Homologs pair.
- ✓ **Tetrads**—**Called Synapsis**
- ✓ **Crossing over** occurs.



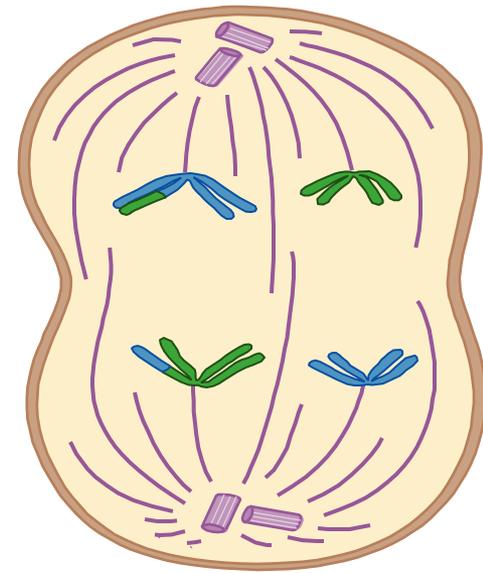
# Metaphase I

- The chromosomes line up at the equator attached by their centromeres to spindle fibers from centrioles.
  - Still in homologous pairs
  - **Homologous pairs** of chromosomes align along the **equator** of the cell
- **Homologs separate** and move to opposite poles.
- **Sister chromatids** remain
- **attached** at their **centromeres**.

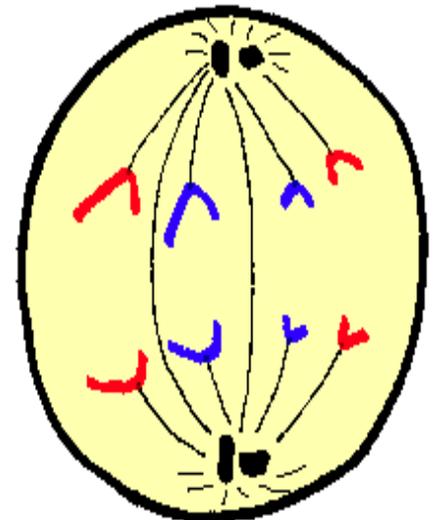


# Anaphase I

- The spindle guides the movement of the chromosomes toward the poles
  - Sister chromatids remain attached
  - Move as a unit towards the same pole
- The homologous chromosome moves toward the opposite pole
  - Contrasts mitosis – chromosomes appear as **Sister chromatids** instead of pairs in (meiosis)



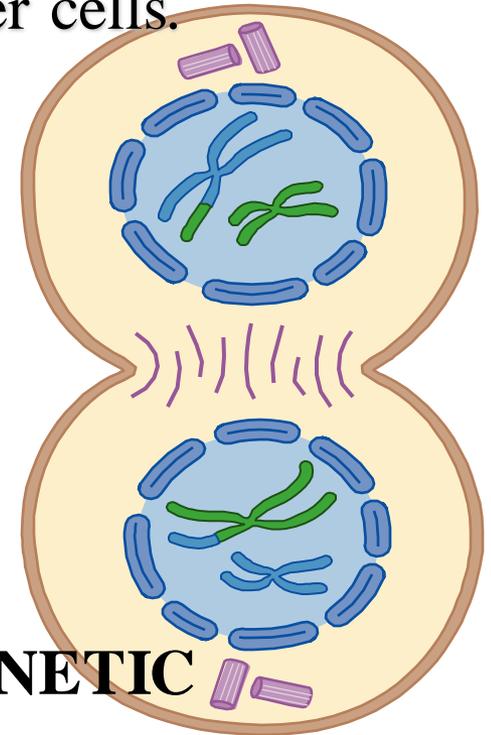
**Meiosis**



**Mitosis**

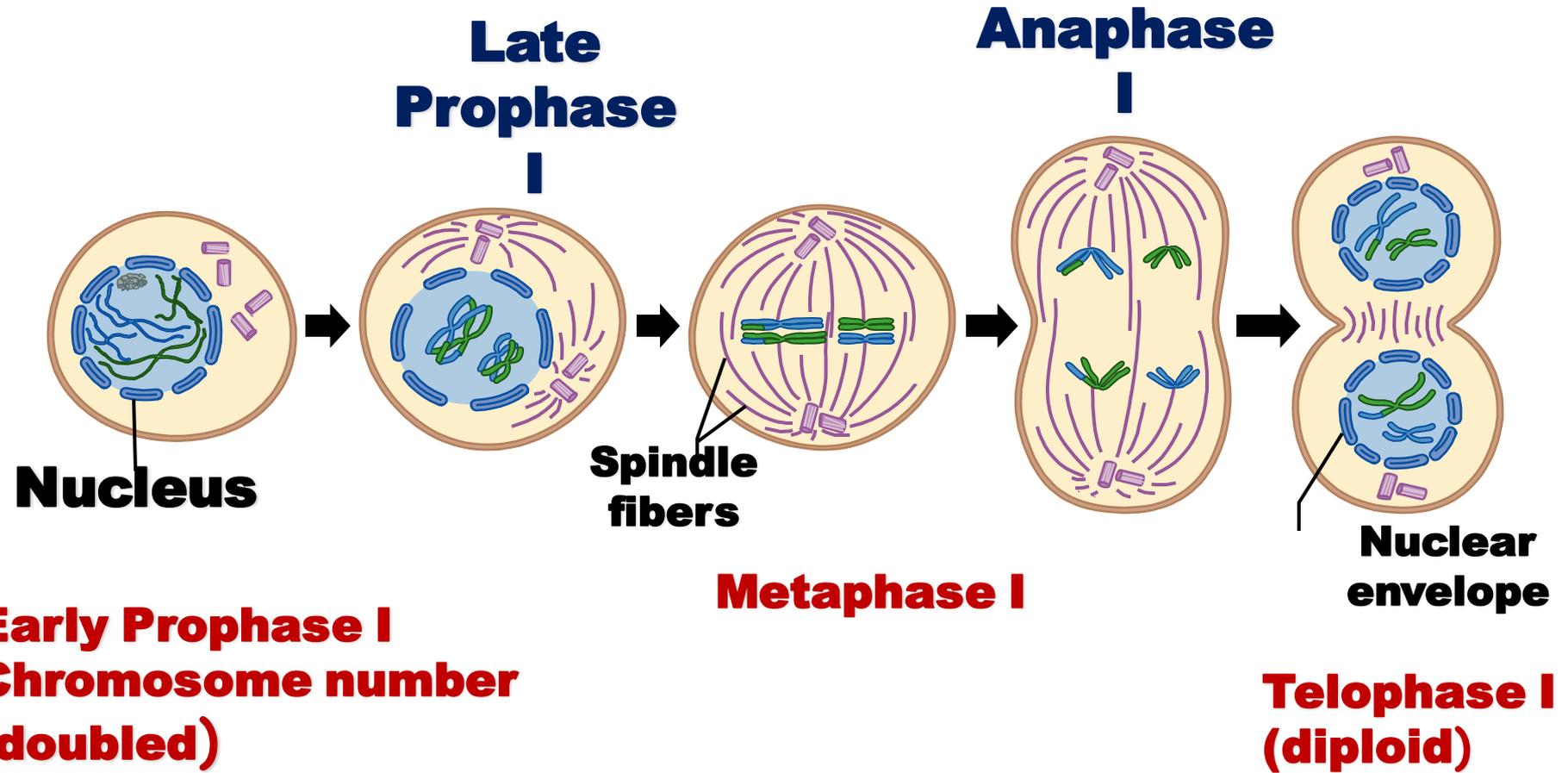
# Telophase I

- This is the end of the first meiotic cell division.
- The cytoplasm divides, forming two new daughter cells.
- Nuclear envelopes reassemble.
- Spindle disappears.
- **Cytokinesis** divides cell into two.
- Occurs simultaneously with telophase I
  - Forms 2 daughter cells
- **NO FURTHER REPLICATION OF GENETIC**



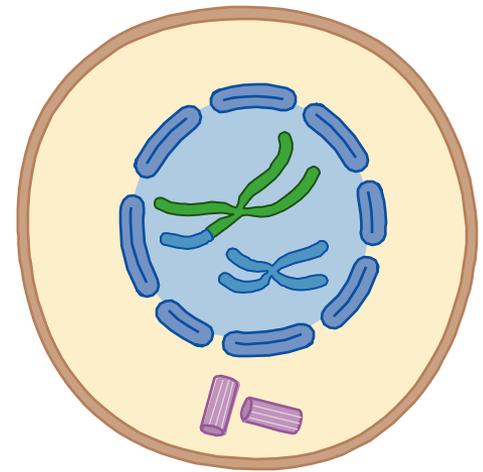
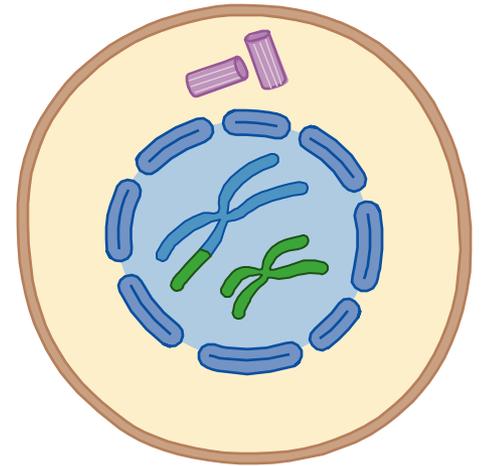
**MATERIAL PRIOR TO THE SECOND DIVISION  
OF MEIOSIS**

# Meiosis I: Reduction Division



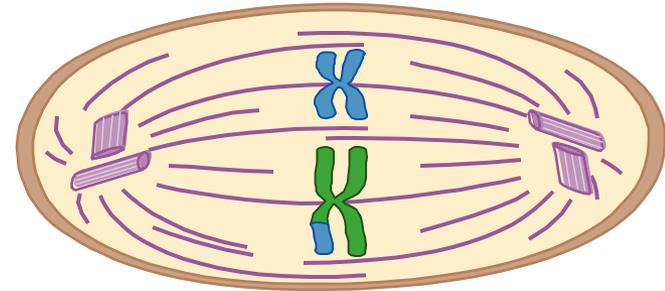
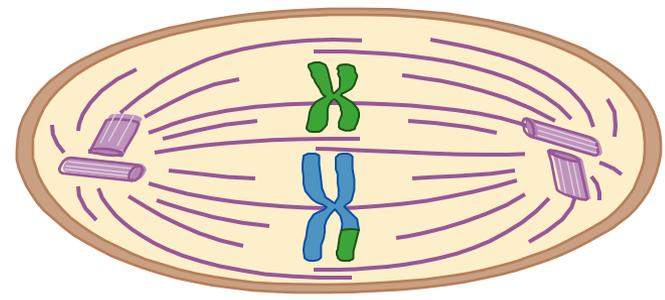
# Meiosis II :

- Prophase II
- Separates sister chromatids
- Proceeds similar to mitosis
- THERE IS **NO INTERPHASE II !**
- Each of the daughter cells forms a spindle, and the double stranded chromosomes move toward the equator
- Nuclear envelope fragments.
- Spindle forms.



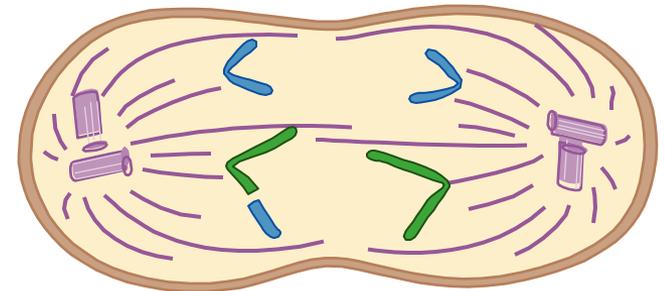
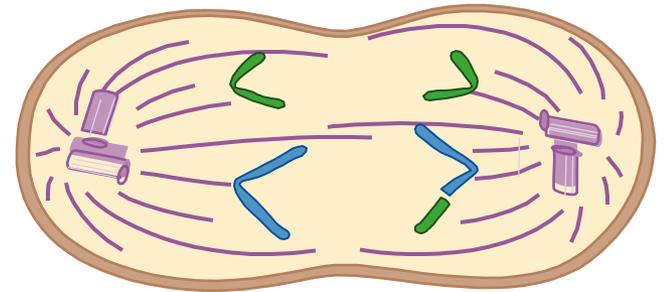
# Metaphase II

- The chromosomes are positioned on the metaphase plate in a mitosis-like fashion
- Chromosomes align
- along **equator** of cell.



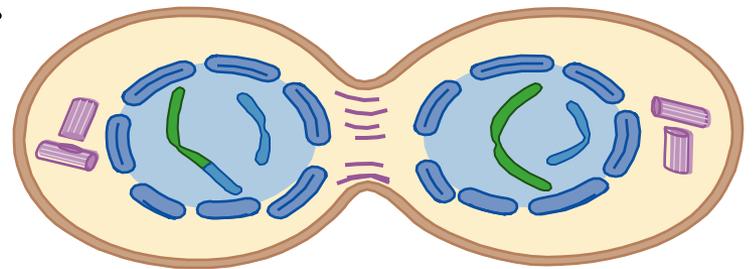
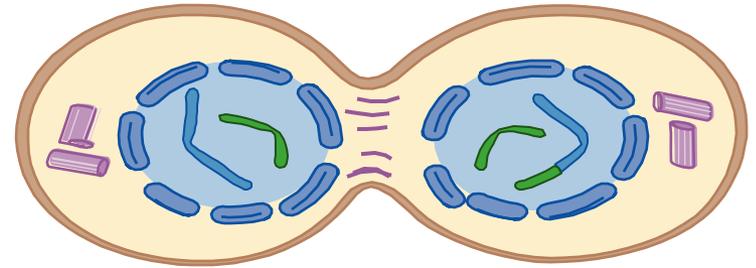
# Anaphase II

- The centromeres of sister chromatids finally separate
- The sister chromatids of each pair move toward opposite poles
- **Sister chromatids** separate and move to **opposite poles**.



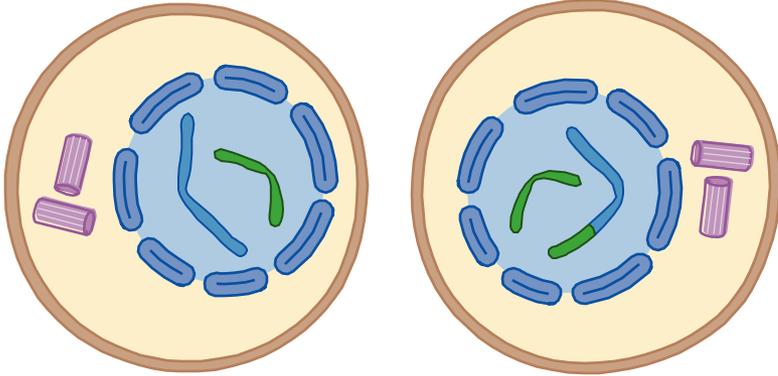
# Telophase II and Cytokinesis

- Nuclei form at opposite poles of the cell and cytokinesis occurs
- After completion of cytokinesis there are four daughter cells
  - All are haploid ( $n$ )
- Nuclear envelope assembles.
- Chromosomes decondense.
- Spindle disappears.
- Cytokinesis divides cell into two.

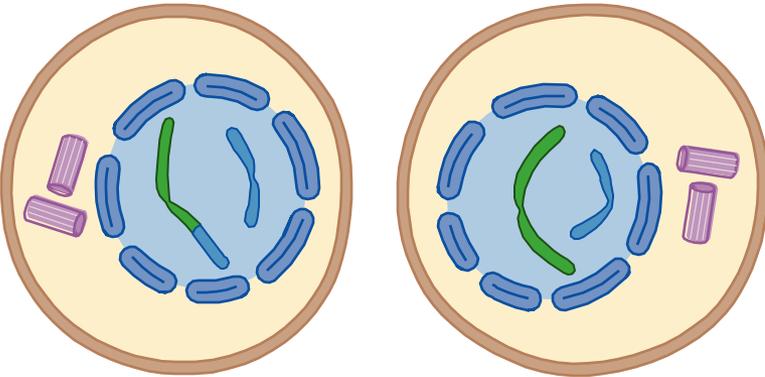


# Results of Meiosis

**Gametes (egg & sperm)  
form**

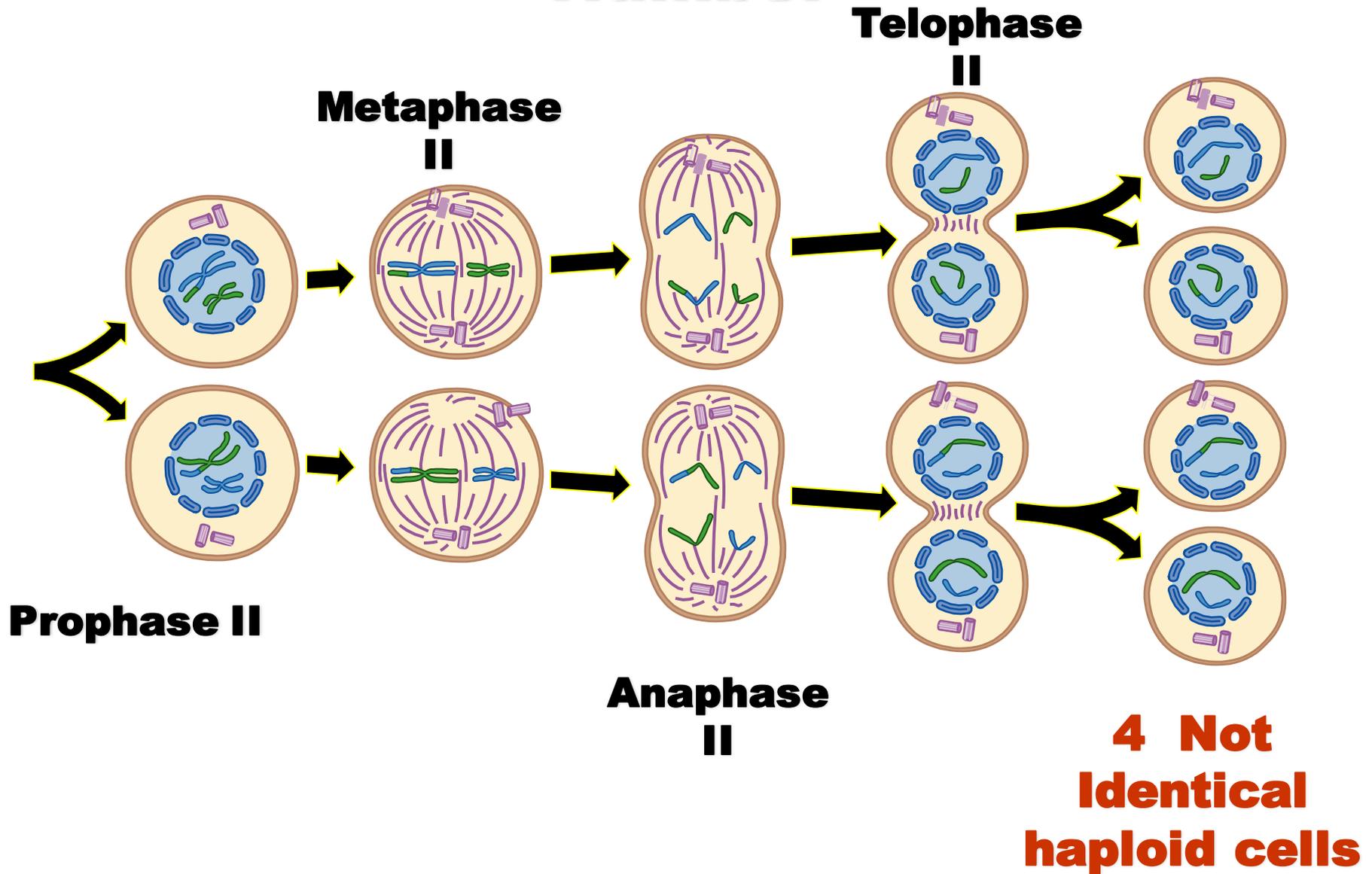


**Four haploid cells with  
one copy of each  
chromosome**



**Different combinations  
for different genes along  
the chromosome**

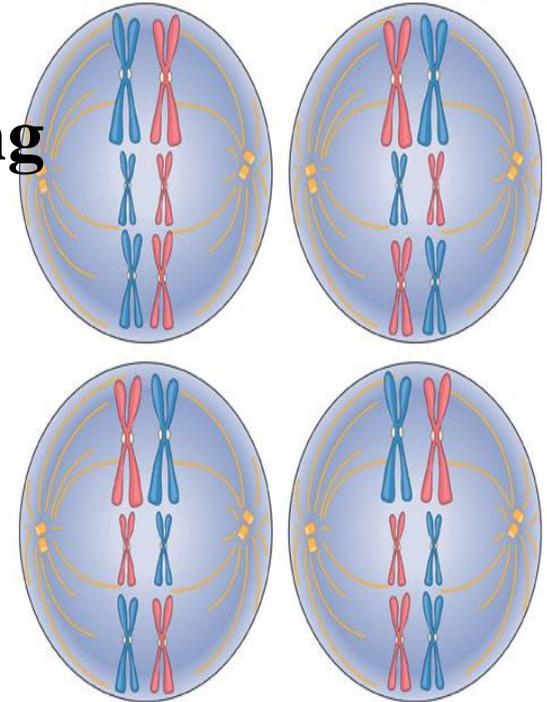
# Meiosis II: Reducing Chromosome Number



# Genetic Diversity

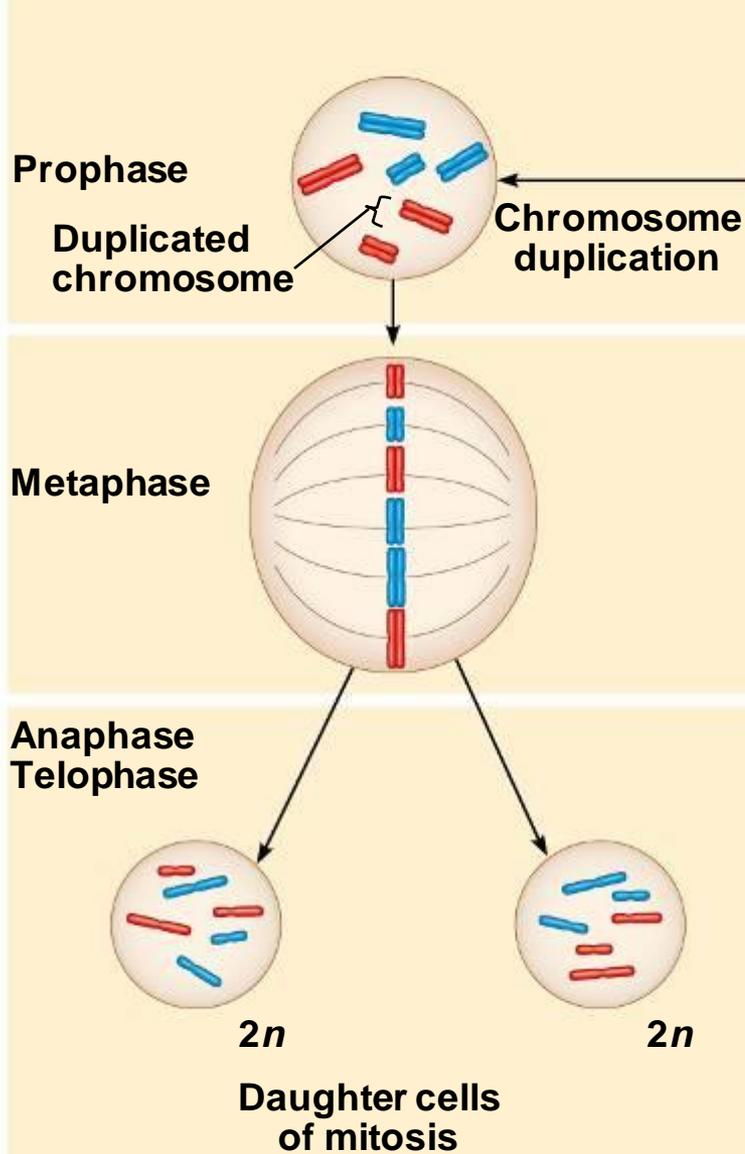
- ❑ Meiosis increases genetic diversity.
- ❑ Genetic Variation Among Offspring
  - ❑ **Two points of genetic recombination.**
  - **Crossing-over** of non sister chromatids—Prophase 1
  - **Independent assortment** of homologous chromosomes during Metaphase 1

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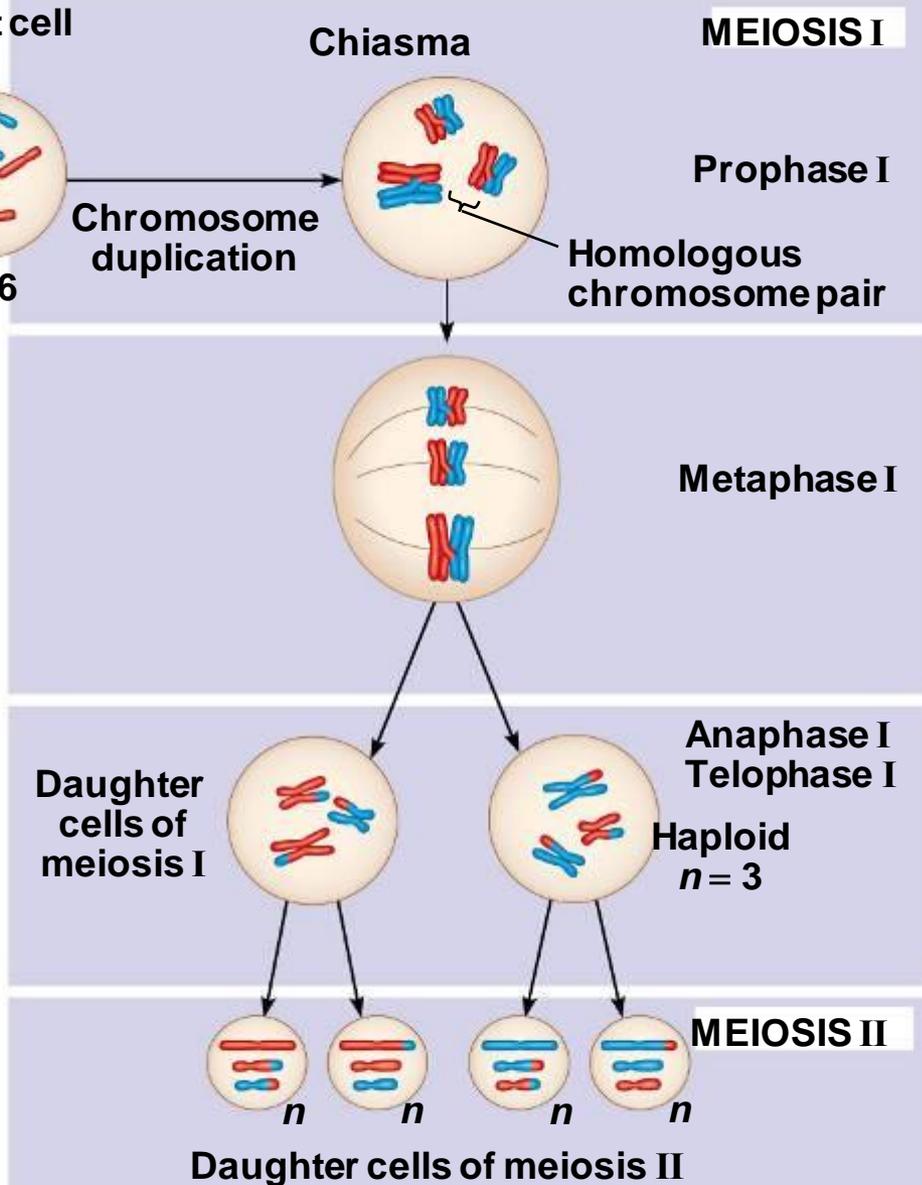


**Independent assortment**

# MITOSIS



# MEIOSIS



# Recommended videos

- <https://youtu.be/g3lhIOei8Sw>
- <https://youtu.be/VzDMG7ke69g>