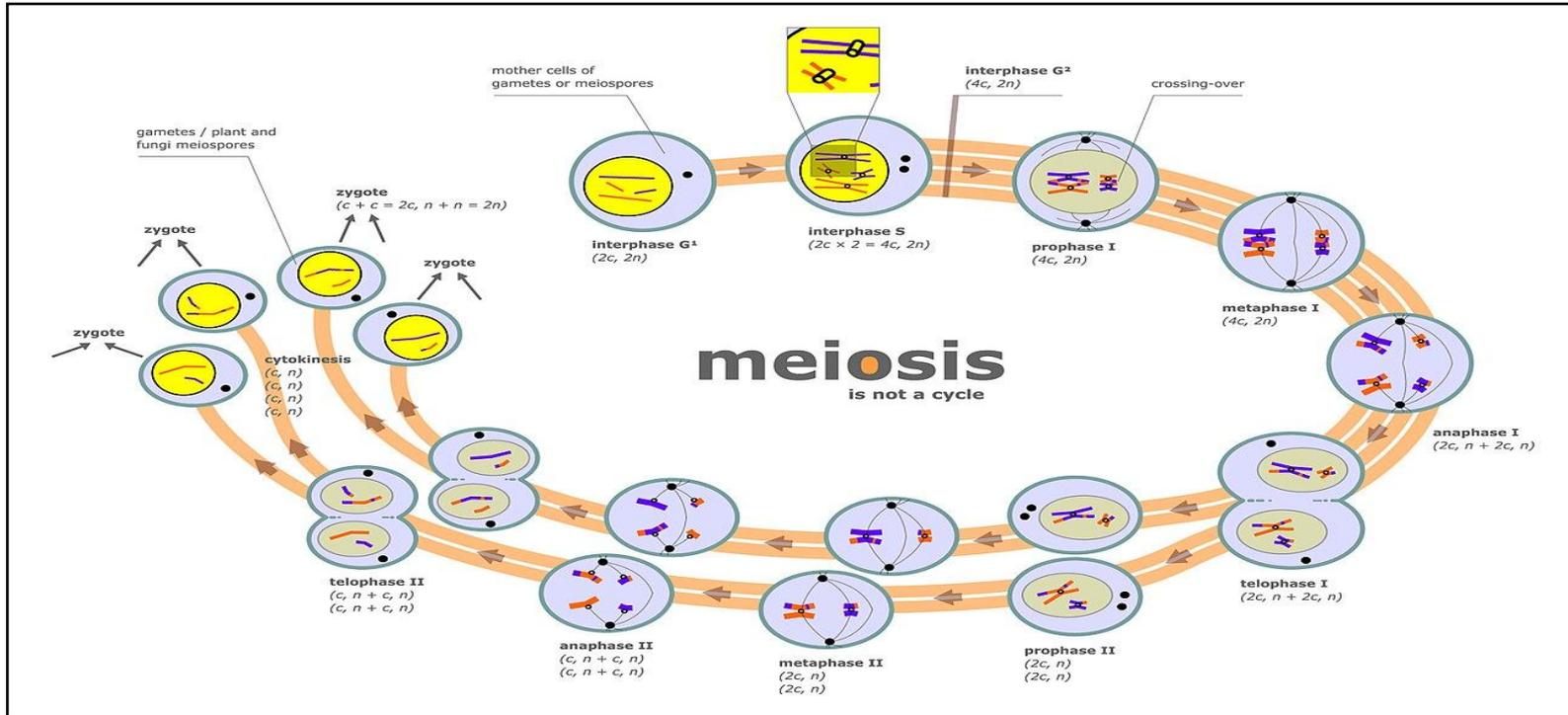


MEIOSIS



By

Dr. Heba Sharaf Eldin

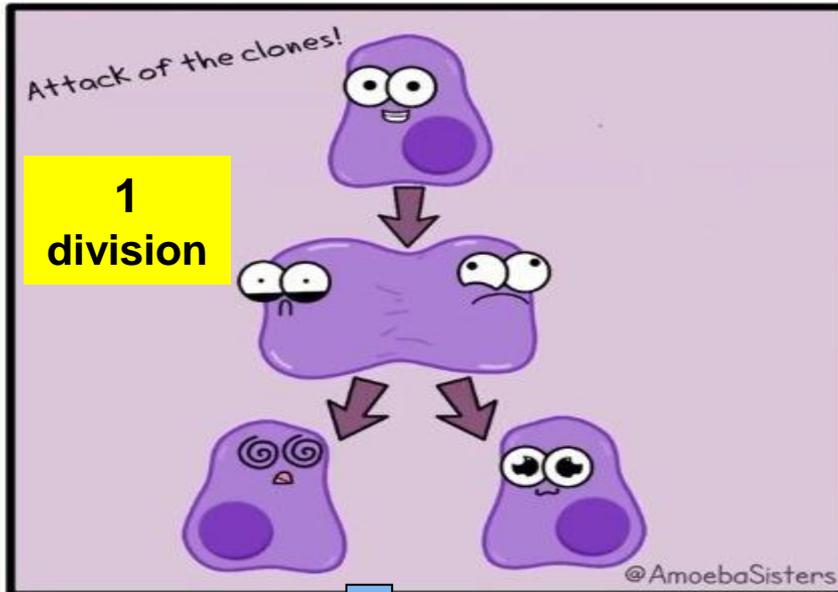
Associated Professor of Histology & Cell Biology

OBJECTIVES

- ✓ Describe the events that characterize each phase of meiosis I & II
- ✓ Explain the cause of genetic variation occur during meiosis.
- ✓ Distinguish between mitosis & meiosis.

MITOSIS

Somatic cell
(46 chromosomes) (diploid)

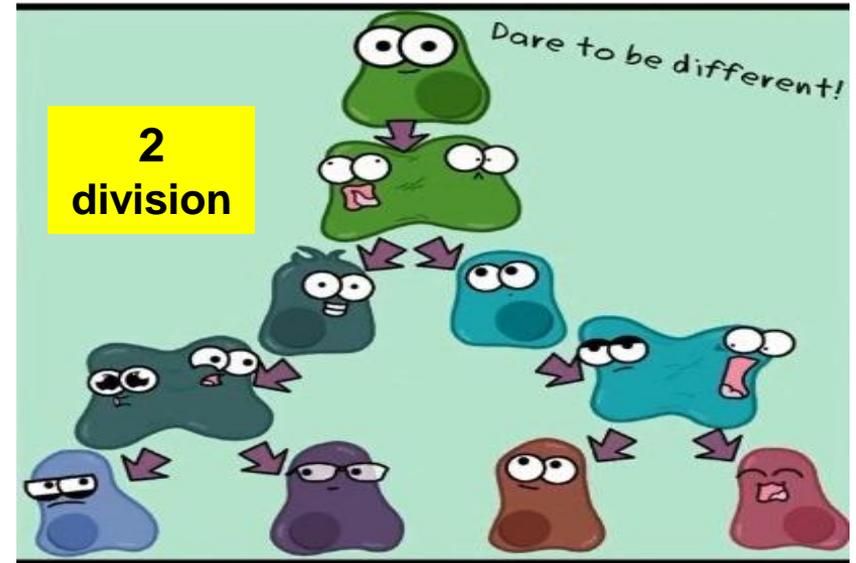


2 identical daughter cells (46 chromosomes) (diploid)

Growth & repair

MEIOSIS

cell will form sperm & ova
(46 chromosomes) (diploid)



4 cells (23 chromosomes) (haploid)

Sexual reproduction

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	Ovary & testis
When	Throughout life	At sexual maturity
Role	Growth and repair	Sexual reproduction

Meiosis

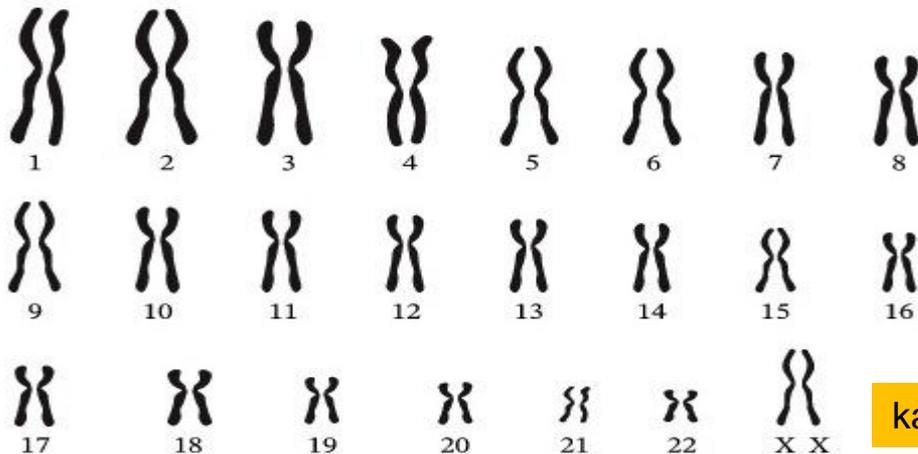
- ❑ A specialized type of cell division that produce **gametes** (germ cells); **spermatozoa** and **ova**.
- ❑ Occurs only in **testis & ovary**.
- ❑ Meiotic cell division is also called ***gametogenesis***
- ❑ **Includes: 2** and **closely associated** cell divisions.
- ❑ **Results in:**
 1. **Reduction** in the number of chromosomes from diploid to **haploid number** in each **gamete cell**.
 2. **Recombination** of genes, ensuring **genetic variability**.

Meiosis is divided into 2 separate events

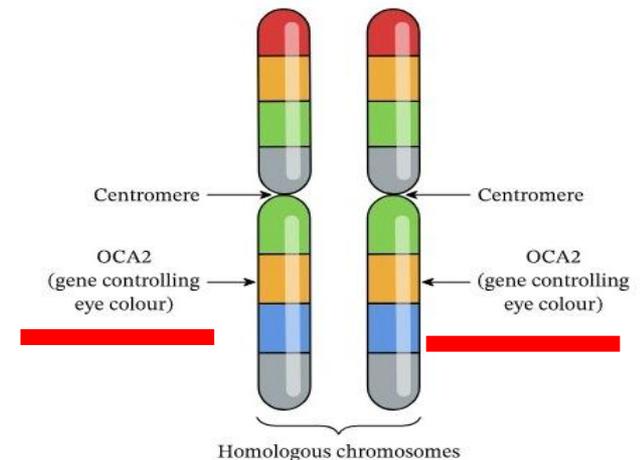
- ✓ **Meiosis I (Reductional- division)** separates the homologous chromosomes.
- ✓ **Meiosis II (Equatorial-division)** separates the sister chromatids.

Homologous chromosomes

- Two [chromosomes](#) in a pair.
- One inherited from the **mother** and one from the **father**
- Example: the two copies of **Chromosome 1** in a [cell](#) would be referred to as homologous chromosomes.
- The chromosomes in a homologous pair **have the same genes** (carry the same type of information)

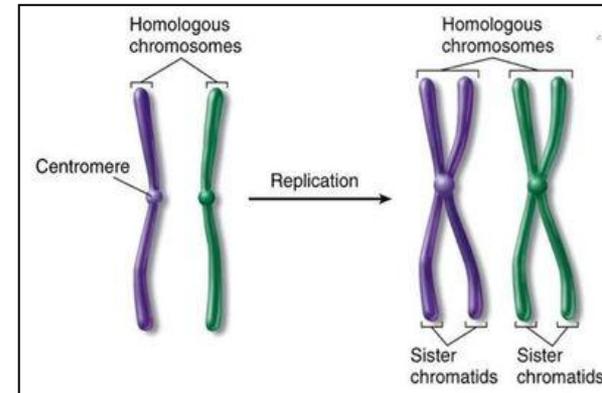


karyotyping



Meiosis I (Reduction division)

- Meiosis I is preceded by interphase, in which the cell replicated its DNA in S phase.
- Each duplicated chromosome contains **two identical DNA molecules** called **sister chromatids** joined at the centromere.

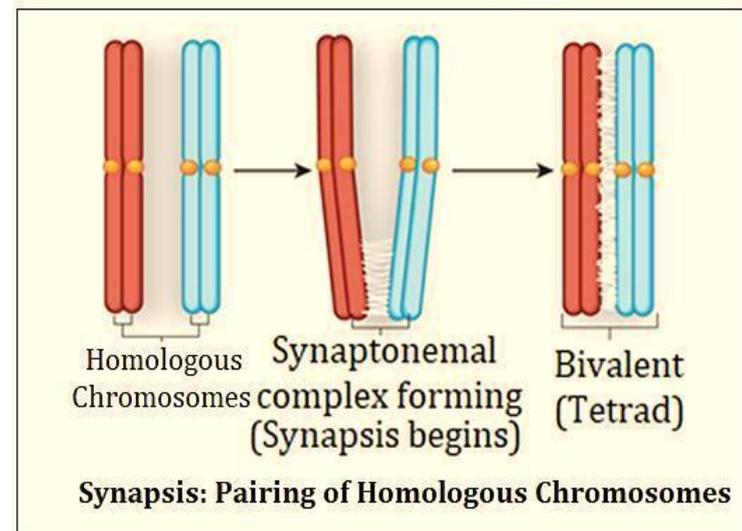
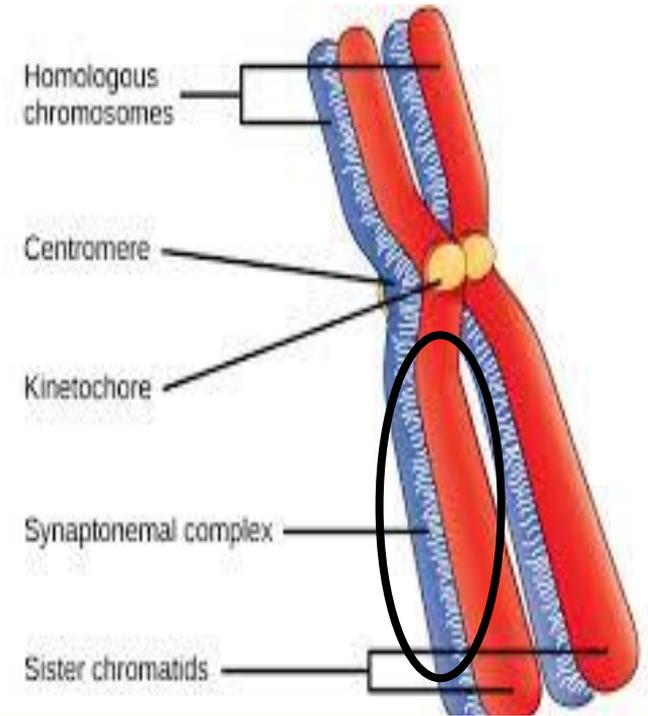


Division in **meiosis I** includes :

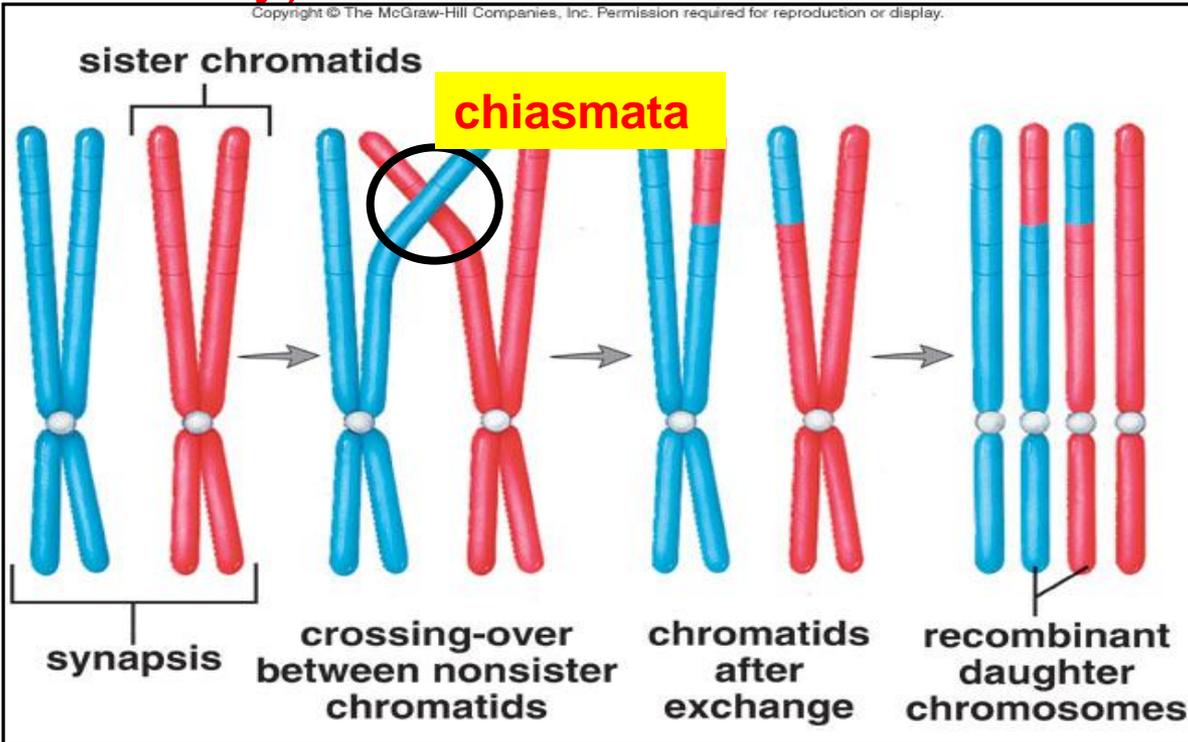
Prophase I, Metaphase I, Anaphase I, Telophase I and cytokinesis

Prophase I: Lasts a **long time** (90% of the time of meiosis).

- Chromosomes begin to condense (shorter & thicker).
- Homologous chromosomes come together and associated along their lengths in a process called **synapsis**.
- They unite by a protein called **synaptonemal complex**.
- **Homologous chromosomes** are arranged in 23 pairs .
- Each pair consists of four chromatids (*tetrads*).

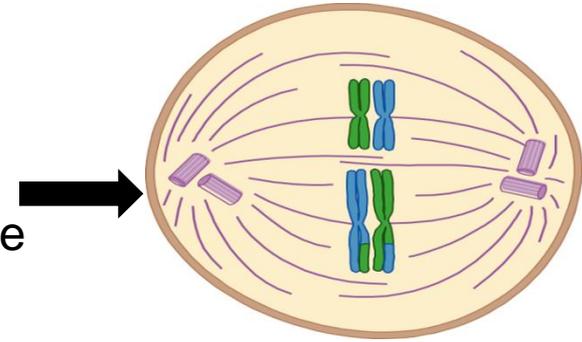


- During synapsis, **crossing over** between non-sister homologous chromatids takes place through **chiasmata** (X-shaped regions) for **DNA exchanges** which mixes up the genes inherited from each parent and form **a new and different set of genes** to be passed on to the next generation (**genetic diversity**).



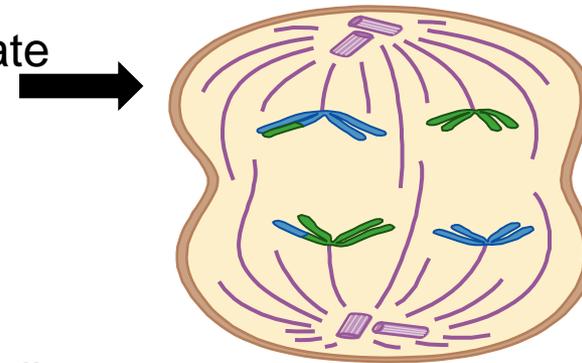
Metaphase I:

- **Homologous chromosomes** are arranged in **equatorial plane**.
- Mitotic spindle become attached to the kinetochores of the chromosomes.



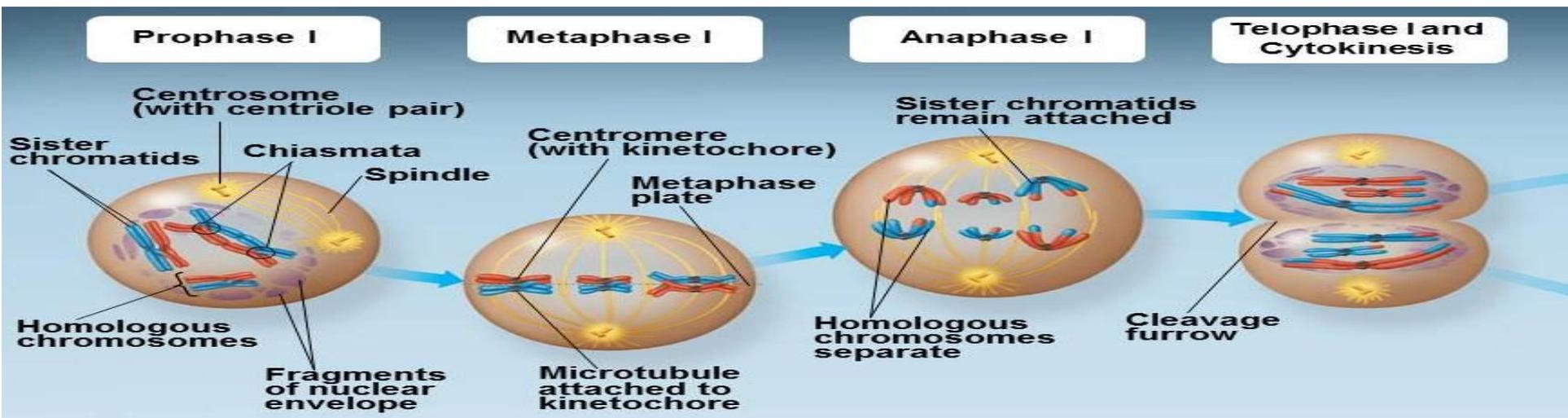
Anaphase I:

- Homologous chromosomes (Each two chromatids) migrate away from each other, going to opposite poles.



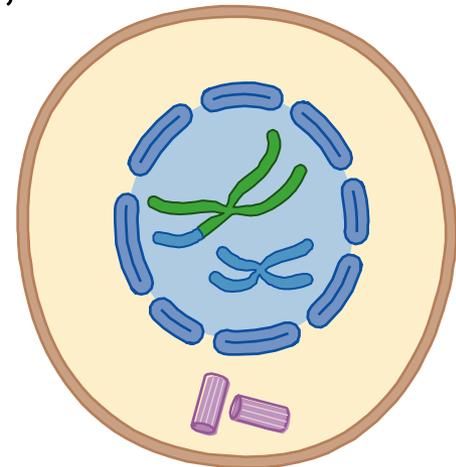
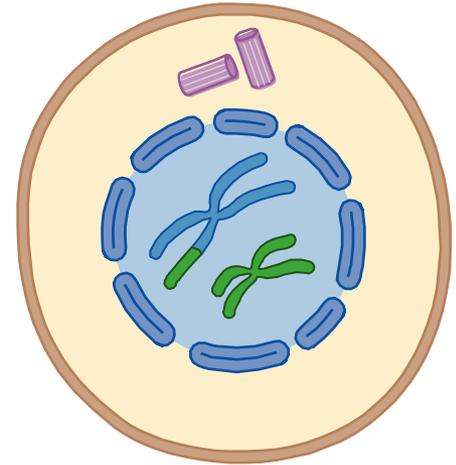
Telophase I:

- The chromosomes reach the opposing poles.
- Nuclei are reformed
- cytokinesis occurs giving rise to **2 daughter cells** each cell contains (**23 d-chromosomes**), each chromosome consists of two chromatids held by centromere.

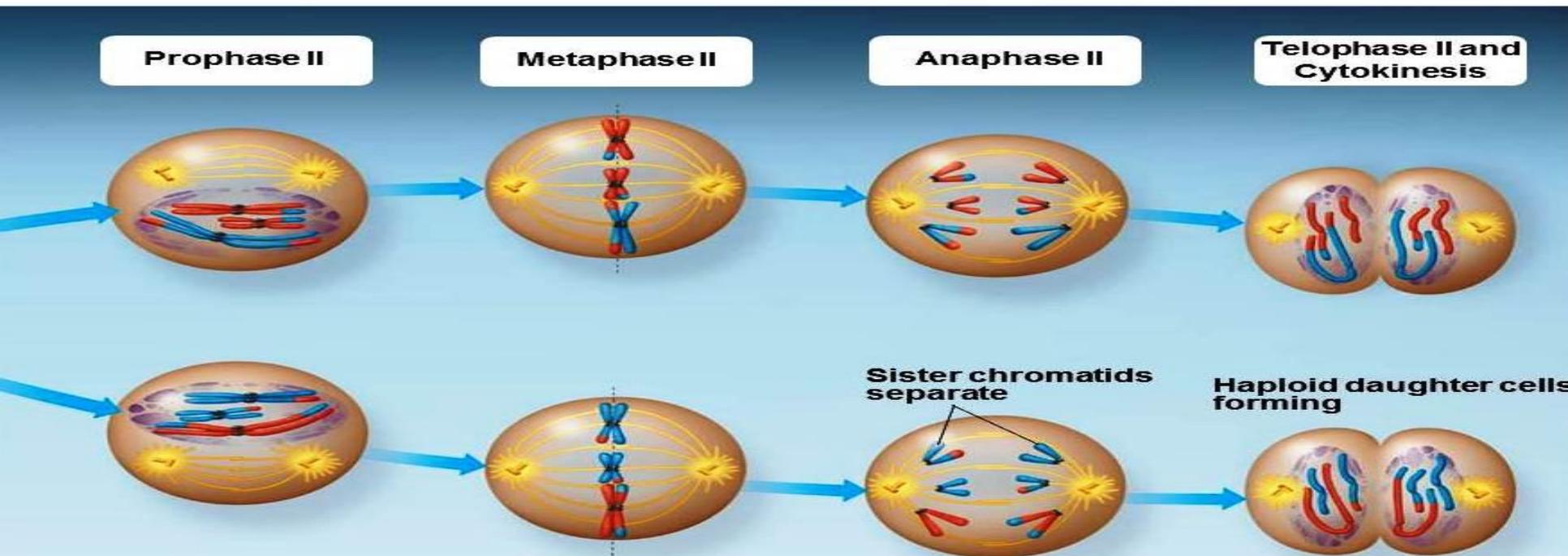


Meiosis II (Equatorial division)

- Each of the 2 newly formed cells (**23 d-chromosomes**) **divide again** much more rapidly.
- The division **is not preceded** by **S- phase**.
- Like **mitosis** and is subdivided into **prophase II**, **metaphase II**, **anaphase II**, **Telophase II** and **Cytokinesis**.



- The chromosomes arranged in equatorial plane and kinetochores attach to the mitotic spindle.
- Then migration of the **chromatids** to opposite poles.
- Cytokines divides each of the two cells giving a total of **4 daughter cells**.
- Each of the 4 cells contains **23-s chromosomes**.
- Each daughter cell is **genetically different** from the others and from the parent cell.



❖ In Spermatogenesis

- ✓ Occurs in the **testes**
- ✓ Mitotic division of primary spermatocyte

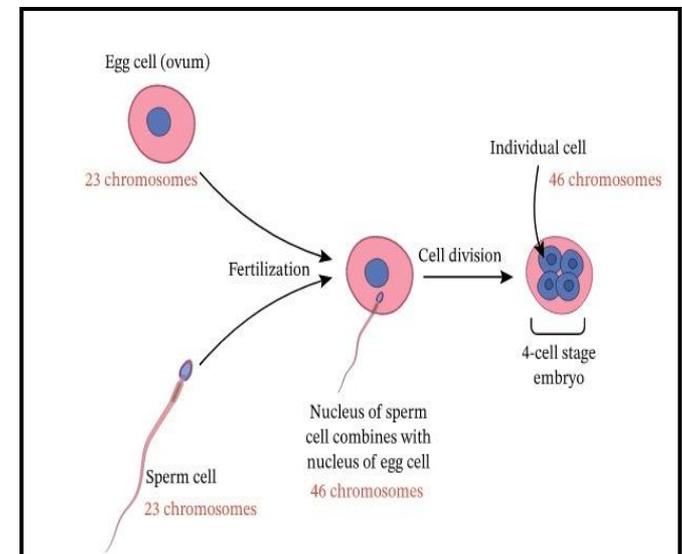
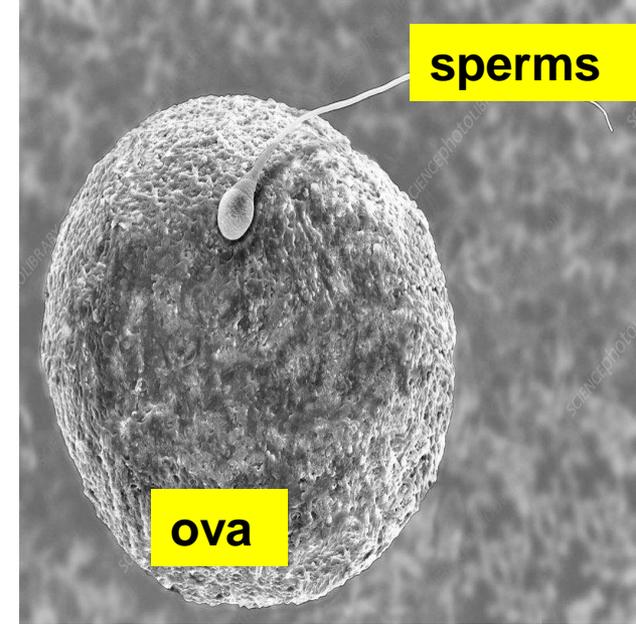
gives 4 spermatids

❖ In oogenesis

- ✓ Occurs in the **ovaries**
- ✓ Mitotic division of primary oocyte produce **1 ova** and **3 polar bodies** which is small and degenerates because of **unequal division of cytoplasm.**

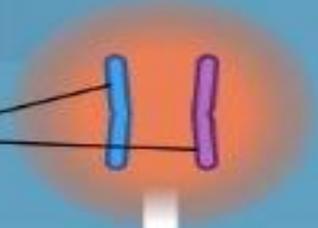
❖ At fertilization

The union of **haploid ova** and **haploid sperm** produce a **new diploid cell** (the zygote) that can develop into a new individual.



Interphase

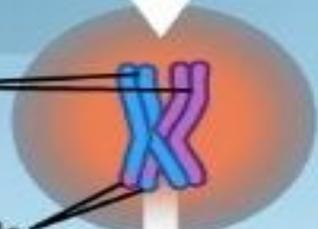
Pair of Homologous Chromosomes in Diploid Parent Cell



Chromosomes Replicate

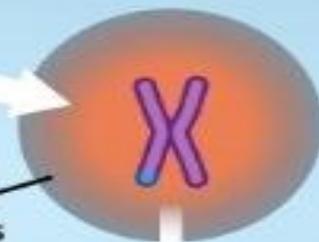
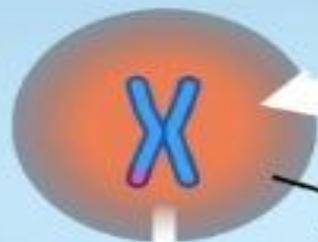
Meiosis I

Pair of Replicated Homologous Chromosomes



Diploid Cell with Replicated Chromosomes

Sister Chromatids



1 Homologous Chromosomes Separate

Haploid Cells with Replicated Chromosomes

Meiosis II



2 Sister Chromatids Separate

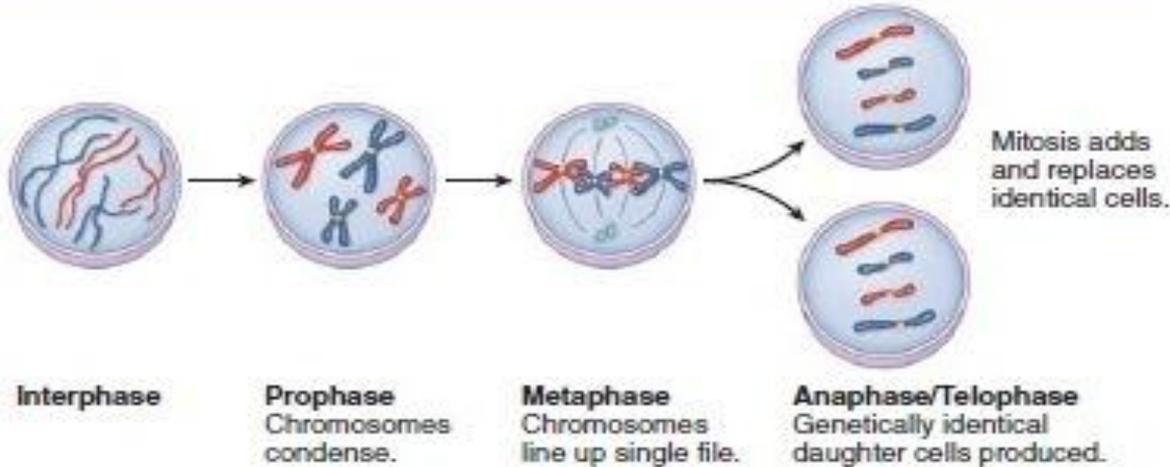
Haploid Cells with Unreplicated Chromosomes

Comparison of Mitosis and Meiosis

Property	Mitosis	Meiosis
DNA replication	Occurs during interphase before mitosis begins	Occurs during interphase before <u>meiosis I</u> begins
Number of divisions	<u>One</u> , including prophase, metaphase, anaphase, and telophase	<u>Two</u> , each including prophase, metaphase, anaphase, and telophase
Synapsis of homologous chromosomes	Does not occur	<u>Occurs</u> during prophase I along with crossing over between nonsister chromatids; resulting chiasmata hold pairs together due to sister chromatid cohesion
Number of daughter cells and genetic composition	<u>Two</u> , each diploid ($2n$) and genetically identical to the parent cell	<u>Four</u> , each haploid (n), containing half as many chromosomes as the parent cell; genetically different from the parent cell and from each other
Role in the animal body	Enables multicellular adult to arise from zygote; produces cells for <u>growth</u> , repair, and, in some species, asexual reproduction	<u>Produces gametes</u> ; reduces number of chromosomes by half and introduces <u>genetic variability</u> among the gametes

Mitosis and Meiosis

MITOSIS



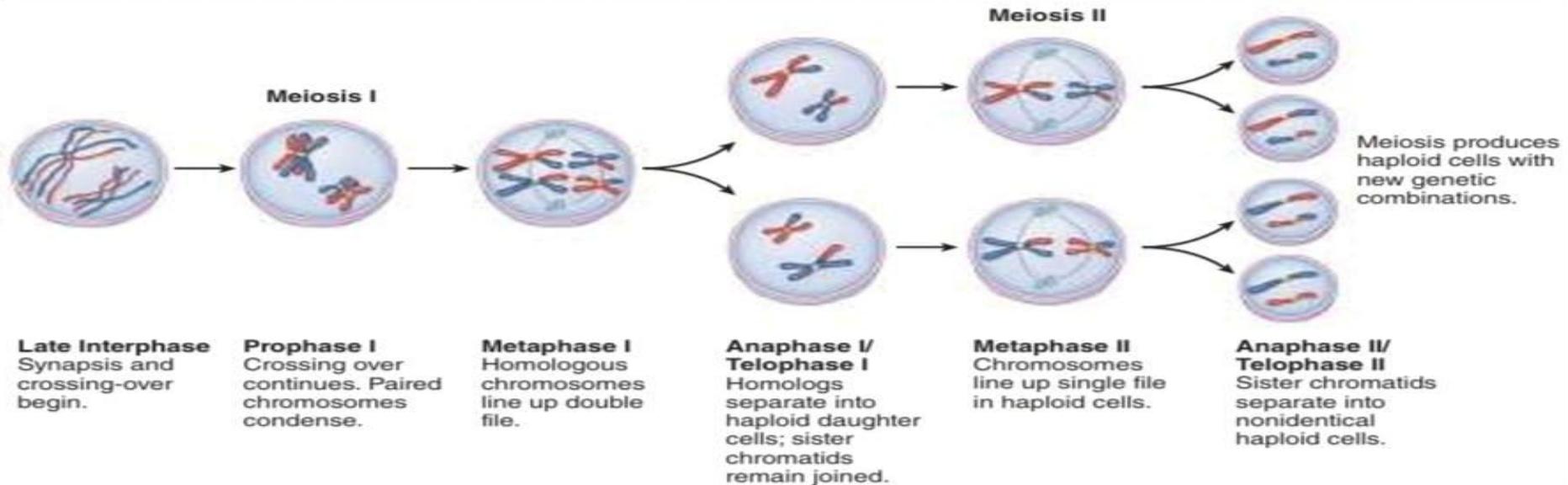
Interphase

Prophase
Chromosomes condense.

Metaphase
Chromosomes line up single file.

Anaphase/Telophase
Genetically identical daughter cells produced.

MEIOSIS



Late Interphase
Synapsis and crossing-over begin.

Prophase I
Crossing over continues. Paired chromosomes condense.

Metaphase I
Homologous chromosomes line up double file.

Anaphase I / Telophase I
Homologs separate into haploid daughter cells; sister chromatids remain joined.

Metaphase II
Chromosomes line up single file in haploid cells.

Anaphase II / Telophase II
Sister chromatids separate into nonidentical haploid cells.

Animation

- <https://www.youtube.com/watch?v=kQu6Yfrr6j0>
- https://www.youtube.com/watch?v=gMpl_Ilyoqk

MCQ

- ❖ **During which phase of mitosis do the sister chromatids separate?**
 - a. Prophase
 - b. Metaphase
 - c. Anaphase
 - d. Telophase
- ❖ **What is the primary function of meiosis?**
 - a. Cell growth and repair
 - b. Production of somatic cells
 - c. Production of gametes (sex cells)
 - d. Asexual reproduction
- ❖ **What is the different between mitosis and meiosis?**
 - A. Crossing over occurs in meiosis II , not in mitosis
 - B. Separation of chromatids occur in mitosis not in meiosis II
 - C. S-phase occur before mitosis but not meiosis II.
 - D. Homologues chromosomes in meiosis II , not in mitosis.
- ❖ **Which of the following describe equatorial division?**
 - A. The division is preceded by S- phase
 - B. The division is not preceded by S- phase
 - C. The homologues chromosomes are arranged into the equatorial plane of the cell.
 - D. Lasts a long time than reduction division.

Thank
You!

