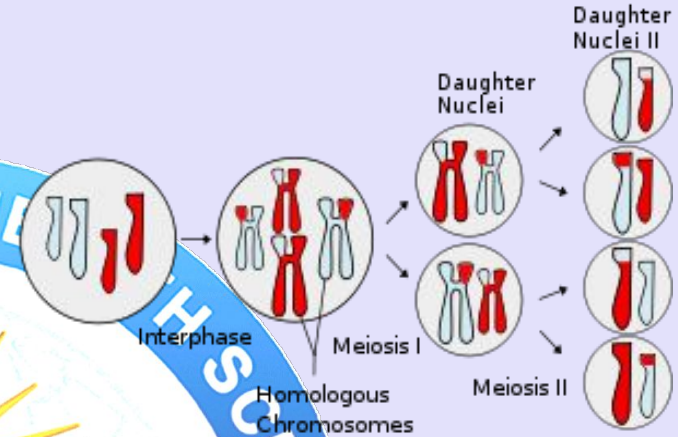
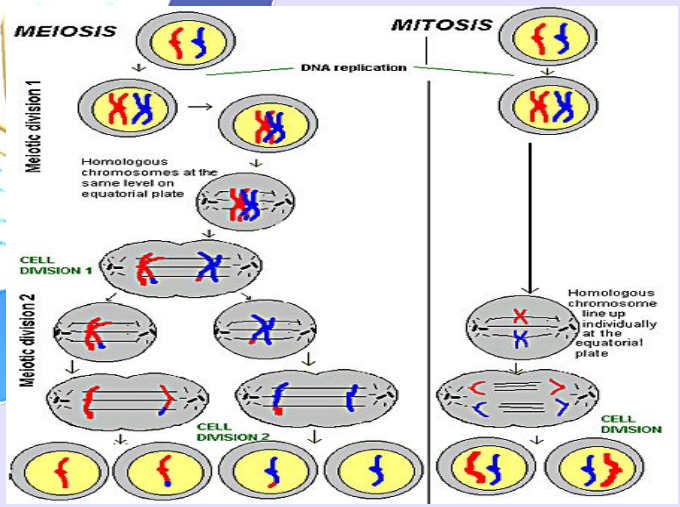
MEIOSIS

+



COMPARISON WITH MITOSIS



LEARNING OBJECTIVES

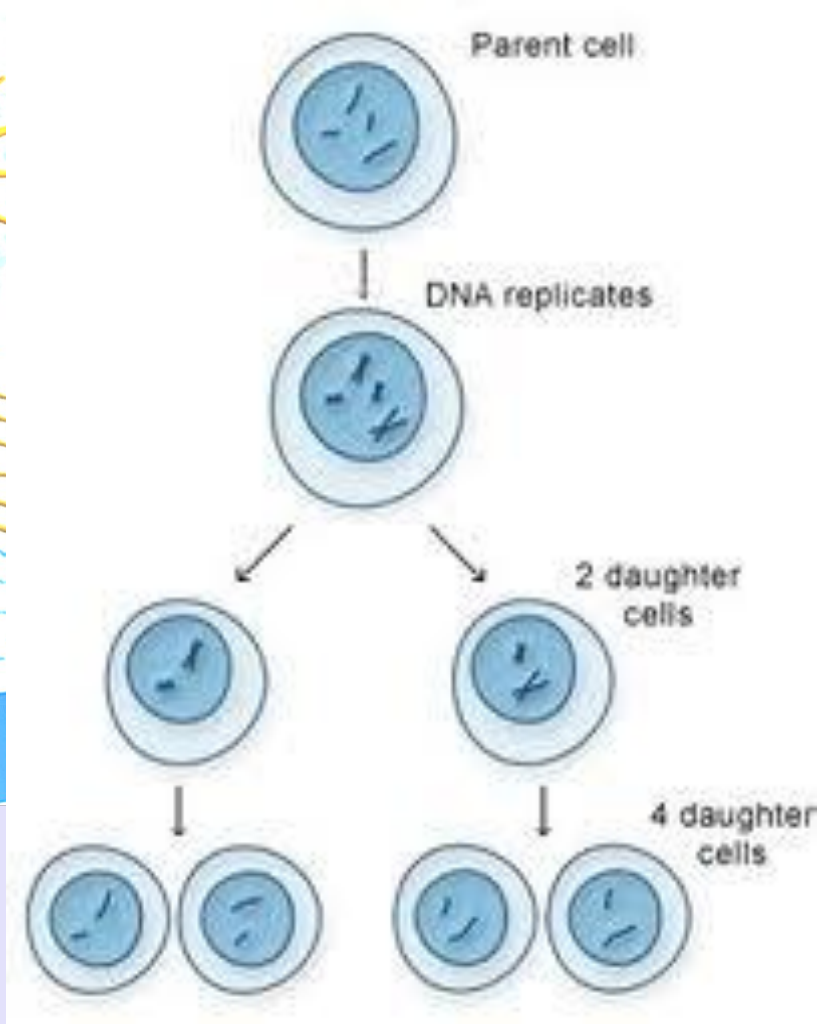
At the end of the lecture, students should be able to:

- Define Meiosis.
- Differentiate first and second meiotic divisions.
- State the phases of meiotic divisions.
- Justify the importance and result of meiosis in both sexes.
- Differentiate between mitosis and meiosis.

MEIOSIS

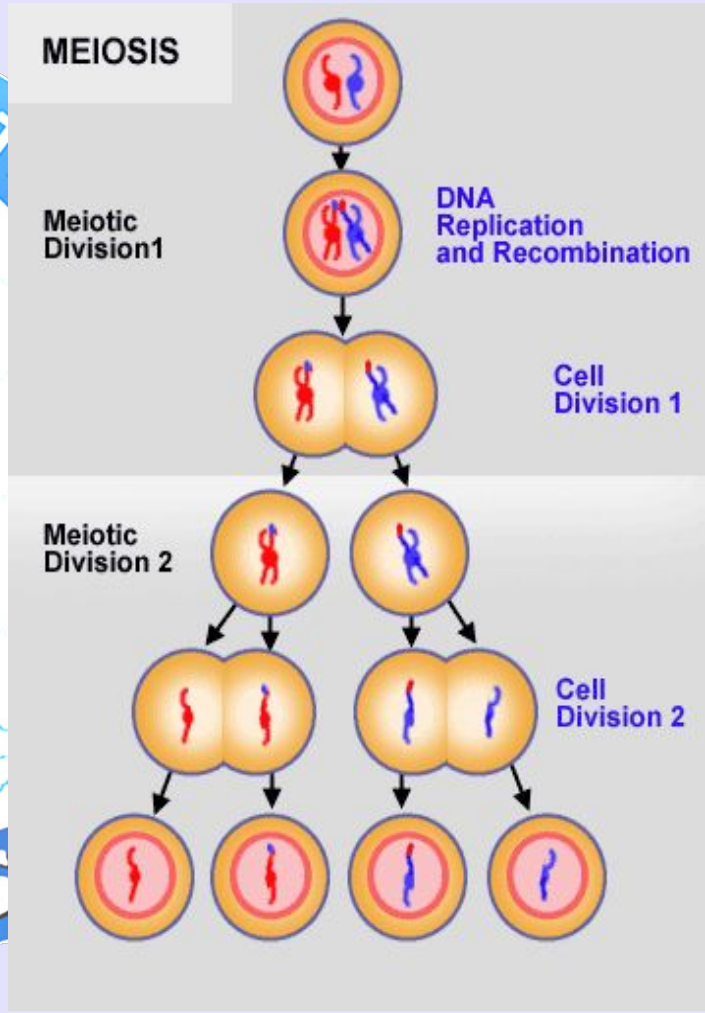
- Meiosis is a special type of cell division , occurs **only in germ cells.**

- Occurs during the process of their development and maturation to form gametes.



MEIOSIS

- It comprises of two successive cell divisions with only one replication of chromosomes.
- Referred as “ Meiosis I” and “Meiosis II”.
- Two meiotic divisions form four cells have diploid number of chromosomes.
- Gametes that develop from them have haploid no. of chromosomes..



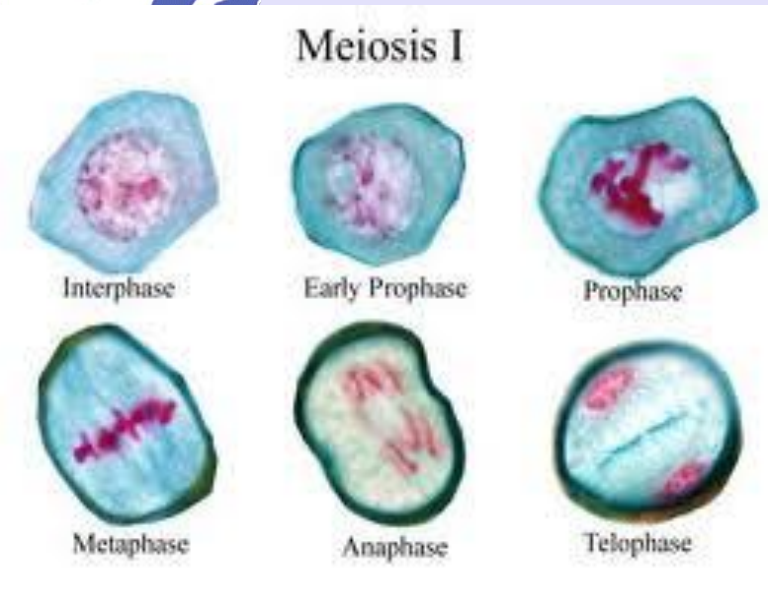
MEIOSIS I

- It has four phases:
- Prophase, metaphase, anaphase and telophase.

PROPHASE

Prophase of meiosis I is divided into five stages:

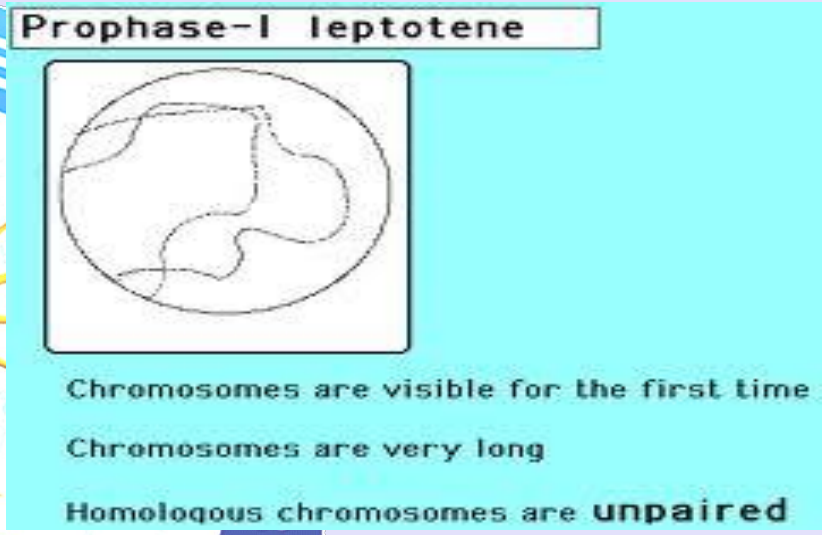
1. Leptotene.
2. Zygotene.
3. Pachtene.
4. Diplotene.
5. Diakinesis.



PROPHASE

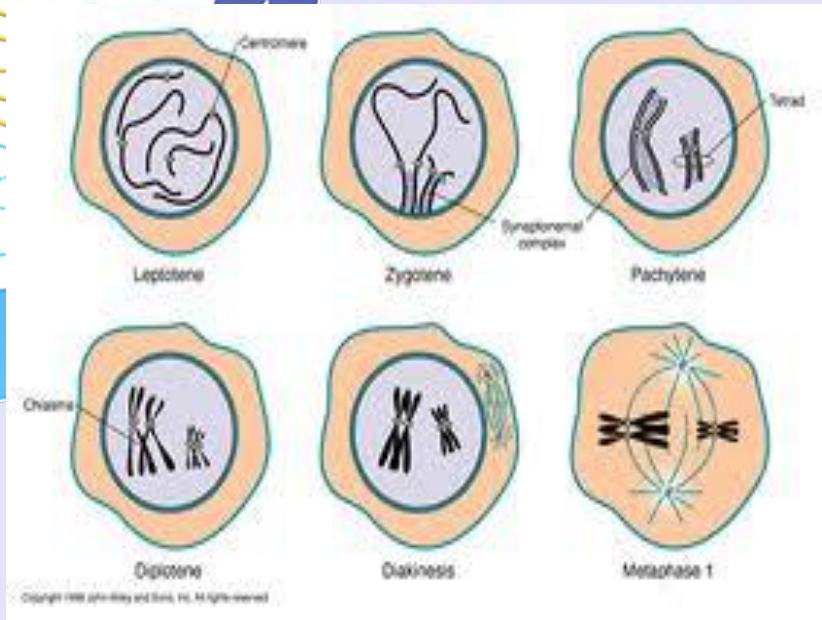
1. LEPTOTENE:

- Chromosomes become visible in nucleus as long , thin strands.



2. ZYGOTENE:

- Homologous chromosomes come together in close apposition along entire length.
- Pairing of homologous chromosomes is termed as synapses.



PROPHASE

3. PACHTENE:

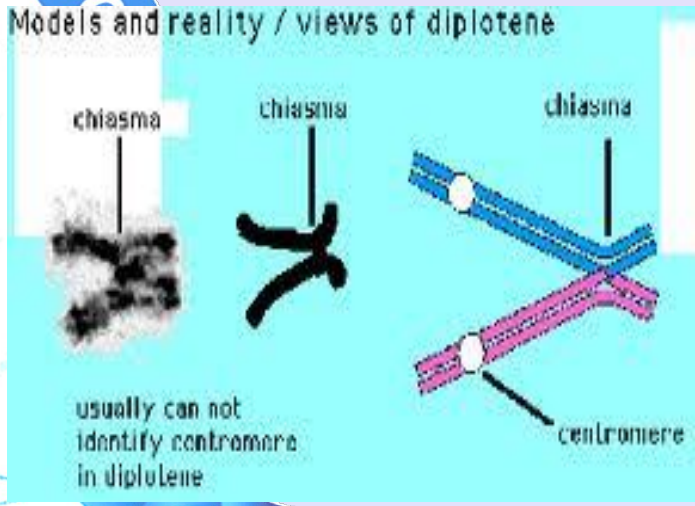
- Chromosomes become thicker and shorter due to coiling.
- Each chromosome pair is called a bivalent.

4. DIPLOTENE:

- Chromosomes Begin to separate.
- Each Chromosome consists of two chromatids.
- Each bivalent consists of four chromatids.

4. DIPLOTENE

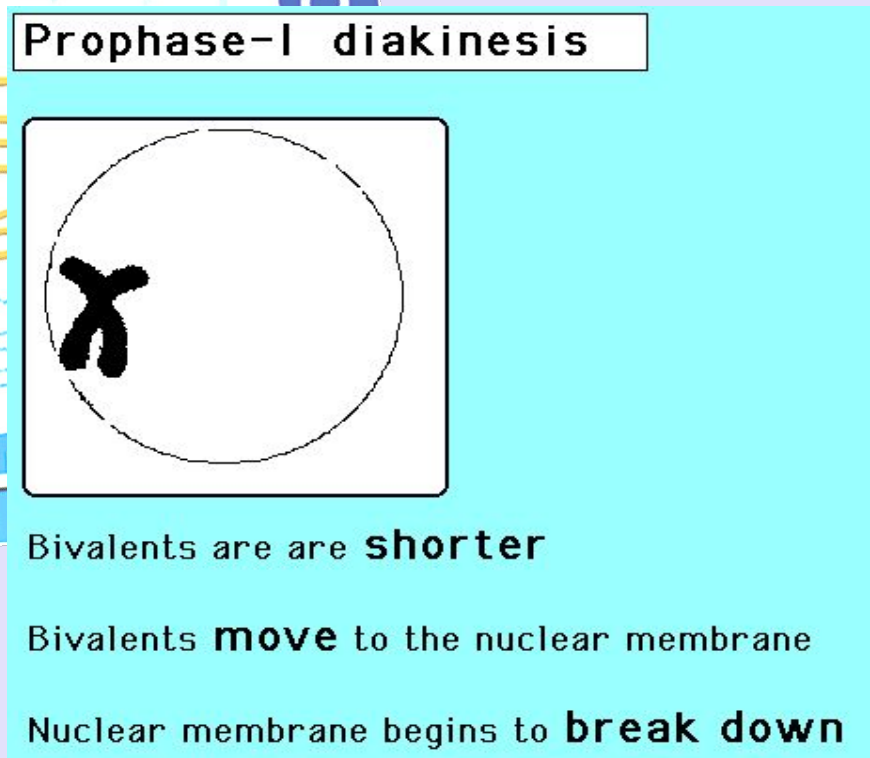
- During diplotene it becomes clearly visible that each replicated chromosome consists of two sister-chromatids.
- Each bivalent consist of a bundle of four homolog chromatids.
- Homologs exhibit a weaker binding and slightly diverge.
- The crossings chiasmata, between non-sister-chromatids are visible.
- Each bivalent shows in general one or more chiasmata, where crossing-overs have occurred.



PROPHASE

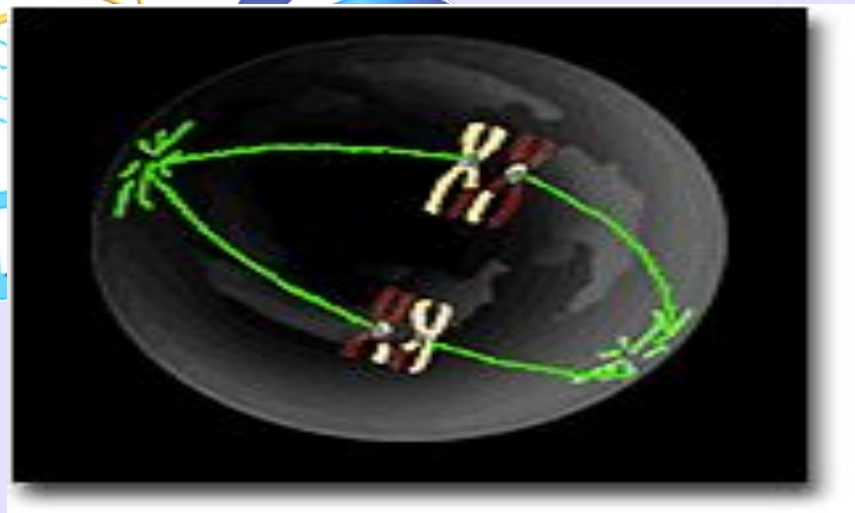
5. DIAKINESIS:

- In this stage, separation of chromosomes continues.
- Chiasmata and chromosomes are more obvious during this stage.
- The nucleolus and nuclear envelope disappear by the end of diakinesis.



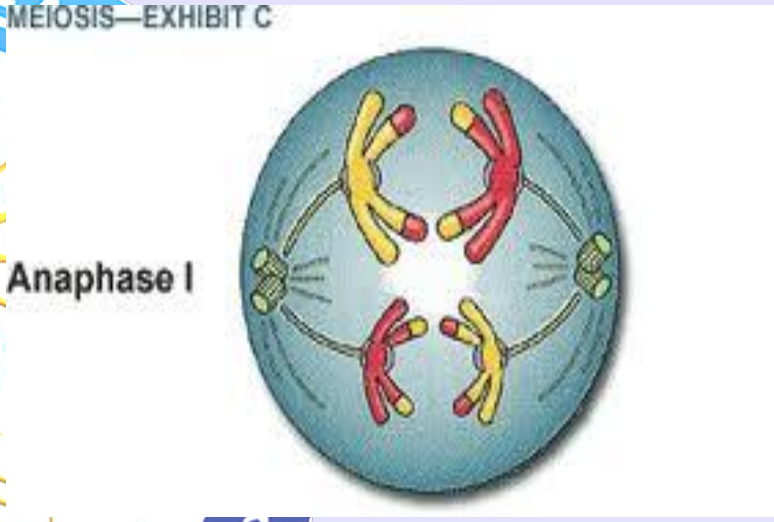
METAPHASE I

- A spindle of microtubules is produced by centrioles.
- the homologous chromosomes align along an equatorial plane that bisects the spindle.

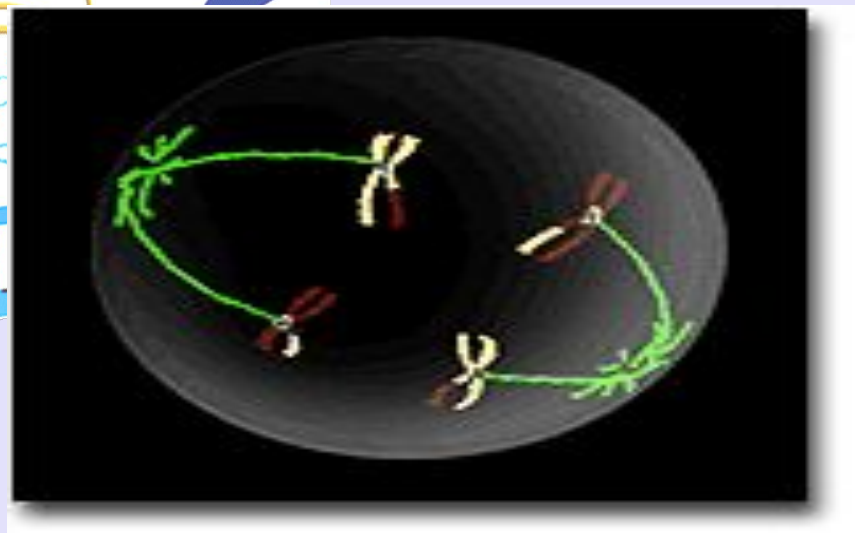


ANAPHASE I

- In anaphase I the chromatids holding the chromosomes together loosen.

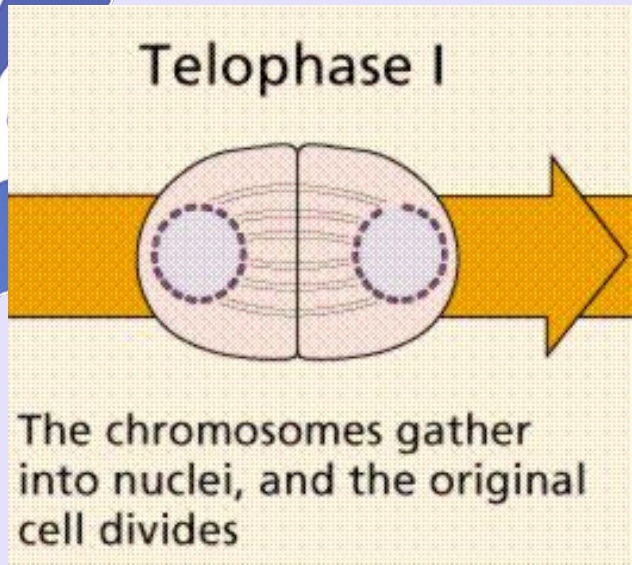


- The two homologous chromatids of each tetrad are separated into separate poles.



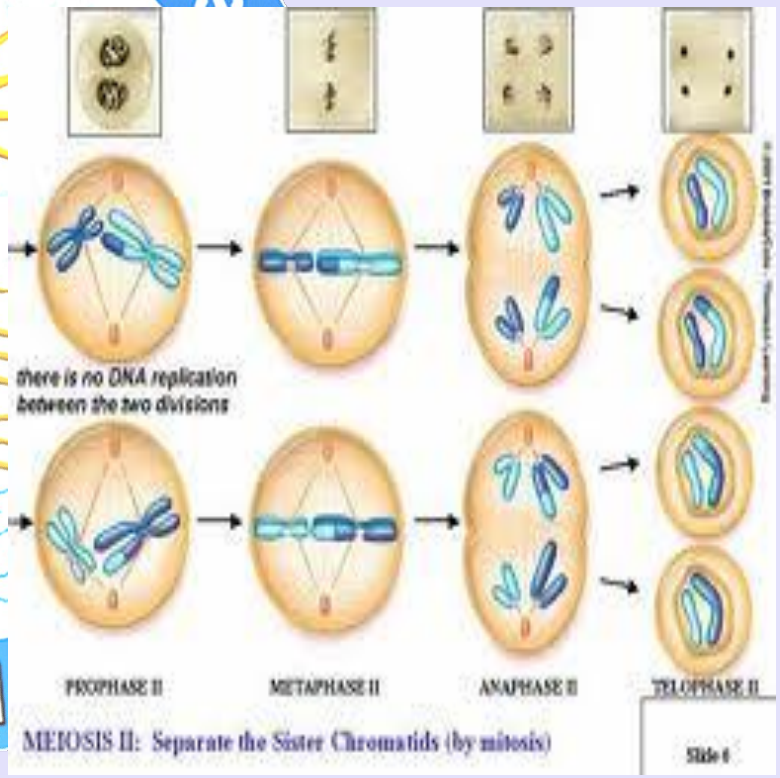
TELOPHASE I

- In this stage, the nuclei are reconstituted and cytokines divides the parent cell into two daughter cells.
- Each daughter cell contains haploid (i.e 23) chromosomes.
- But each chromosome is a double structured chromosome consisting of two sister chromatids.



MEIOSIS II

- Each of two daughter cells (resulting from meiosis-I) soon enters meiosis II, consists of four stages prophase, metaphase, anaphase and telophase.
- The behaviour of chromosomes is same as in mitosis.
- Division of centromere in each doubled chromosome takes place.

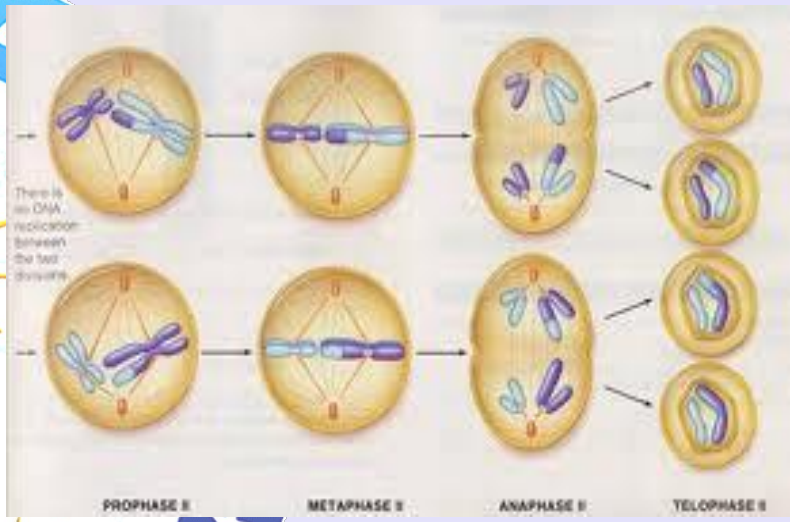


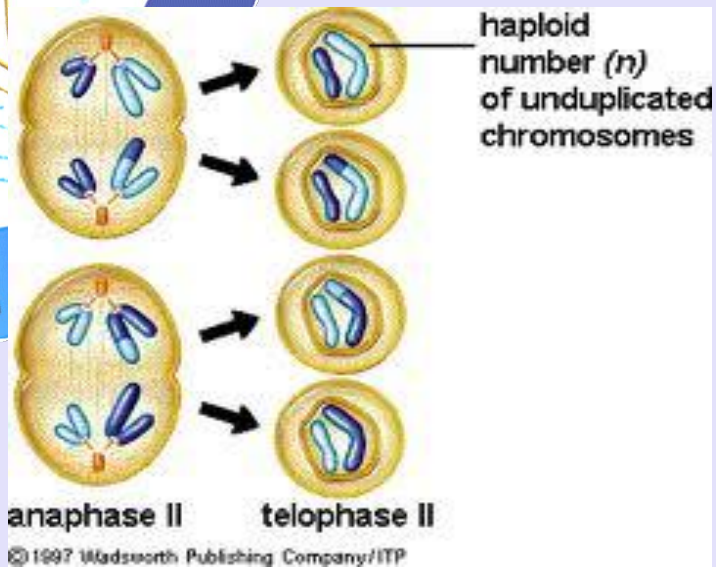
MEIOSIS II

- Sister chromatids separate and move independently to opposite poles.
- Soon cytokinesis divides the cell into two daughter cells.

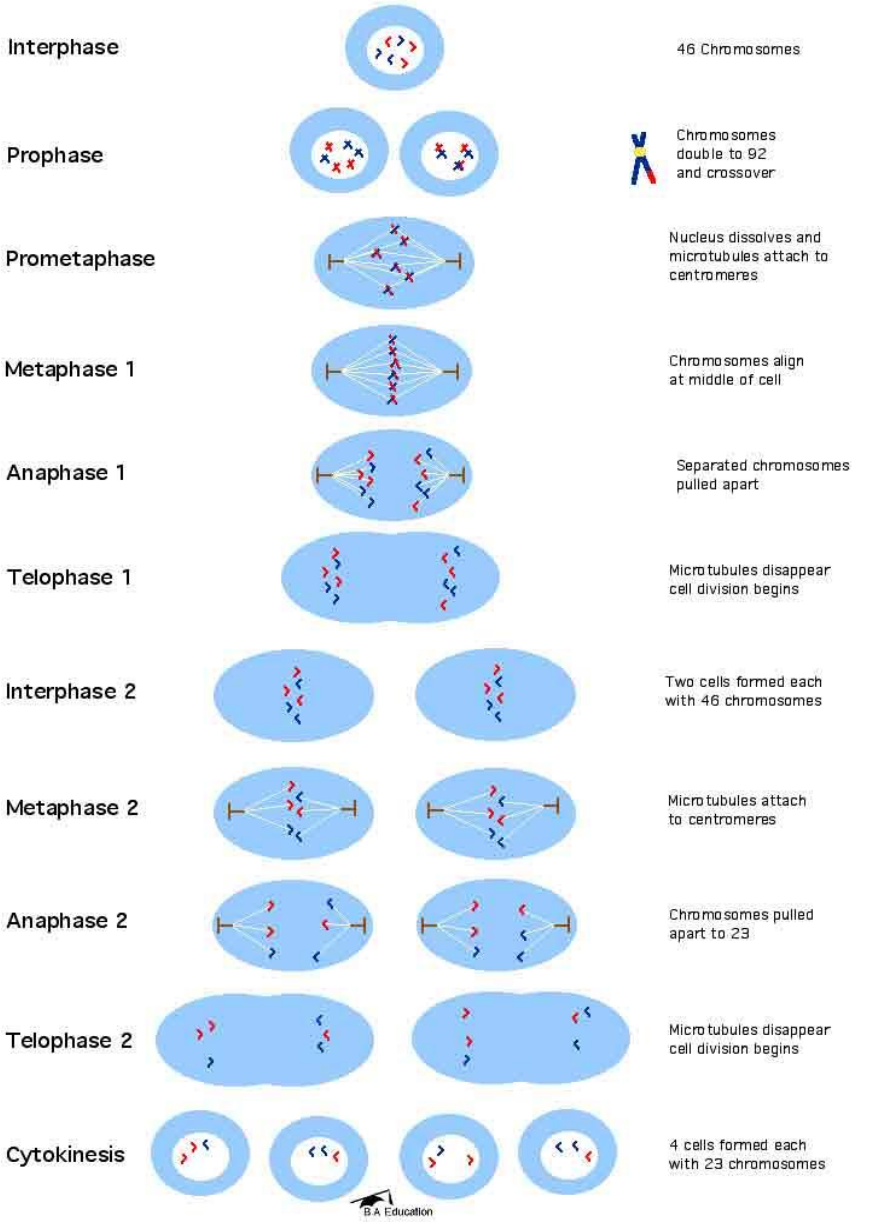
- **CONCLUSION:**

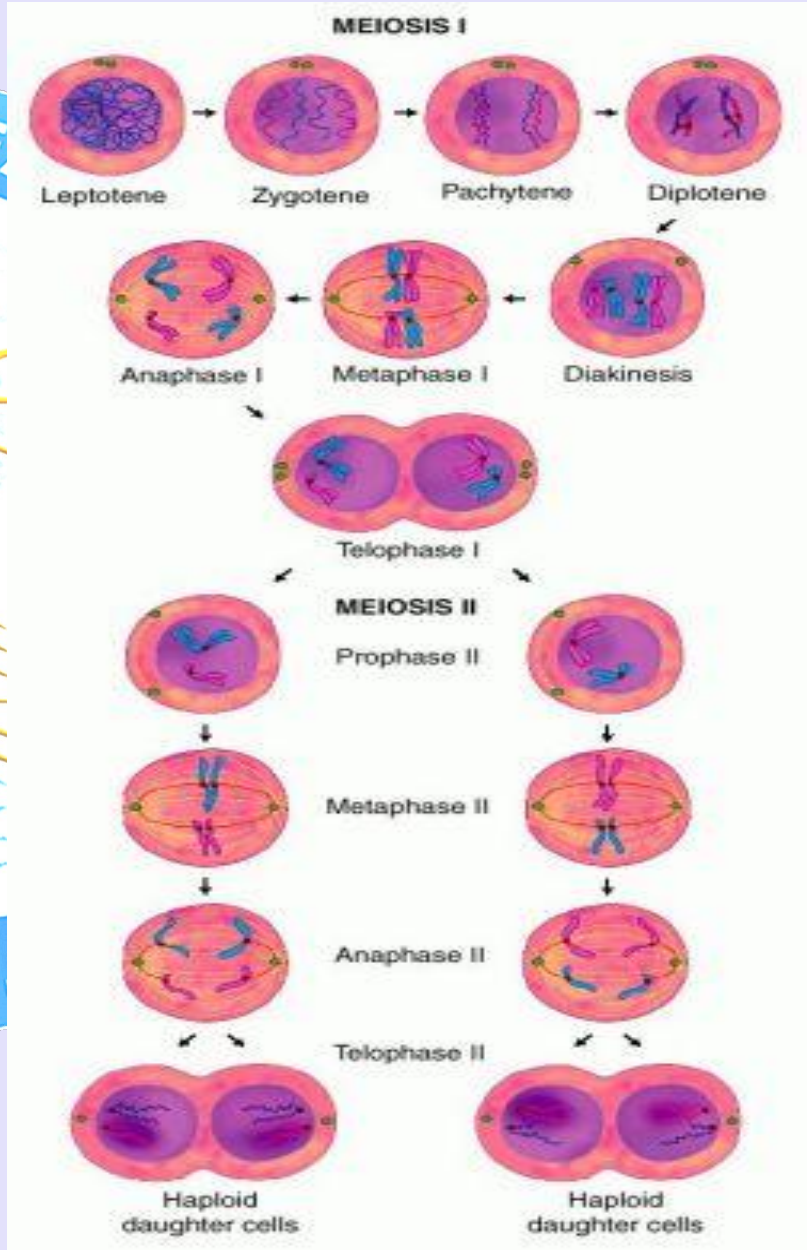
- At the end of second meiotic division four cells are obtained.
- Nucleus of each of these cells contains haploid chromosomes.





MEIOSIS


Interphase
46 Chromosomes
Prophase
Chromosomes double to 92 and crossover
Prometaphase
Nucleus dissolves and microtubules attach to centromeres
Metaphase 1
Chromosomes align at middle of cell
Anaphase 1
Separated chromosomes pulled apart
Telophase 1
Microtubules disappear cell division begins
Interphase 2
Two cells formed each with 46 chromosomes
Metaphase 2
Microtubules attach to centromeres
Anaphase 2
Chromosomes pulled apart to 23
Telophase 2
Microtubules disappear cell division begins
Cytokinesis
4 cells formed each with 23 chromosomes
B A Education


MEIOSIS I
Leptotene
Zygotene
Pachytene
Diplotene
Anaphase I
Metaphase I
Diakinesis
Telophase I
MEIOSIS II
Prophase II
Metaphase II
Anaphase II
Telophase II
Haploid daughter cells
Haploid daughter cells

Mitosis v/s Meiosis

- **Mitosis v/s Meiosis - Differences in Purpose :**

- Both Meiosis and Mitosis are found in complex organisms which reproduce sexually.
- Mitosis may be used for human growth, the replenishment of depleted organs and tissues, healing, and sustenance of the body. Identical versions of cells can be created to form tissues through Mitosis.
- Meiosis is a special process reserved for the creation of the egg and sperm cells.

- **Significance of Mitosis vs. Meiosis:**

- The importance of mitosis is the maintenance of the chromosomal set; each cell formed receives chromosomes that are alike in composition and equal in number to the chromosomes of the parent cell.

- **Occurs in :**

- Meiosis is found to occur in Human, animals, plants while Mitosis is found in single-cell species as well.

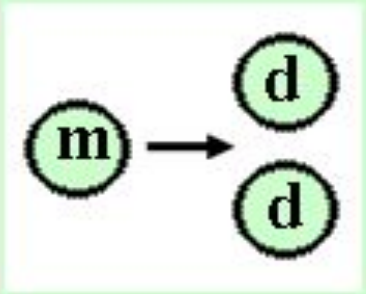
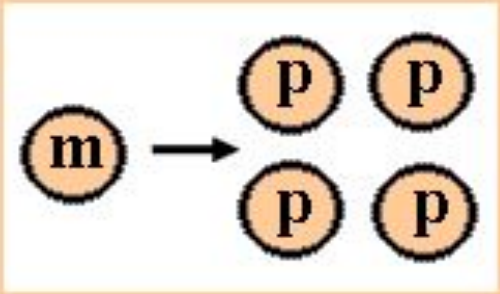
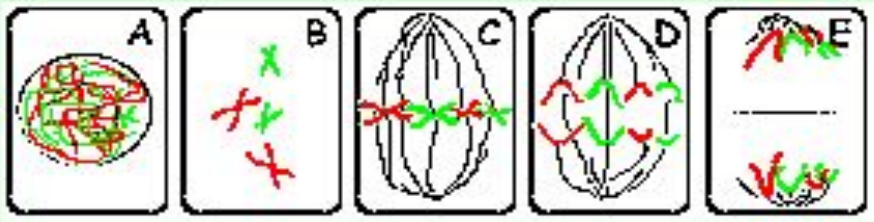
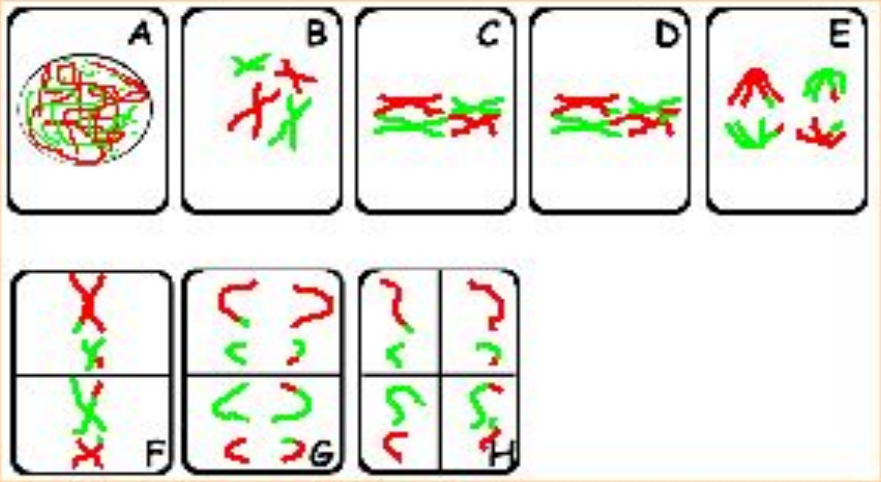
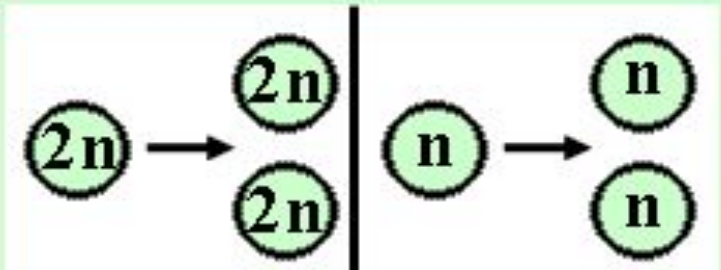
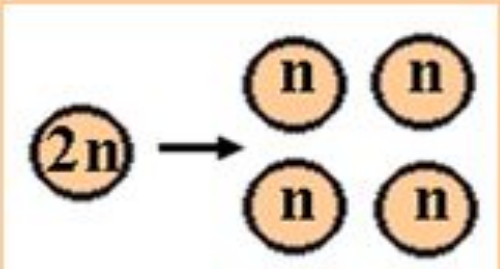
DIFFERENTIATE B/W MITOSIS AND MEIOSIS

	Meiosis	Mitosis
Occurrence of Crossing Over:	Yes	No
Occurs in:	Humans, animals, plants, fungi	all organisms
Number of Daughter Cells produced:	4	2
Creates:	Sex cells only: Female egg cells or Male sperm cells	Makes everything other than sex cells
Definition:	A type of cellular reproduction in which the number of chromosomes are reduced by half through the separation of homologous chromosomes in a diploid cell.	A process of asexual reproduction in which the cell divides in two producing a replica, with an equal number of chromosomes in haploid cell
Produces:	four haploid daughter cells	two diploid daughter cells
Steps:	The steps of meiosis are Interphase, Prophase I, Metaphase I, Anaphase I, Telophase I, Prophase II, Metaphase II, Anaphase II and	The steps of mitosis are Interphase, Prophase, Metaphase, Anaphase, Telophase and Cytokinesis

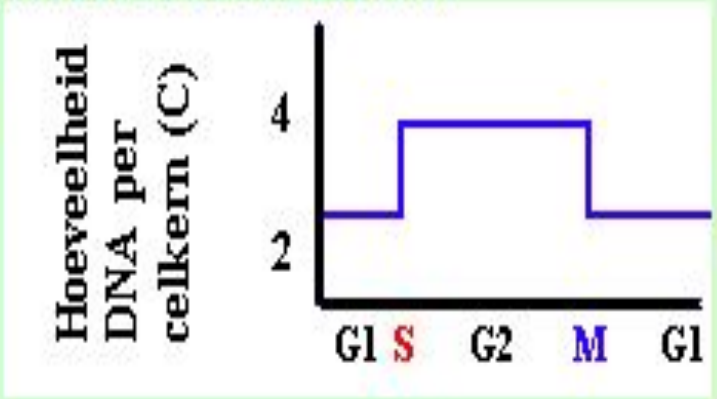
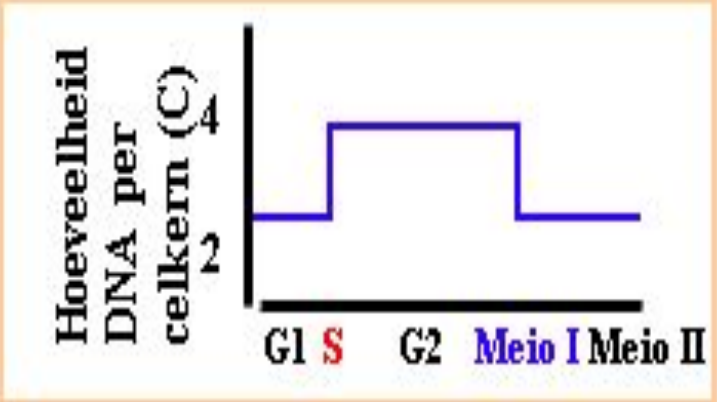
DIFFERENTIATE B/W MITOSIS AND MEIOSIS (contd)

	Telophase II.	
Discovered by:	Oscar Hertwig	Walther Flemming
Type of Reproduction:	Sexual	Asexual
Genetically:	different	identical
Cytokenesis:	Occurs in Telophase I & Telohpase II	Occurs in Telophase
Number of Divisions:	2	1
Pairing of Homologues:	Yes	No
Function:	sexual reproduction	Cellular Reproduction & general growth and repair of the body
Chromosome Number:	Reduced by half	Remains the same
Karyokenesis:	Occurs in Interphase I	Occurs in Interphase
Crossing Over:	Mixing of chromosomes	Does not occur
Centromeres Split:	The centromeres do not separate during anaphase I, but during anaphase II	The centromeres split during Anaphase

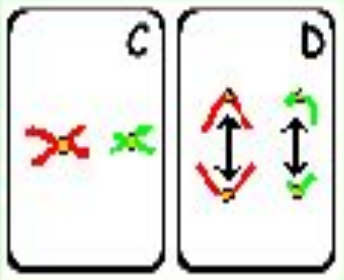
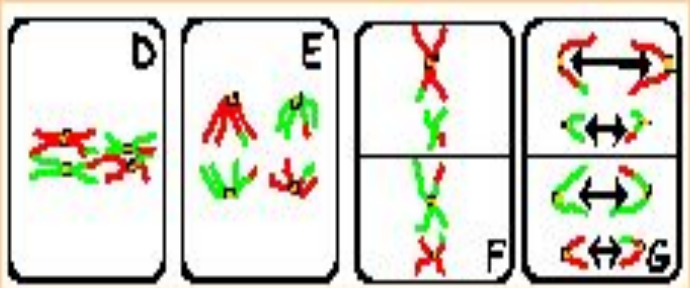
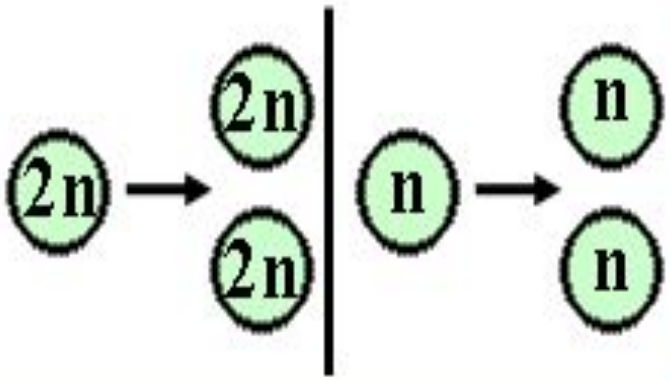
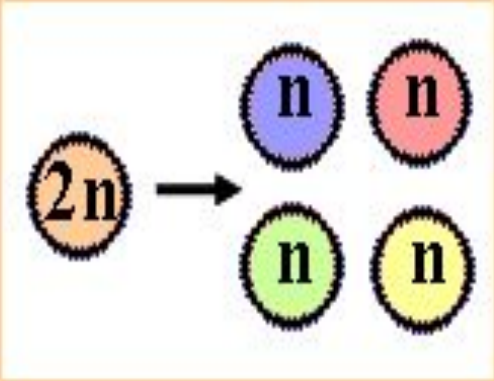
COMPARISON OF MITOSIS AND MEIOSIS

MITOSIS	MEIOSIS
In somatic cells	**In reproductive cells**
One single division (here below A-E) of the mother cell (m) results in two daughter cells (d)	Two divisions (here below: meiosis I in A-E and meiosis II in F-H) of the mother cell (meiocyte; m) result in four meiotic products (p)
	
	
A mitotic mother cell can be *either* haploid *or* diploid	A meiotic mother cell (meiocyte) is *always* diploid
	

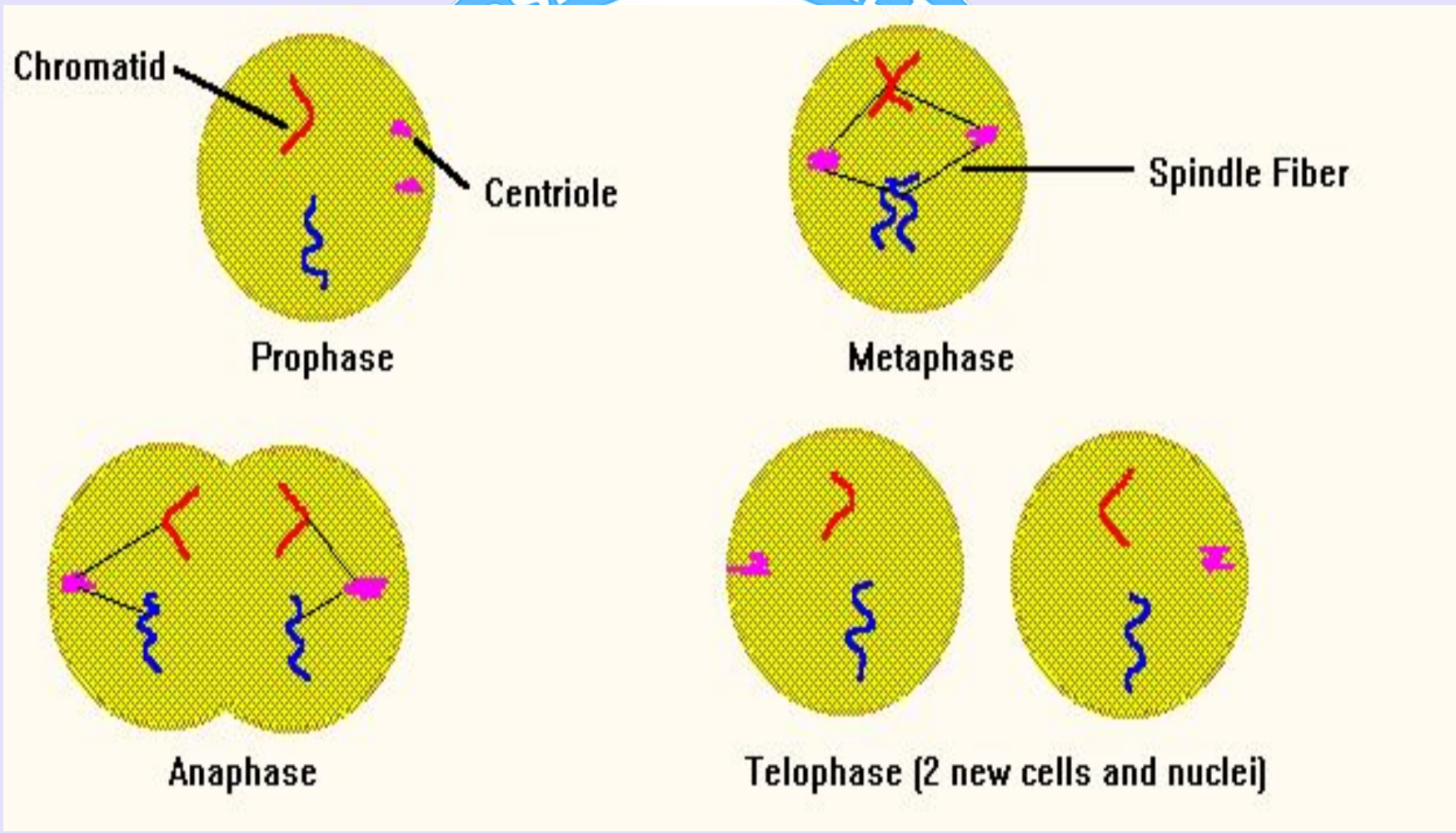
COMPARISON OF MITOSIS AND MEIOSIS (contd)

The number of chromosomes per nucleus remains the same after division	Diploid (= 2n) remains 2n Haploid (= 1n) remains 1 n	The meiotic products contain a haploid (n) number of chromosomes, in contrast to the 2 n mother cell	From 2n to n
Mitosis is preceeded by a S-phase in which the amount of DNA is duplicated	Example for a diploid mother cell: 	Only meiosis I is preceeded by a S-phase	
Normally *no pairing* of homolog chromosomes	x	Complete pairing of all homolog chromosomes during prophase I	

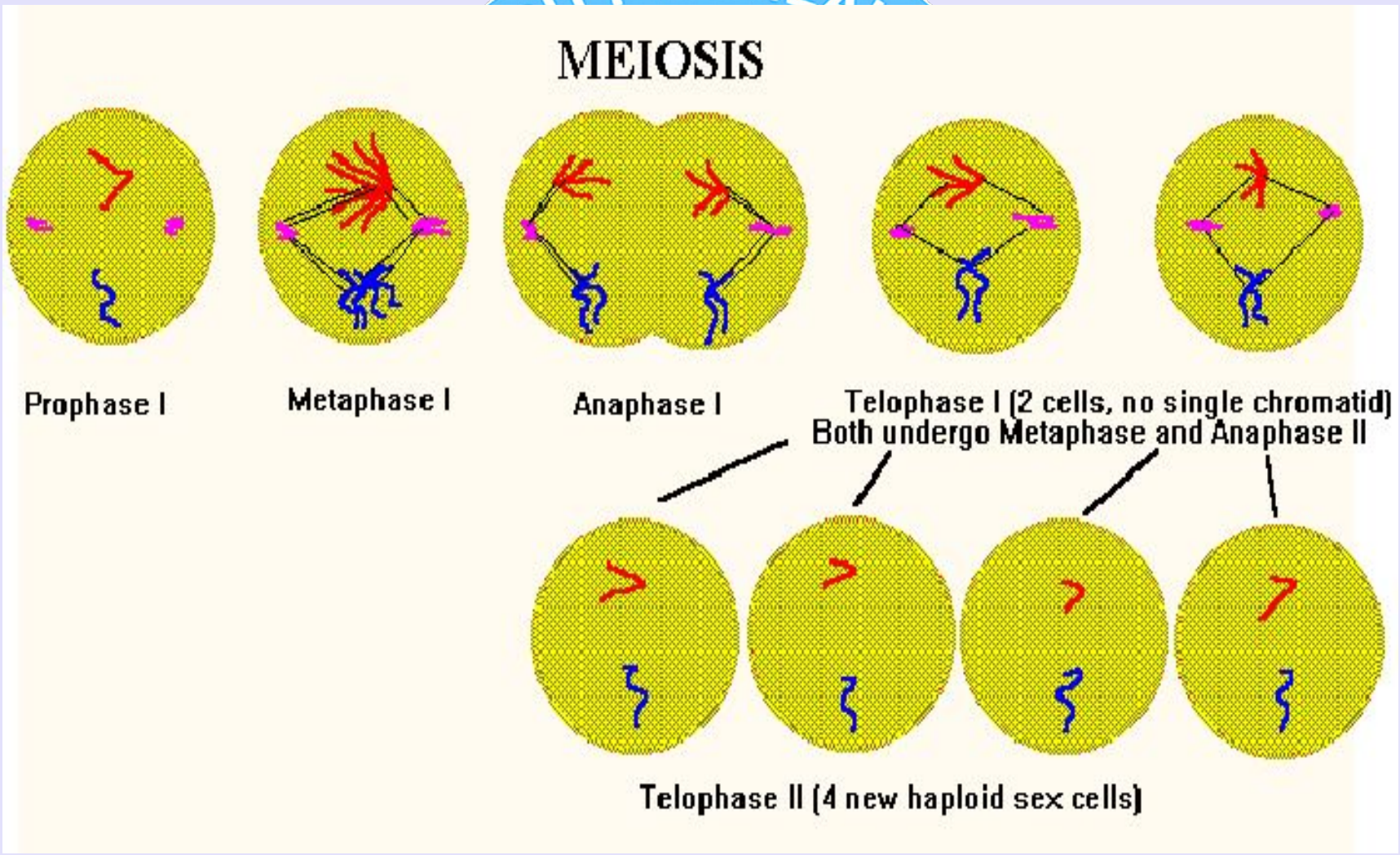
COMPARISON OF MITOSIS AND MEIOSIS (contd)

Normally *no exchange of DNA* (crossing-over) between chromosomes	x	At least one crossing-over per homolog pair of chromosomes	
The centromeres are split during anaphase		The centromeres do not separate during anaphase I, but during anaphase II	
Conservative process: the genotype of the daughter cells is identical to that of the mother cells		Meiotic products differ in their genotype from the mother cell (increase in genetic variation in the offspring)	

MITOSIS


Chromatid
Centriole
Prophase
Spindle Fiber
Metaphase
Anaphase
Telophase (2 new cells and nuclei)

MEIOSIS


MEIOSIS
Prophase I
Metaphase I
Anaphase I
Telophase I (2 cells, no single chromatid)
Both undergo Metaphase and Anaphase II
Telophase II (4 new haploid sex cells)

REFERENCES

- Keith L. Moore Developing Human 8th edition Chapter 2 – Pages 15-17.


Thanks