Meiosis

Meiosis: involves two sequential nuclear divisions followed by cell divisions that produce gametes (sex cells) containing half the number of chromosomes and half the DNA found in somatic cells.

The zygote: the cell resulting from the fusion of an ovum and a sperm
The zygote and all the somatic cells derived from zygote are diploid (2n) in chromosome number (46 chromosomes in human); thus, human cells have two copies of every chromosome. These chromosomes are called homologous chromosomes because they are similar but not identical; one set of chromosomes is from mother, the other set is from father.
During gametogenesis, these homologous chromosome (2n or diploid or 46) reduce in number to the haploid (23 chromosomes or 1n) occurs through meiosis. So gametes, having only one chromosome from each chromosome pair, are described as haploid (1n). This reduction is necessary to maintain a constant number of chromosomes in a given species.

In the first meiotic division, chromosome number Reduced to (1n)
In the second meiotic division, DNA content is reduced to the haploid (1d) amount.

Crossing-over occurs in meiosis, where parts of chromosomes are exchanged between homologous chromosomes, leading to genetic diversity. Additionally, chromosomes are randomly sorted into gametes, contributing to even more genetic variation.

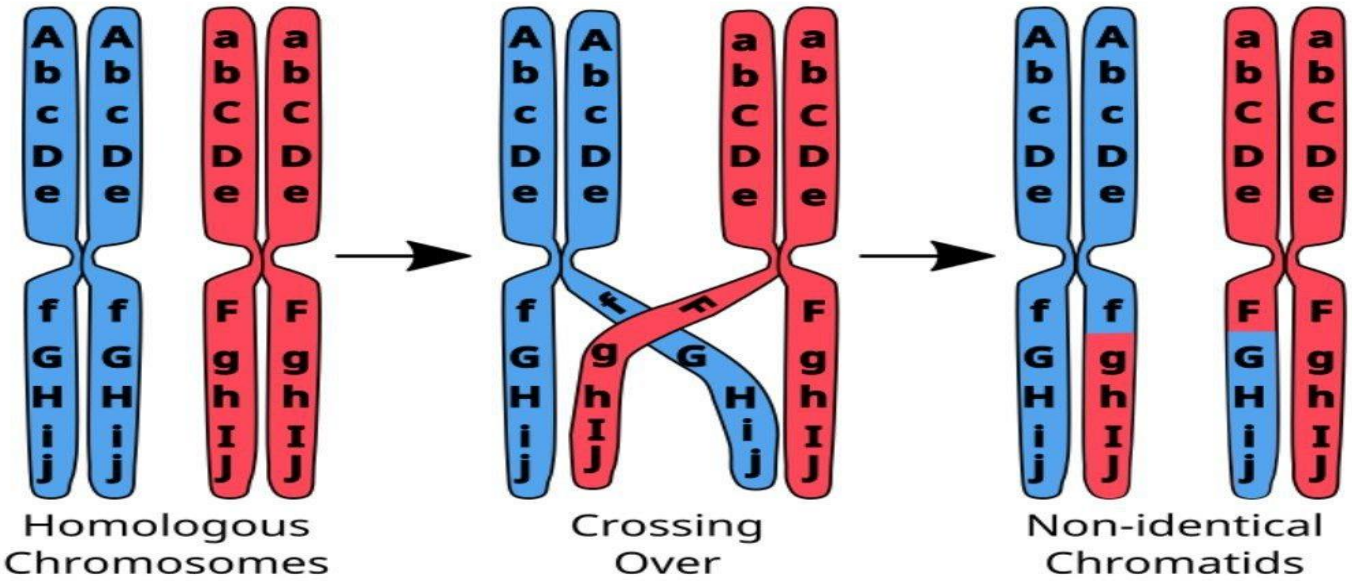

Figure (1) cross over of meiosis division

Differences in meiosis between male and female

1. The nuclear events of meiosis are the same in males and females
2. The cytoplasmic events are markedly different.

- In males, the two meiotic divisions of a primary spermatocyte yield 4 structurally identical, although genetically unique, haploid spermatids.
  Each spermatid has the capacity to differentiate into a spermatozoon.

- in females, the two meiotic divisions of a primary oocyte yield 1 haploid ovum and 3 haploid polar bodies.
  The ovum receives most of the cytoplasm and becomes the functional gamete.
  The polar bodies receive very little cytoplasm and degenerate.

Divisions & Phases of Meiosis

- Meiosis consists of two successive mitotic divisions without the additional S phase between the two divisions. By another words
  - Remember : Interphase (with s phase) → meiosis 1→ interphase (without s phase) → meiosis 2
- During the S phase that precedes meiosis 1: DNA synthesize lead to chromosome replication
- The cells then enter to (meiosis I) or called a reductional division, during meiosis I: these 46 doubled chromosomes form 23 homologous chromosome, then these homologous chromosome (diploid (2n)) reduce in number to double chromosome (haploid (1n)), this doubled chromosome will enter to meiosis II.

  - Before enter to meiosis II remember .. There is No s phase precedes meiosis II.

- Meiosis II (an equatorial division) LOOK like mitosis in which double chromosomes are divide to single chromosome thus the number of chromosomes does not change. It remains at (1n), although the amount of DNA represented by the number of chromatids is reduced to (1d).

"The story in few lines "

Interphase 1: 1 cell has
46 single chromosome (1n)(1DNA) "1 chromatid "
↓
1 cell has
46 double chromosomes (2n) (2DNA) "sister chromatids "
-Meiosis I ↓
1cell has
23 homologous chromosomes (2n) (4DNA) (4 similar non identical chromatids)
↓
2 cells
Each one has 23 double chromosome (1n) and 2 DNA (sister chromatids)
Meiosis : ↓
4 cells have
23 single chromosome (1n) each one have 1 DNA. "1 chromatid"

Meiosis II like mitosis ,but meiosis II from 4 cells while mitosis form 2 cells

Phases of Meiosis I

1. Prophase I: It is an extended phase that is subdivided into the following five stages: ***mnemonic ☺ Little Zebra Play During Daylight***.

- Leptotene: chromosomes start to condense.
- Zygotene: homologous chromosomes become closely associated (synapsis) to form pairs of chromosomes (bivalents) consisting of four chromatids (tetrads).
- Pachytene: crossing over between pairs of homologous chromosomes to form chiasmata.
- Diplotene: homologous chromosomes start to separate but remain attached at chiasmata.
- Diakinesis: homologous chromosomes continue to separate, and chiasmata move to the ends of the chromosomes unit they separate and thus genetic diversity has been occurred.

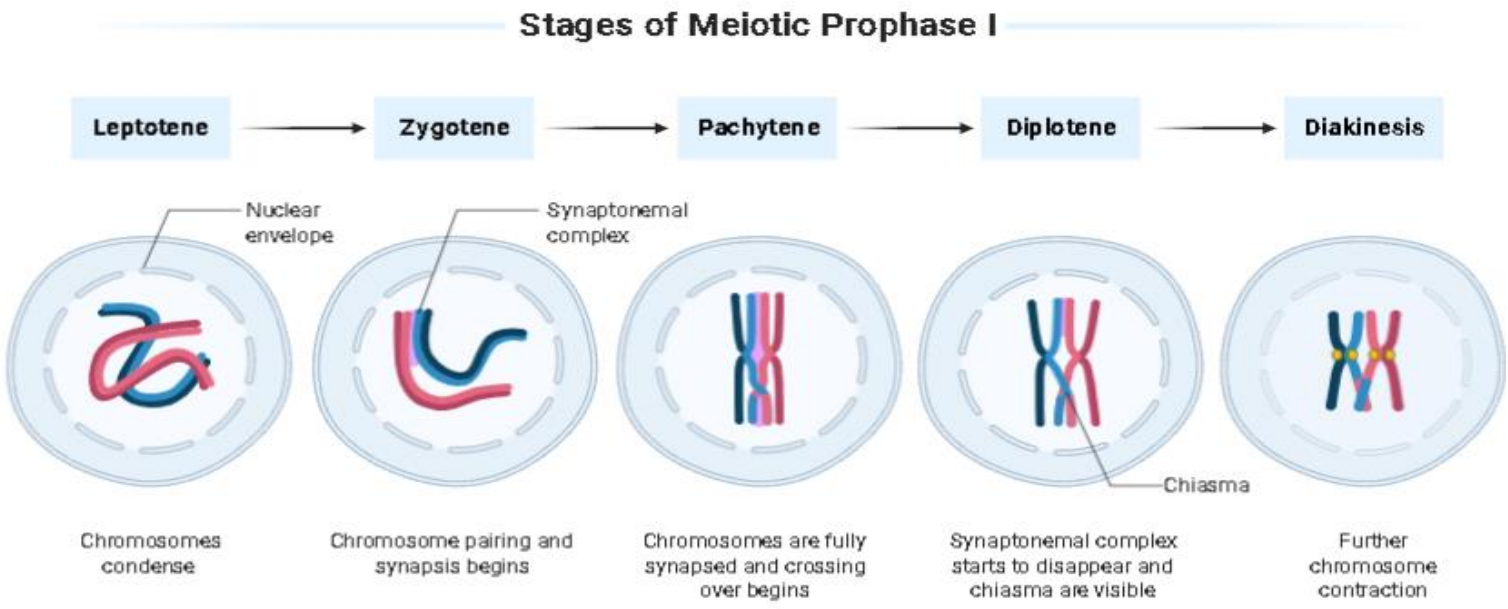

Figure (2) stages of meiotic prophase 1

2. Metaphase I:

- Spindle fibers attach to the homologues chromosomes at the centromere. They are move until their centromeres are aligned along the center of the cell, with one homologous chromosome on each side.

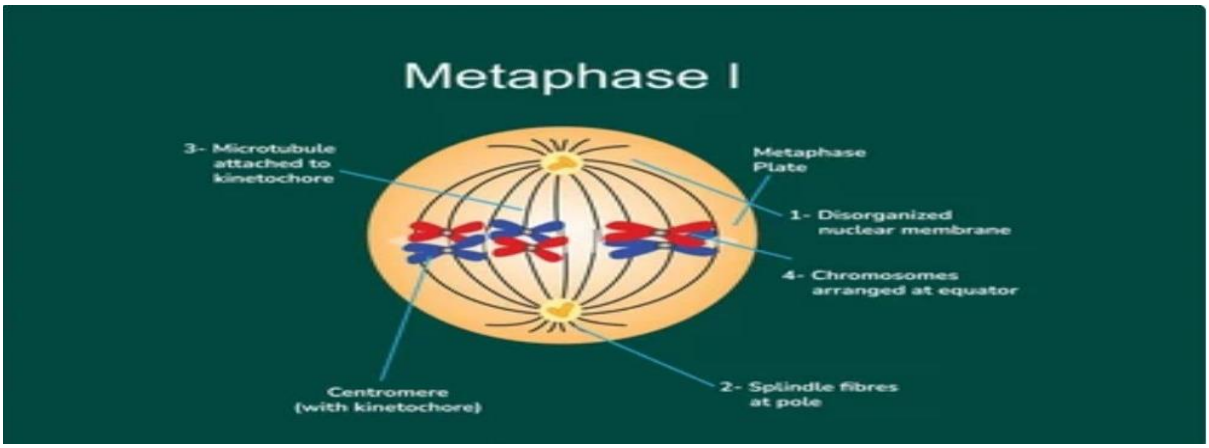

Figure (3) metaphase 1

3. Anaphase I:
    - The sister chromatids (one member of homologous chromosomes), by the centromere, remain together.
    - A maternal or paternal member of each homologous pair moves to each pole.

Note: Segregation or random assortment occurs because the maternal and paternal chromosomes of each pair are randomly aligned on one side or the other of the metaphase plate, thus contributing to genetic diversity.

4. Telophase I:
    - Each member of Homologous chromosomes that consisting of two sister chromatids, are now at the opposite poles of the cell.
    - Reappearance of the nucleolus and nuclear envelope.
    - At the end of this phase, the cytoplasm divides occurred. Result in 2 daughter cells, each cell is haploid in chromosome number (1n) and contains one member of each homologous chromosomes. The cell is still diploid in DNA content (2d).

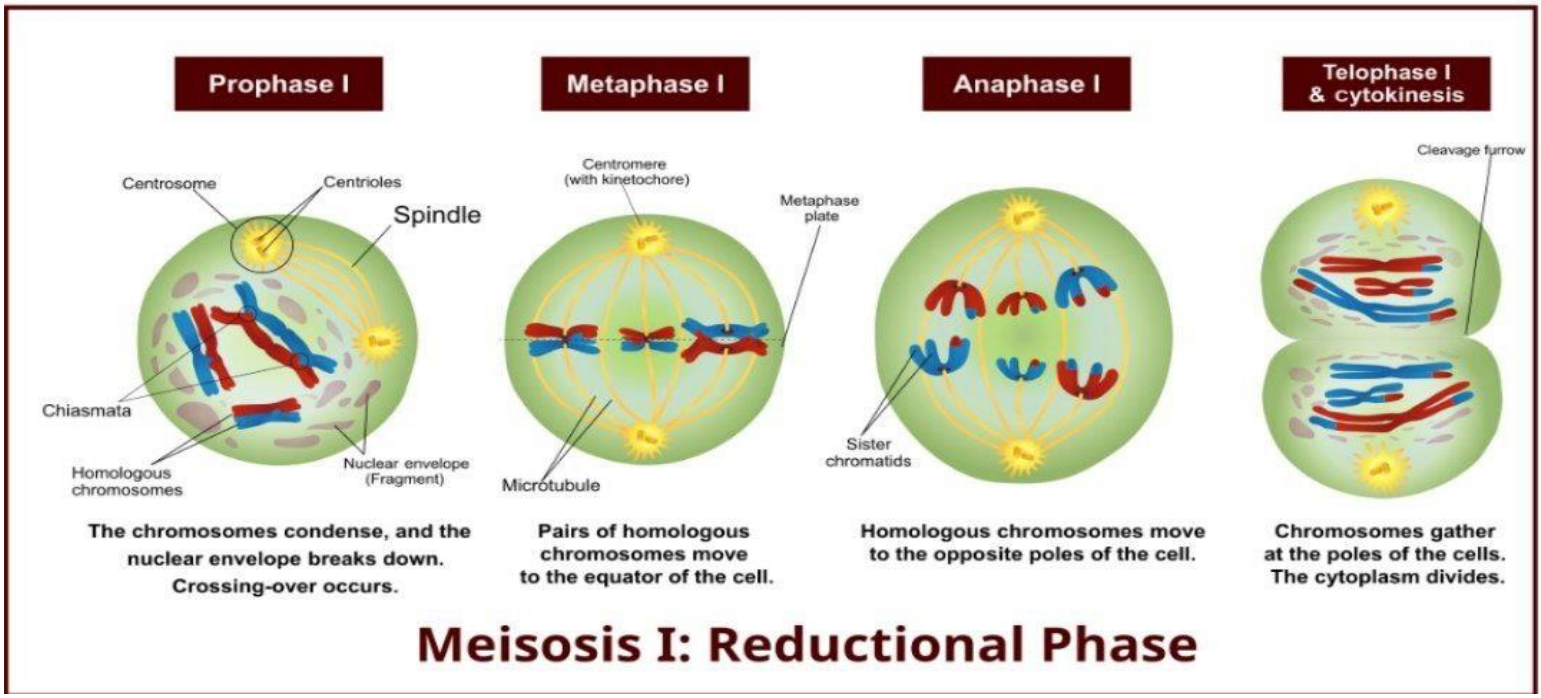

Figure (4) meiosis 1 phases

Phases of Meiosis II:

After meiosis I, the cells quickly enter meiosis II without passing through an S phase.

- Meiosis II is an equatorial division and resembles mitosis
- During meiosis II, the cells pass through prophase II, metaphase II, anaphase II, and telophase II.
- During anaphase II, the sister chromatids will separate and move to opposite poles of the cell.

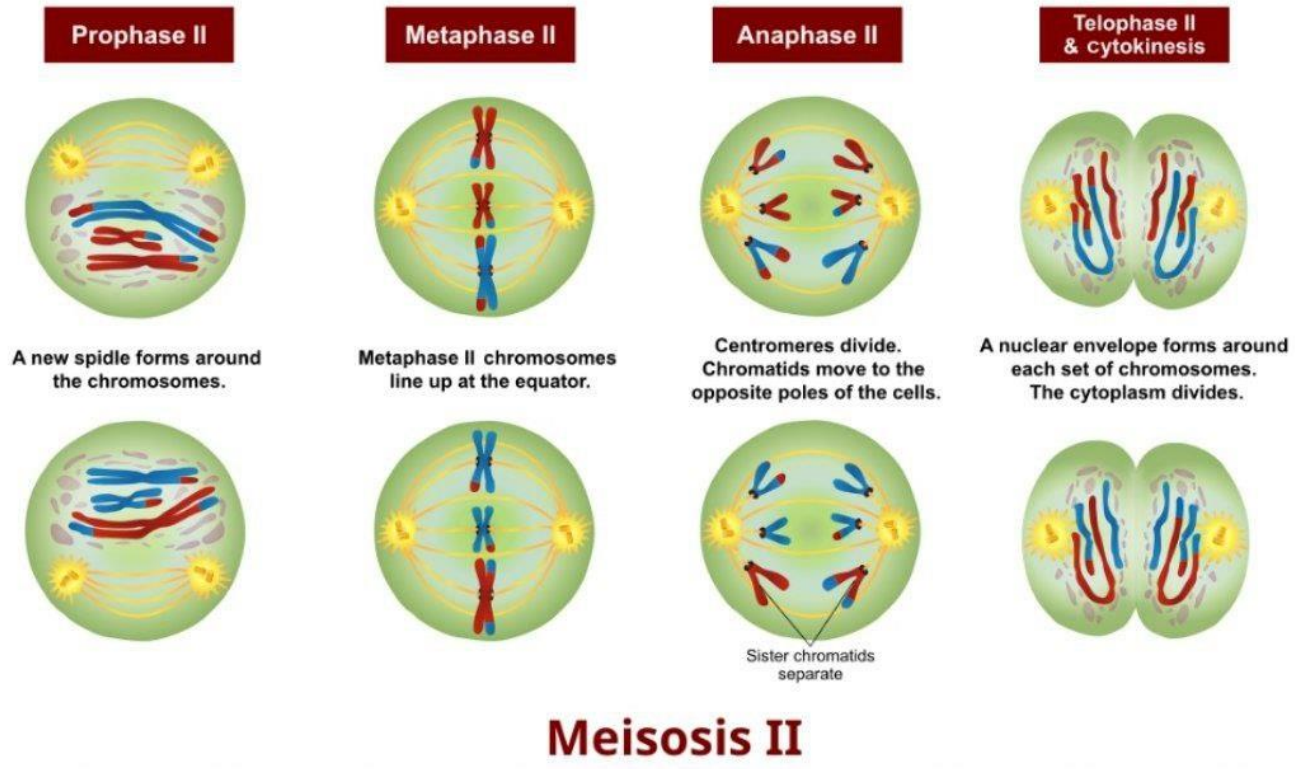

Figure (5) meiosis II.

Differences between meiosis I and meiosis II

meiosis I	meiosis II
1. Meiosis I is a reductional division. Generally longer due to the complex processes of prophase I.	1. Meiosis II: It is an equational division. Shorter, resembling a mitotic division.
2.Proceed by interphase has s phase	2.Proceed by interphase without s phase
3.Prophase II involve A. Crossing over occurs between homologous chromosomes. B. Genetic variation is occurred through crossing over where they exchange genetic material, leading to genetic variation C. Pair up (synapsis) and form tetrads.	3.Prophase II involve A. No crossing over occurs. B. No additional genetic variation occurs. C. No pairing occurs; chromosomes behave independently.
3. Homologous chromosomes are align at metaphase I and there are pulled apart during anaphase I. where the chromosome number is reduced by half (1n).	3. Sister chromatids are align at metaphase II and they separated during anaphase II, similar to mitosis. The chromosome number remains the same in the daughter cells (1n).
4. Results in two haploid daughter cells, but each chromosome still consists of two chromatids.	4. Results in four haploid daughter cells (n), each with single chromatids.

Differences between mitosis and meiosis II

Mitosis	Meiosis II
1. A process of cell division, crucial for growth, tissue repair, and asexual reproduction.	1. Is a Part of the overall meiosis process, crucial for gametes formation.
2. Starts with a diploid (2n) cell	2. Starts with haploid cells (1n) produced from Meiosis I
3. Produces genetically identical cells, with no variation between the daughter cells and the original parent cell	3. Produces genetically distinct cells due to genetic recombination & crossing over that occurred during Meiosis I
4. A single division process	4. The second division in a two-part process (following Meiosis I).
5. Sister chromatids are separated during anaphase.	5. Sister chromatids are a separated during anaphase II, but these chromatids may carry different genetic information due to the crossover from Meiosis I.
6. Results in two diploid daughter cells, where the chromosome number is maintained.	6. Results in four haploid cells, where the chromosome number is maintained.
7. Involved in somatic (body) cell division.	7. Involved in gametes formation

Q/Differences between mitosis and meiosis1?
Q/Similarity between mitosis and meiosis II?