Meiosis Dr. Kawthar Khalaf

The formation of all the body's cells except for sex cells occurs by mitosis, sex cells are formed by meiosis.

Meiosis; Is the form of cell division by which gametes are produced, with half number of chromosomes. Each gamete (spermatozoa in male and oocyte in female) contain a half number of chromosomes as a somatic cell plus one chromosome X or Y in male or X in the female, the complement of chromosomes in a gamete is referred to as a haploid number. During fertilization between oocyte and spermatozoon, the normal number of 46 chromosomes in 23 pair returns.

Purpose of meiosis:

1- **Creation of eggs and sperm for sexual reproduction**
2- **Generate large amounts of recombination**

The sexual reproduction increases genetic variability due to:

1- Crossover in prophase I
2- Independent assortment of meiosis
3- Random fertilization

Meiosis includes two divisions : Reductional division (meiosis I) and equational division (meiosis II) , as in mitosis meiosis occurs after an interphase period.

Interphase:

Similar to mitosis interphase in which the chromosomes replicate (S phase).Each duplicated chromosome consists of two identical sister chromatids attached at their centromeres. Centriole pairs also replicate. Nucleus and nucleolus visible

First meiotic division (Reductional division):

Is divided into five stages: prophase I, Prometaphase, Metaphase I, Anaphase I and Telophase I .

Prophase I:

Lasts a long time and is subdivided into five stages (phases):

1- **Leptotene :**
The chromosomes become visible (condense) as long, thin threads.

2- Zygotene :
Homologous chromosomes have begun to pair and synapses called bivalent (one of each pair came from the father, the other from the mother). The homologous chromosomes associate by the synaptonemal complex. The synaptonemal complex allows interacting chromatids to complete crossing-over.

3- **Pachytene:**
The chromosomes coil and appear shorter and thicker, each homologous pair or bivalent consist of four chromatids, the centromere does not split.

4- Diplotene:

The chromosomes start to separate, however, this separation is incomplete, and the certain points along their lengths they contact each other at sites of crossing over called chiasmata and exchanged segments, including an exchange of genetic information between homologous chromosomes.

5-Diakinesis:

The separation of chromosomes are proceeds, and at this stage the nuclear envelope starts to disappears. The centrosomes move away from each other, and a spindle starts to form between them.

Prometaphase I:

Homologous chromosomes are attached to spindle microtubules at the fused kinetochore shared by the sister chromatids and the nuclear envelope completely disappears.

Metaphase I:

In metaphase I the microtubule spindle attaches to the chromosomes and the homologous chromosomes (bivalents or tetrad) line up along the equatorial plate in pairs. Alignment of each pair of chromosomes relative to the poles of the cell is random and independent of the other pairs. This is referred to as independent assortment.

Anaphase I:

- Kinetochore microtubules contract, pulling the 2 members of each homologous pair of chromosomes to opposite poles of the cell.
- Centromeres do not split and sister chromatids remain attached.
- When the kinetochore microtubules have fully contracted, each pole has one complete set of duplicated chromosomes.
- Each daughter cell has 23 chromosomes each of which is composed of 2 chromatids, therefore, the cell still in duplicate form.

Telophase I:

- The movements of homologous chromosomes to the opposite poles are completed during telophase. The cell then divides into two daughter cells each ready for the second division due to cytokinesis.
- A nuclear membrane reforms around each set of duplicated chromosomes
- Cytokinesis divides the original cell into 2 haploid, non-identical, daughter cells
- Each chromosome is still duplicated and consists of 2 chromatids, but the sister chromatids are not identical due to crossing over during prophase I.

Before the beginning of meiosis II, cell first enters the resting stage also called interkinesis.

Interkinesis:

Is the time between the formation of daughter cells and the second meiotic division, there is no duplication of DNA during interkinesis. Only the chromosomes uncoil and the nuclear envelope reforms as interphase.

Second meiotic division (equational division):

Have five stages, these stages occur much as they do in mitosis except that there are 23 chromosomes instead of 46.

Prophase II:

The chromosomes recoil (condense) again, spindle form and the nuclear membrane start to disappear. Centrioles move towards the polar regions.

Prometaphase II:

The nuclear envelopes are completely broken down, and the spindle is fully formed. Each sister chromatid forms an individual kinetochore that attaches to microtubules from opposite poles.

Metaphase II:

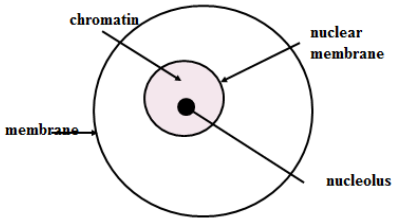
The chromosomes are aligned along the midplanes , with the kinetochores of the sister chromatids of each chromosome.

Anaphase II:

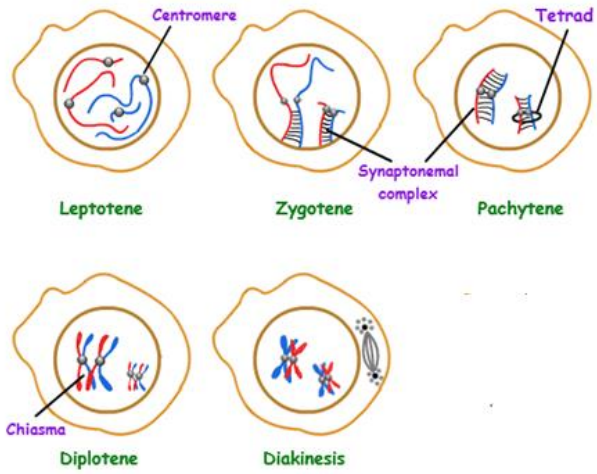
Each chromosome splits at its centromere, Kinetochore microtubules contract pulling the 2 members of each pair of chromosomes (that were formerly sister chromatids) to opposite poles of the cell. Each chromatid is now reformed to as daughter chromosome.

Telophase II:

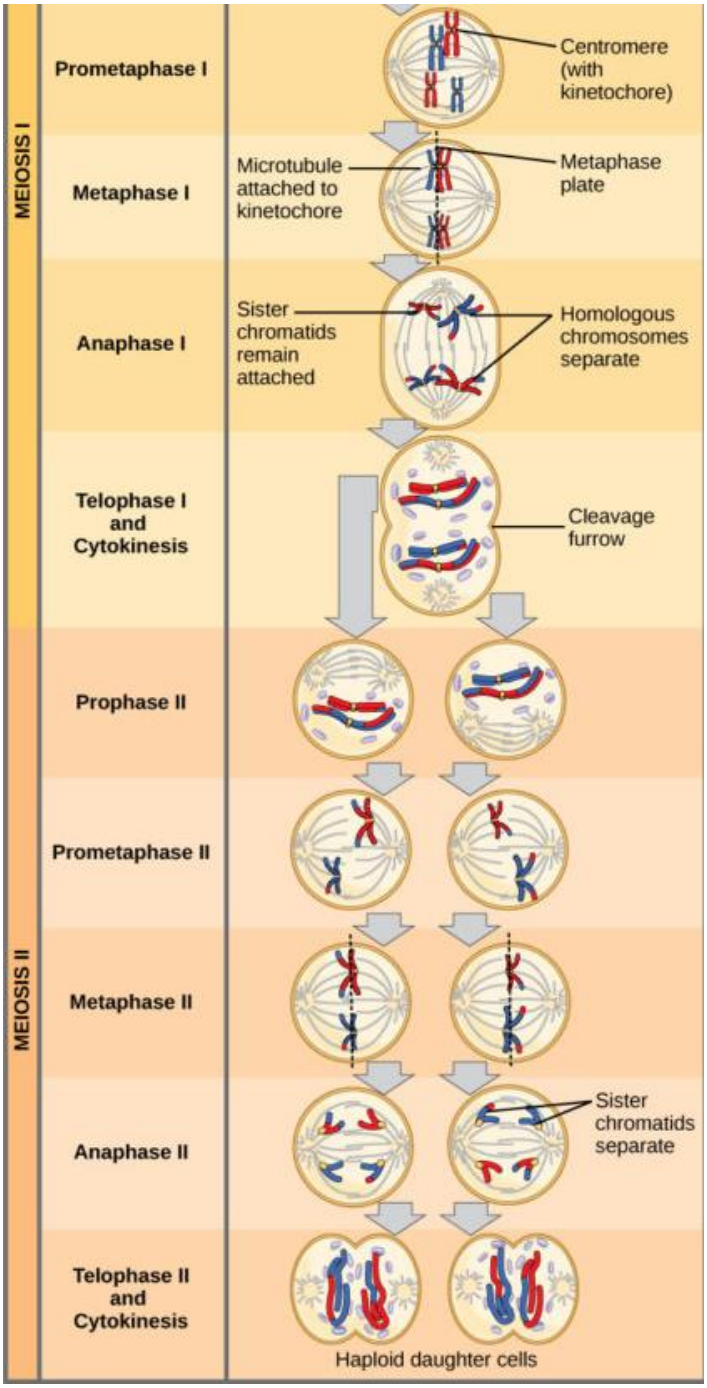
- The movement of chromosomes is complete and chromosomes uncoil.
- Nuclear envelope reforms around each group of daughter chromosomes.
- Cytokinesis divides the 2 cells from meiosis into forming a total of four daughter haploid cells.
- The two cells are alike due to crossing over during prophase I and independent assortment of homologous pairs during metaphase I.



Interphase



prophase I


MEIOSIS I
MEIOSIS II
Prometaphase I
Centromere (with kinetochore)
Metaphase I
Microtubule attached to kinetochore
Metaphase plate
Anaphase I
Sister chromatids remain attached
Homologous chromosomes separate
Telophase I and Cytokinesis
Cleavage furrow
Prophase II
Prometaphase II
Metaphase II
Anaphase II
Sister chromatids separate
Telophase II and Cytokinesis
Haploid daughter cells