Meiosis

Meiosis , is used for just one purpose in the human body: the production of **gametes**—sex cells, or sperm and eggs. Its goal is to make daughter cells with exactly half as many chromosomes as the starting cell.

To put that another way, **meiosis** in humans is a division process that takes us from a diploid cell—one with two sets of chromosomes—to haploid cells—ones with a single set of chromosomes. In humans, the haploid cells made in meiosis are sperm and eggs. When a sperm and an egg join in fertilization, the two haploid sets of chromosomes form a complete diploid set: a new genome.

Phases of meiosis:

In many ways, meiosis is a lot like mitosis. The cell goes through similar stages and uses similar strategies to organize and separate chromosomes. In meiosis, however, the cell has a more complex task. It still needs to separate **sister chromatids** (the two halves of a duplicated chromosome), as in mitosis. But it must also separate **homologous chromosomes**, the similar but no identical chromosome pairs an organism receives from its two parents.

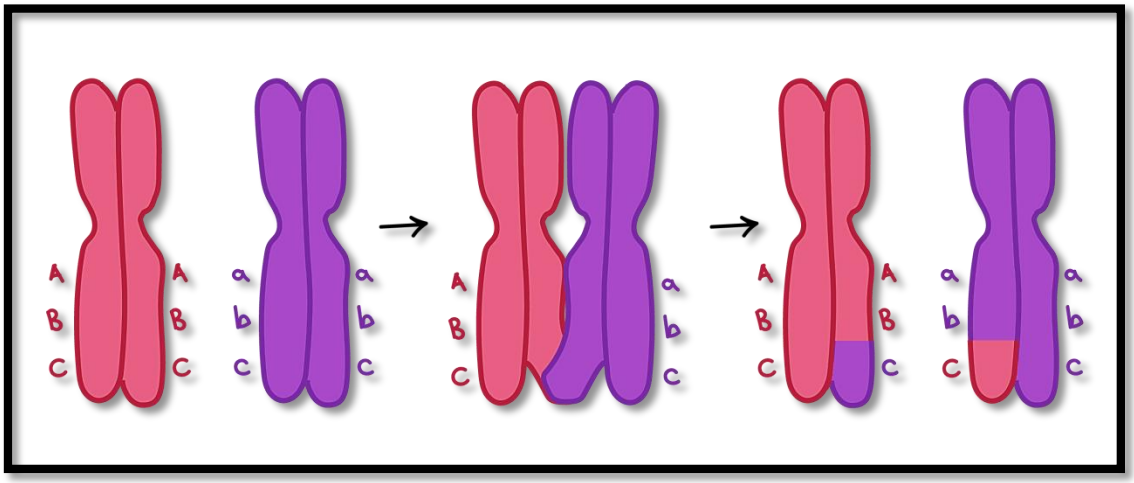
These goals are accomplished in meiosis using a two-step division process. Homologue pairs separate during a first round of cell division, called **meiosis I**. Sister chromatids separate during a second round, called **meiosis II**.

Since cell division occurs twice during meiosis, one starting cell can produce four gametes (eggs or sperm). In each round of division, cells go through four stages:(prophase, metaphase, anaphase, and telophase).

Meiosis I:

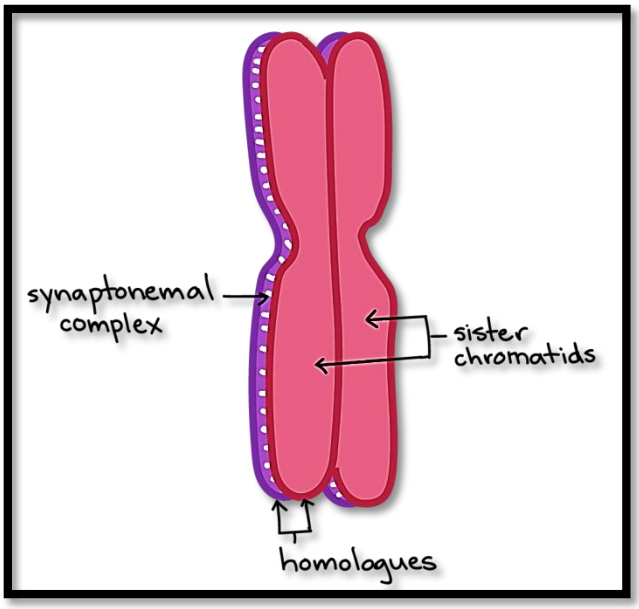
Before entering meiosis I, a cell must first go through interphase. As in mitosis, the cell grows during G1 start subscript, end subscript phase, copies all of its chromosomes during S phase, and prepares for division during G2 start subscript, end subscript phase.

During **prophase I**, differences from mitosis begin to appear. As in mitosis, the chromosomes begin to condense, but in meiosis I, they also pair up. Each chromosome carefully aligns with its homologue partner so that the two match up at corresponding positions along their full length.



(Image of crossing over)

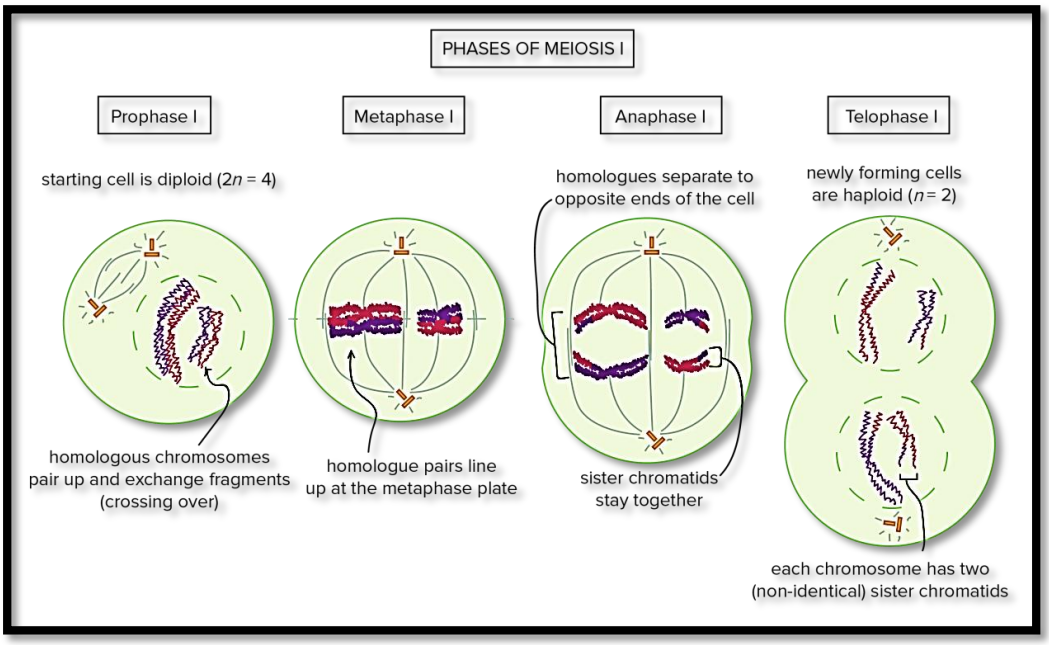
- This process, in which homologous chromosomes trade parts, is called **crossing over**. It's helped along by a protein structure called the **synaptonemal complex** that holds the homologues together. The chromosomes would actually be positioned one on top of the other as in the image below throughout crossing over; they're only shown side-by-side in the image above so that it's easier to see the exchange of genetic material.



- The spots where crossovers happen are more or less random, leading to the formation of new, "remixed" chromosomes with unique combinations of alleles.
- After crossing over, the spindle begins to capture chromosomes and move them towards the center of the cell (metaphase plate).
- Each chromosome attaches to microtubules from just one pole of the spindle, and the two homologues of a pair bind to microtubules from opposite poles.

During **metaphase I**, homologue pairs not individual chromosomes line up at the metaphase plate for separation.

- When the homologous pairs line up at the metaphase plate, the orientation of each pair is random.



- For instance, in the diagram above, the **pink version** of the big chromosome and the **purple version** of the little chromosome happen to be positioned towards the same pole and go into the same cell.

- But the orientation could have equally well been flipped, so that both purple chromosomes went into the cell together. This allows for the formation of gametes with different sets of homologues.

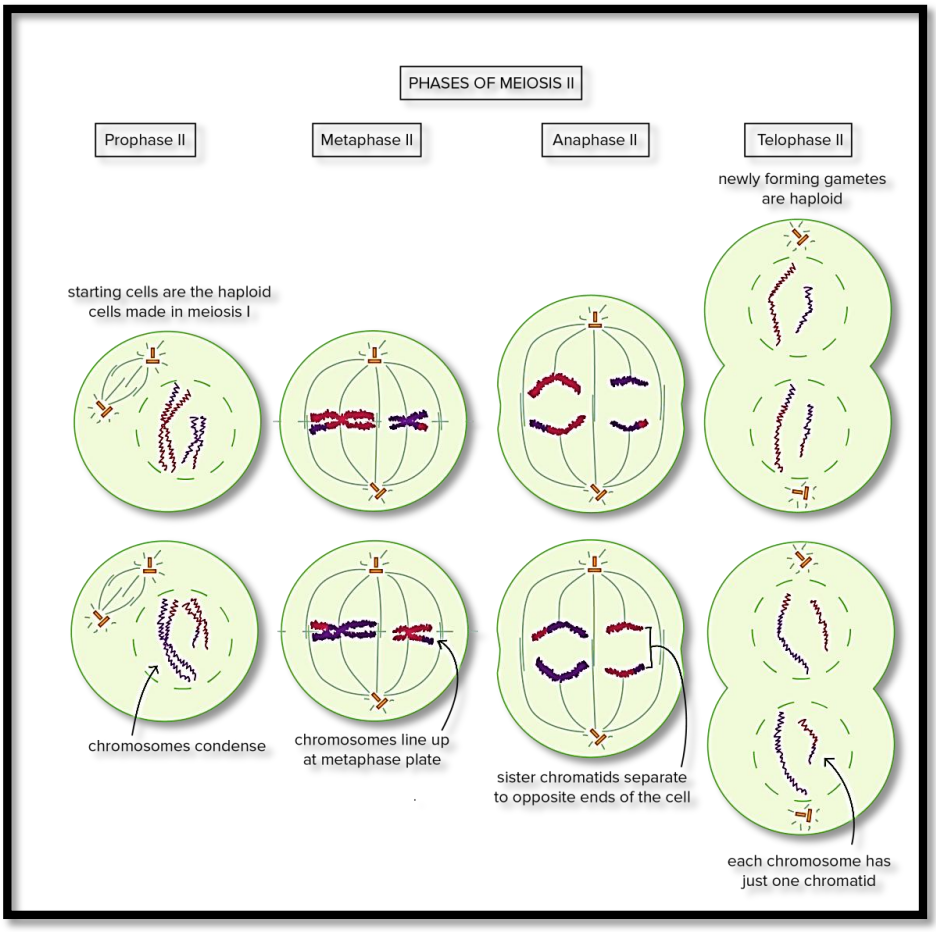
In **anaphase I**, the homologues are pulled apart and move apart to opposite ends of the cell. The sister chromatids of each chromosome, however, remain attached to one another and don't come apart.

Finally, in **telophase I**, the chromosomes arrive at opposite poles of the cell. In some organisms, the nuclear membrane re-forms and the chromosomes decondense . Cytokinesis usually occurs at the same time as telophase I, forming two haploid daughter cells.

Meiosis II

Cells move from meiosis I to meiosis II without copying their DNA. Meiosis II is a shorter and simpler process than meiosis I, and you may find it helpful to think of meiosis II as "**mitosis for haploid cells**."

The cells that enter meiosis II are the ones made in meiosis I. These cells are haploid, have just one chromosome from each homologue pair, but their chromosomes still consist of two sister chromatids. In meiosis II, the sister chromatids separate, making haploid cells with non-duplicated chromosomes.

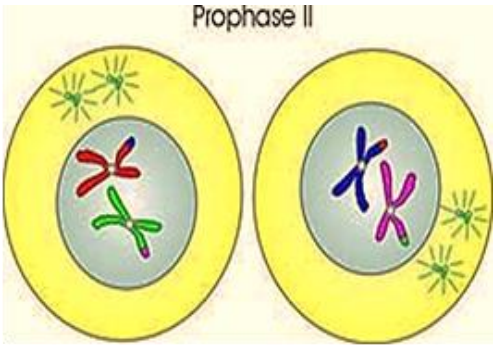


(Phases of meiosis II)

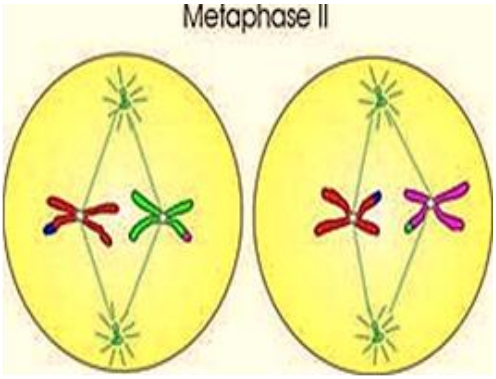
During **prophase II**, chromosomes condense and the nuclear envelope breaks down, if needed. The centrosomes move apart, the spindle forms

between them, and the spindle microtubules begin to capture chromosomes.

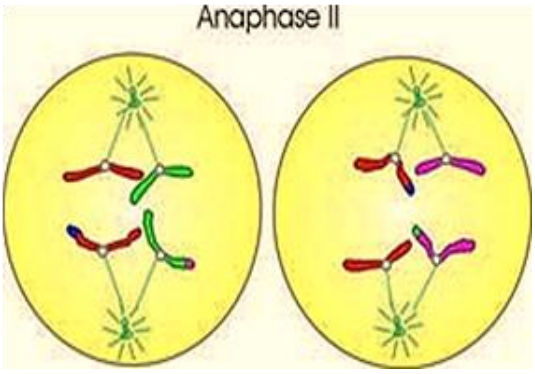
The two sister chromatids of each chromosome are captured by microtubules from opposite spindle poles.



In **metaphase II**, the chromosomes line up individually along the metaphase plate.

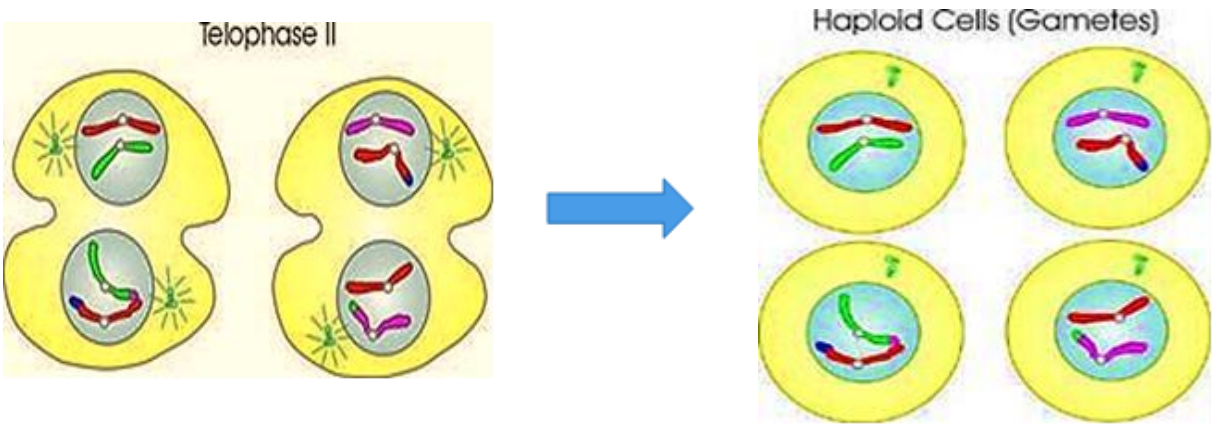


In **anaphase II**, the sister chromatids separate and are pulled towards opposite poles of the cell.



In **telophase II**, nuclear membranes form around each set of chromosomes, and the chromosomes decondense.

Cytokinesis splits the chromosome sets into new cells, forming the final products of meiosis: four haploid cells in which each chromosome has just one chromatid. In humans, the products of meiosis are sperm or egg cells.



Differences between mitosis and meiosis

Mitosis	Meiosis
1- Take place in somatic cells.	1- Take place in the germ cells.
2- Occur in both sexually as well as asexually reproducing organisms.	2- Occur only in sexually reproducing organisms.
3- The cell divide only once.	3- There are two cell divisions first and second meiotic divisions.
4- Interphase occurs prior to each division.	4- Interphase precedes only in meiosis. It does not occur prior meiosis II.
5- Prophase is simple.	5- Prophase is divided into Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.
6- The two chromatids of a chromosome don't exchange segment during prophase.	6- Chromatids of two homologous chromosomes exchange segments during crossing over.
7- The chromosome number remains constant at the end of mitosis.	7- The chromosome number is reduced from the diploid to the haploid.