

Meiosis reduces chromosome number from diploid to haploid: *a closer look*

- Many steps of meiosis resemble steps in mitosis.
- Both are preceded by the replication of chromosomes during interphase.
- However, in meiosis, there are two consecutive cell divisions, **meiosis I** and **meiosis II**, which results in four daughter cells.
- Each final daughter cell has only half as many chromosomes as the parent cell.
- Meiosis reduces chromosome number by copying the chromosomes once, but dividing twice.
- The first division, meiosis I, separates homologous chromosomes.
- The second, meiosis II, separates sister chromatids (the copies).
- Division in meiosis I occurs in four phases: prophase, metaphase, anaphase, and telophase.
- During the preceding interphase the chromosomes are replicated to form sister chromatids (just like mitosis!).
 - These are **genetically identical** and joined at the centromere.
- Also, the single centrosome is replicated.
- In prophase I, the chromosomes condense and homologous chromosomes pair up to form tetrads.
 - In a process called synapsis, special proteins attach homologous chromosomes tightly together.
 - At several sites the chromatids of homologous chromosomes are crossed (chiasmata) and segments of the chromosomes are traded.
 - A spindle forms from each centrosome and spindle fibers attached to kinetochores on the chromosomes begin to move the tetrads around.

- At **metaphase I**, the tetrads are all arranged at the metaphase plate.
 - Microtubules from one pole are attached to the kinetochore of one chromosome of each tetrad, while those from the other pole are attached to the other.
 - In **anaphase I**, the homologous chromosomes separate and are pulled toward opposite poles.
 - In **telophase I**, movement of homologous chromosomes continues until there is a haploid set at each pole.
 - Each chromosome consists of linked sister chromatids.
 - **Cytokinesis** by the same mechanisms as mitosis usually occurs simultaneously.
 - In some species, nuclei may reform, but there is no further replication of chromosomes.
- ✓ So at the end of meiosis I, you have 2 haploid cells, each containing 2 copies (doubled chromosomes, or sister chromatids) of **only 1 of each of the homologous chromosomes**
- Meiosis II is very similar to mitosis.
 - During **prophase II** a spindle apparatus forms, attaches to kinetochores of each sister chromatid, and moves them around.
 - Spindle fibers from one pole attach to the kinetochore of one sister chromatid and those of the other pole to the other sister chromatid.
 - At **metaphase II**, the sister chromatids are arranged at the metaphase plate.
 - The kinetochores of sister chromatids face opposite poles.
 - At **anaphase II**, the centomeres of sister chromatids separate and the now separate sisters (single chromosomes) travel toward opposite poles.
 - In **telophase II**, separated sister chromatids arrive at opposite poles.
 - Nuclei form around the chromatids.
 - Cytokinesis separates the cytoplasm.
 - At the end of meiosis, there are four haploid daughter cells.

- Mitosis and meiosis have several key differences.
 - ✓ The chromosome number is reduced by half in meiosis, but not in mitosis.
 - ✓ Mitosis produces daughter cells that are genetically identical to the parent and to each other.
 - ✓ Meiosis produces cells that differ from the parent and each other.
- Three events, unique to meiosis, occur during the first division cycle.

1. During ***prophase I***, homologous chromosomes pair up in a process called **synapsis**.

- A protein zipper, the *synaptonemal complex*, holds homologous chromosomes together tightly.
- Later in prophase I, the joined homologous chromosomes are visible as a tetrad.
- At X-shaped regions called **chiasmata**, sections of nonsister chromatids are exchanged.
- Chiasmata is the physical manifestation of crossing over, a form of genetic rearrangement.

2. At ***metaphase I*** homologous pairs of chromosomes, not individual chromosomes are aligned along the metaphase plate.

- In humans, you would see 23 tetrads.
- In mitosis, you would see 46!

3. At ***anaphase I***, it is homologous chromosomes, not sister chromatids, that separate and are carried to opposite poles of the cell.

- Sister chromatids remain attached at the centromere until anaphase II.
- The processes during the second meiotic division are virtually identical to those of mitosis.
- Mitosis produces two identical daughter cells, but meiosis produces 4 very different cells.