Glossary

allosome: chromosomes that play a role in sex determination

autosome: any non-allosome

chiasmata: (singular = *chiasma*) the structure that forms at the crossover points after genetic material is exchanged

crossing over: (also, recombination) the exchange of genetic material between homologous chromosomes resulting in chromosomes that incorporate genes from both parents of the organism forming reproductive cells

diploid: describes a cell, nucleus, or organism containing two sets of chromosomes ($2n$)

egg (ovum): the female gamete; a haploid cell

fertilization: the union of two haploid cells typically from two individual organisms

gamete: a haploid reproductive cell or sex cell (sperm or egg)

gene: the physical and functional unit of heredity; a sequence of DNA that codes for a specific peptide or RNA molecule

germline cell: specialized cell line that produces gametes, such as eggs or sperm

haploid: describes a cell, nucleus, or organism containing one set of chromosomes (n)

homologous chromosomes: the randomness of how the homologous chromosome pairs align at the metaphase plate during metaphase I of meiosis I

independent assortment: describing something composed of genetic material from two sources, such as a chromosome with both maternal and paternal segments of DNA

interkinesis: a period of rest that may occur between meiosis I and meiosis II; there is no replication of DNA during interkinesis

locus: the position of a gene on a chromosome

meiosis I: the first round of meiotic cell division; referred to as reduction division because the resulting cells are haploid

meiosis II: the second round of meiotic cell division following meiosis I; sister chromatids are separated from each other, and the result is four unique haploid cells

sperm: the male gamete; a haploid cell

somatic cell: all the cells of a multicellular organism except the gamete-forming cells

tetrad: two duplicated homologous chromosomes (four chromatids) bound together by chiasmata during prophase I

zygote: a fertilized egg produced when a sperm and egg fuse

8.6 Errors in Meiosis

Learning objectives

By the end of this section, you will be able to:

- *Explain how nondisjunction leads to disorders in chromosome number*
- *Describe how errors in chromosome structure occur through duplications, deletions, inversions and translocations*
- *Be able to define and explain all bolded terms*

Inherited chromosomal disorders can occur when mistakes happen during meiosis. Chromosome disorders can be divided into two categories: abnormalities in chromosome number and chromosome structural rearrangements. Chromosomal disorders are characteristically noticeable and often fatal. We will look at how errors occur during meiosis and the impact this has on an individual's health and homeostasis.

Disorders in Chromosome Number

Chromosomal abnormalities in humans can be detected by first isolating chromosomes and then observing them using a microscope. A **karyotype** is the number and appearance of an individual's chromosomes, including their length, banding pattern, and centromere position.

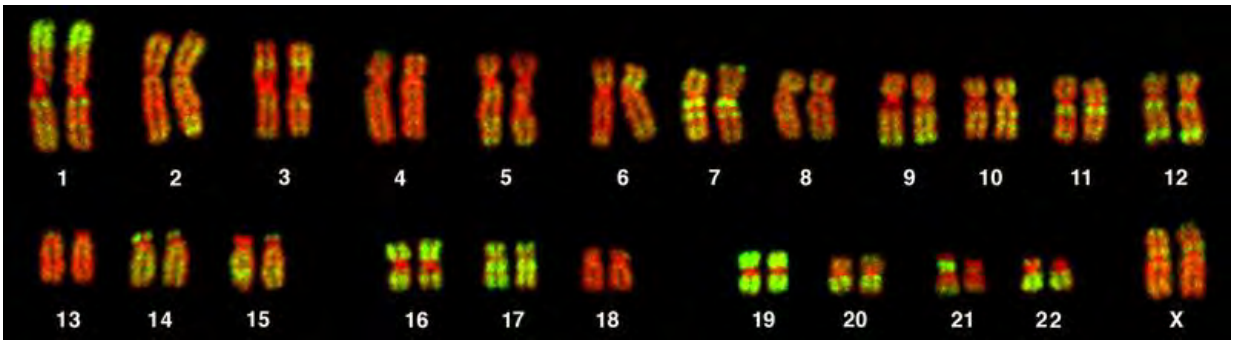

Figure 8.30 This karyogram shows the chromosomes of a female human immune cell during mitosis. (credit: Andreas Bolzer, et al / Biology 2E OpenStax)

To observe an individual's karyotype, a person's cells, such as their white blood cells, are first collected from a blood sample or other tissue sample. The isolated cells are stimulated to begin mitosis. A chemical is then applied to the cells to arrest mitosis during metaphase, and the cells are then fixed to a slide. Chromosomes are stained with one of several dyes to better visualize the distinct and reproducible banding patterns of each homologous chromosome pair. An experienced medical professional can identify each band, size, and centromere location. To generate the **karyogram**, the chart that shows an individual's karyotype, homologous pairs of chromosomes are manually aligned in numerical order from longest to shortest (Figure 8.30).

Chromosomal Number Disorders

Of all chromosomal disorders, abnormalities in chromosome number are the most obvious when looking at a karyogram. Duplicating or losing entire chromosomes can occur through a process called nondisjunction. **Nondisjunction** occurs when homologous chromosome pairs or sister chromatids fail to separate during meiosis I or meiosis II. Misaligned chromosomes, chromosome pairs not forming tetrads, or failure of the microtubules to attach and then move chromosomes to opposite poles can all cause nondisjunction to occur. The risk of nondisjunction occurring increases with the parents' age.

Nondisjunction can occur during either meiosis I or II (Figure 8.32). If homologous chromosomes fail to separate during meiosis I, 100% of the gametes will be affected. In this case, two gametes will lack a particular chromosome, and two gametes will have additional copies of that particular chromosome (Figure 8.31). If sister chromatids fail to separate during meiosis II, there is a chance that 50% of the gametes will contain the correct number of chromosomes (Figure 8.31). Regardless of whether nondisjunction happens in meiosis I or II, some gametes, if not all, will have the wrong chromosome number. If those gametes participate in fertilization, it will result in an individual that has a genetic condition.

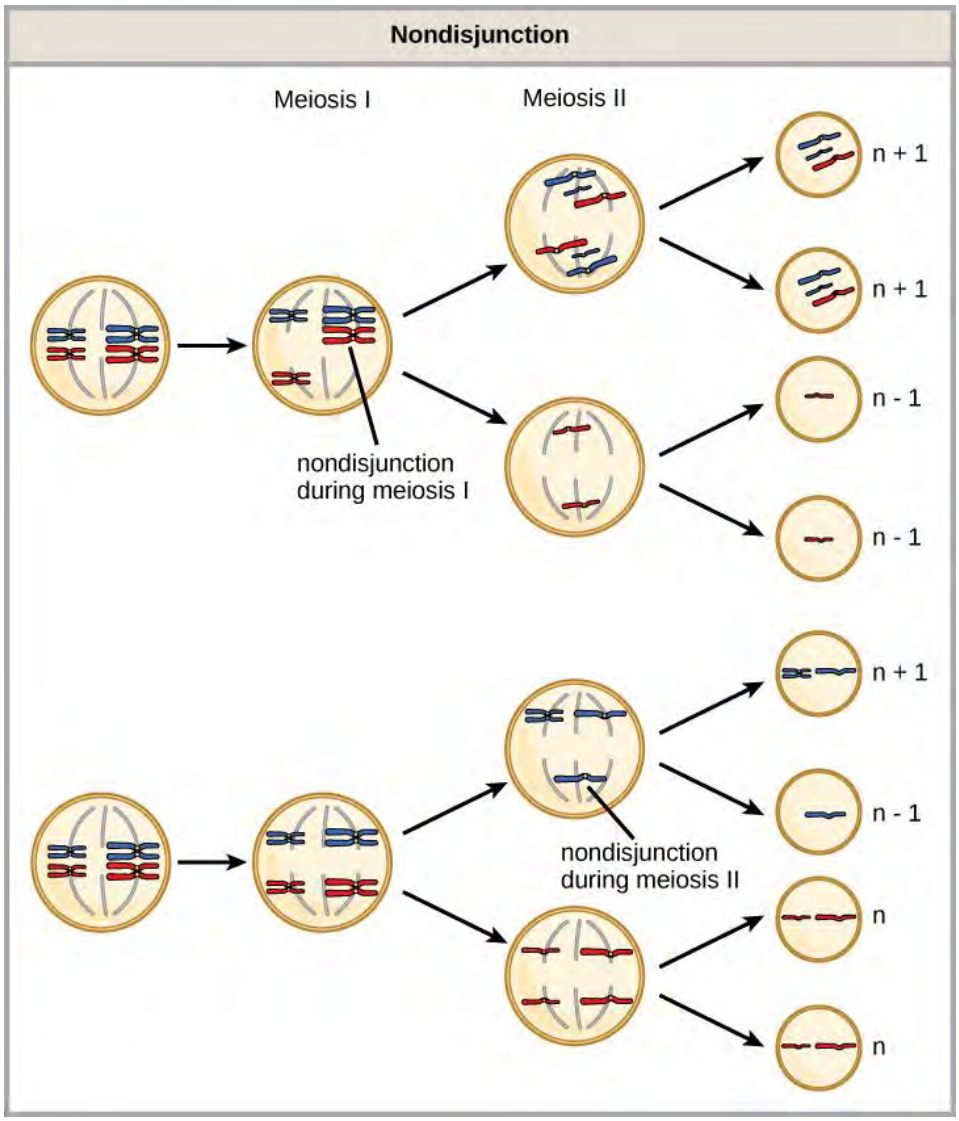

Figure 8.31 Following meiosis, each gamete has one copy of each chromosome. Nondisjunction occurs when homologous chromosomes (meiosis I) or sister chromatids (meiosis II) fail to separate during meiosis. (credit: Clark et al. / Biology 2E OpenStax)