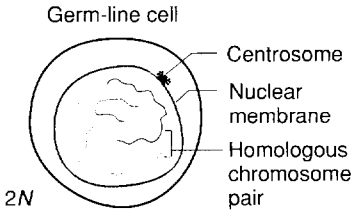
MEIOSIS

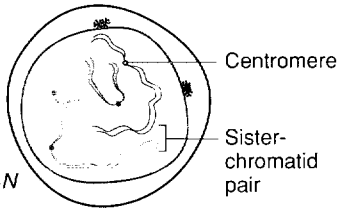
Meiosis is the type of cell division that produces the gametes (eggs and sperms) whose union is the first step in the creation of a new human or other sexually reproducing organism. Only so-called germ-line cells undergo meiosis, and each gamete contains a haploid set of chromosomes—a set composed of one member of each of the *N* pairs of homologous chromosomes possessed by the diploid germ-line cell. The transition from diploidy to haploidy is accomplished by two successive partitions of nuclear material. During each partition the motions of the chromosomes are directed, as they are during mitosis, by microtubules radiating from two centrosomes.

PREMEIOTIC PHASE

The germ-line cell, which may be an oogonium in an ovary or a spermatogonium in a testis, appears little different from a somatic cell in G_1. Only two of the germ-line cell's *N* pairs of homologous chromosomes are shown, and the members of each homologous pair are depicted in different shades of the same color.



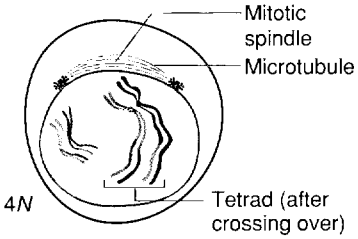
The germ-line cell has replicated its complement of chromosomes and all other cellular material required for cell division, including the centrosome. The two identical copies of each chromosome are bound together along their centromeres into a sister-chromotid pair.



MEIOTIC PHASE

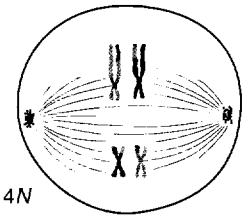
Prophase I

The onset of meiosis is signaled by a limited condensation of chromosomes. Homologous sister-chromatid pairs have become closely associated, forming *N* tetrads and allowing "crossing over" to occur, here within only one tetrad. Crossing over results in the exchange of corresponding portions of homologous chromosomes. The germ-line cell now lingers in prophase I for a time that ranges, depending on the species, from a few days to many years.



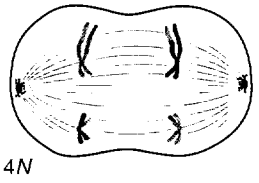
Metaphase I

The germ-line cell has passed through prometaphase I (not shown) and has entered metaphase I. The chromosomes have fully condensed, and the tetrads have become aligned along the midplane of the cell.



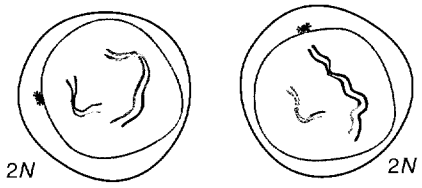
Anaphase I

The members of each tetrad have separated and begun moving toward opposite sides of the cell. Depicted here is but one of the 2^N possible outcomes of the motion of the members of the *N* tetrads. The equal probability of each possible outcome is the physical basis for Mendel's laws of equal segregation and independent assortment.



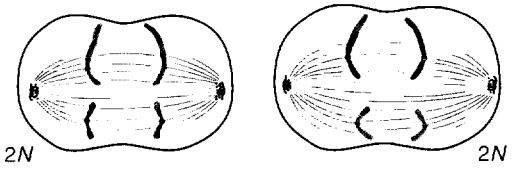
Prophase II

The germ-line cell has passed through telophase I (not shown) and has divided into two cells, each of which has entered prophase II. Note that the products of the first meiotic division, like the products of mitosis, have the same number of chromosomes as the original cell. However, a product of mitosis contains *N* homologous chromosome pairs, whereas a product of the first meiotic division contains two identical copies of each of *N* nonhomologous chromosomes.



Anaphase II

Both cells have passed through prometaphase II and metaphase II (not shown). Each sister-chromatid pair has separated, and the members of each former sister-chromatid pair have begun migrating to opposite sides of the cell.



POSTMEIOTIC PHASE

Each cell has passed through telophase II (not shown) and divided into two gametes. Thus each meiosis can yield four gametes. However, meiosis of an oogonium usually yields only one egg because each division of extranuclear material usually yields only one cell that survives because it receives most of the extranuclear material.