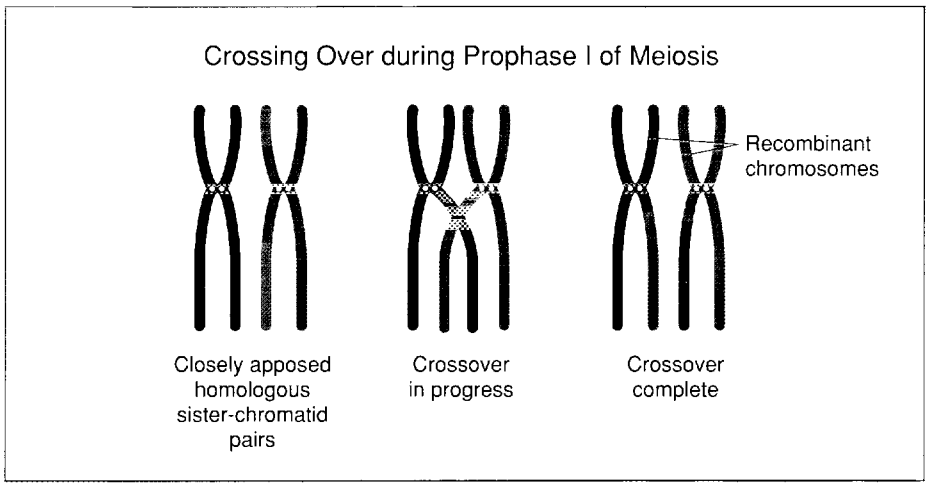
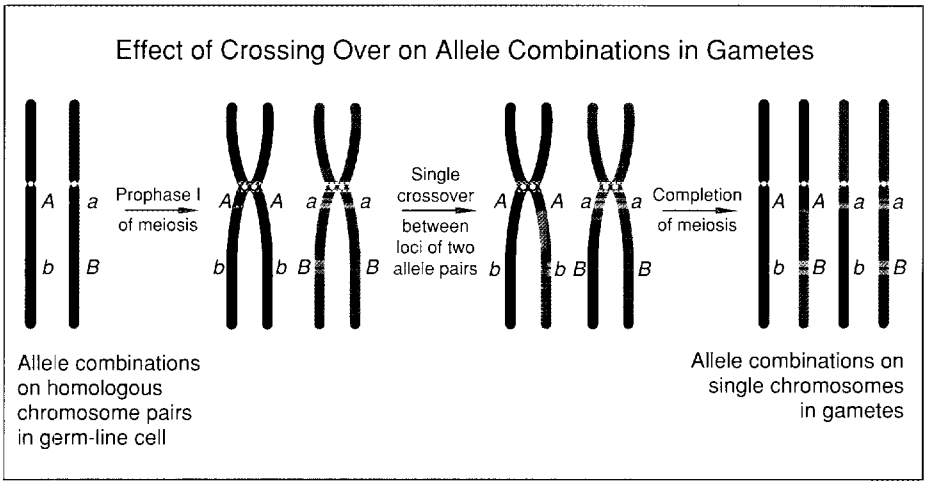
CROSSING OVER: a special type of recombination

DNA molecules, and hence chromosomes, are not immutable, even in the absence of external mutagenic agents. One of the natural mechanisms whereby DNA molecules can change is recombination, which rearranges genetic material by breaking and joining portions of the same DNA molecule or portions of different DNA molecules of the same organism. (Recombination can occur also between the DNA of an organism and the DNA of a virus that infects the organism.) Crossing over is the type of recombination undergone by the similar DNA molecules within two homologous chromosomes. It occurs almost exclusively during prophase I of meiosis, when homologous chromosomes are closely apposed. A single crossover between homologous chromosomes effects an exchange of corresponding chromosome regions and results in the formation of recombinant chromosomes, which differ in their content of hereditary information from the chromosomes that participated in the crossover. Crossing over also occurs between the identical DNA molecules within the chromosomes of a sister-chromatid pair, but because the recombinant chromosomes so formed are usually identical to the participants, such recombination has little genetic significance.





The occurrence of a single crossover between the loci of two allele pairs, say *A* and *a* and *B* and *b*, resident on a homologous chromosome pair results in the formation of some gametes that possess combinations of alleles different from the combinations possessed by the parent germ-line cell. Crossing over is thus a mechanism for increasing genetic diversity. It also is the basis of a standard method for determining a "distance" between the locus of *A* and *a* and the locus of *B* and *b*. The first step in the method (see "Determining a Genetic Distance") is to carry out a certain breeding experiment and thereby measure, among a group of gametes produced by one parent, the fraction possessing the new allele combinations (the so-called recombination fraction). When the measured recombination fraction is relatively small (less than about 0.10), it is approximately equal to the "genetic distance" between the two loci, that is, to the average number of crossovers between the two loci per meiosis. The genetic distance between the two loci in turn is a rough measure of the physical distance (the distance along the DNA molecule) between the two loci.