8.4: Advantages of Genetic Recombination

Not only is recombination needed for homologous pairing during meiosis, but recombination has at least two additional benefits for sexual species. It makes new combinations of alleles along chromosomes, and it restricts the effects of mutations largely to the region around a gene, not the whole chromosome.

Since each chromosome undergoes at least one recombination event during meiosis, new combinations of alleles are generated. The arrangement of alleles inherited from each parent are not preserved, but rather the new germ cells carry chromosomes with new combinations of alleles of the genes (Figure 8.4). This remixing of combinations of alleles is a rich source of diversity in a population.

**Figure 8.4.** Recombination during meiosis generates new combinations of alleles in the offspring. One homologous pair of chromosomes is illustrated, starting at the “four-strand” stage. Each line is a duplex DNA molecule in a chromatid. The two chromosomes in the father (inherited from the paternal grandparents) are blue and green; the homologous chromosomes in the mother (inherited from the maternal grandparents) are brown and pink. All chromosomes have genes A, B and C; different numbers refer to different alleles. In this illustration, a crossover on the short arm of the...
chromosome during development of the male germ cells links allele 4 of gene C with alleles 1 of gene A and allele 2 of gene B, as well as the reciprocal arrangement. A crossover on the long arm of the chromosome is illustrated for development of the female germ cell, making the new combination A3, B3 and C1. A child can have the new chromosomes A1B2C4 and A3B3C1. Note that neither of these combinations was in the father or mother.

Over time, recombination will separate alleles at one locus from alleles at a linked locus. A chromosome through generations is not fixed, but rather it is "fluid," having many different combinations of alleles. This allows nonfunctional (less functional) alleles to be cleared from a population. If recombination did not occur, then one deleterious mutant allele would cause an entire chromosome to be eliminated from the population. However, with recombination, the mutant allele can be separated from the other genes on that chromosome. Then negative selection can remove defective alleles of a gene from a population while affecting the frequency of alleles only of genes in tight linkage to the mutant gene. Conversely, the rare beneficial alleles of genes can be tested in a population without being irreversibly linked to any potentially deleterious mutant alleles of nearby genes. This keeps the effective target size for mutation close to that of a gene, not the whole chromosome.

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