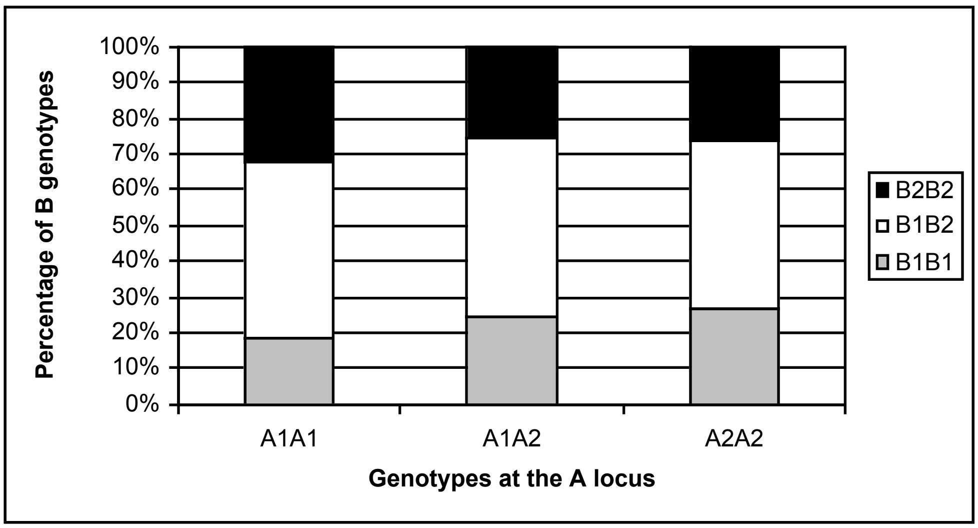
Answers to Exercise 30

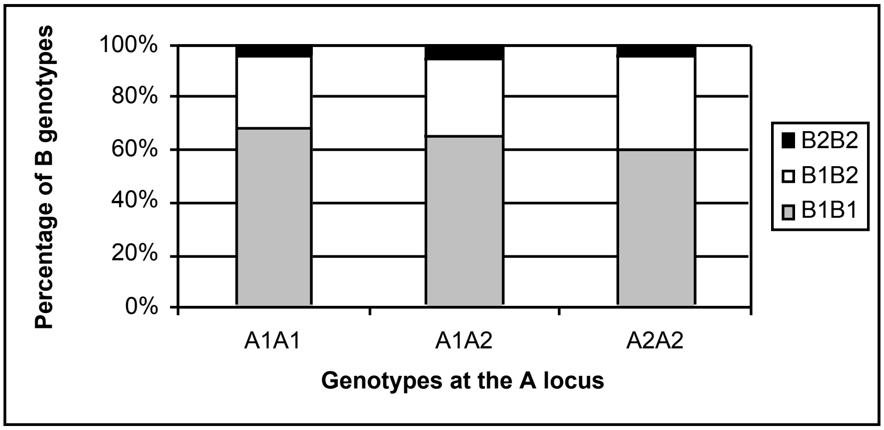
Multilocus Hardy-Weinberg and Linkage Disequilibrium

1. Your graph should indicate that the *B* genotypes are distributed more or less in the same manner across the various kinds of *A* genotypes. Given that $p_2 = 0.5$ and $q_2 = 0.5$, about 25% of the total offspring population should have B_1B_1 genotypes, about 50% of the offspring should have B_1B_2 genotypes, and about 25% of the offspring population should have B_2B_2 genotypes. If the population is in linkage equilibrium, these percentages should be distributed approximately equally among the various *A* genotypes—as they appear to be. The numbers may be off a bit due to the way in which parental genotypes were assigned, and due to the way in which gametes were modeled (randomly).

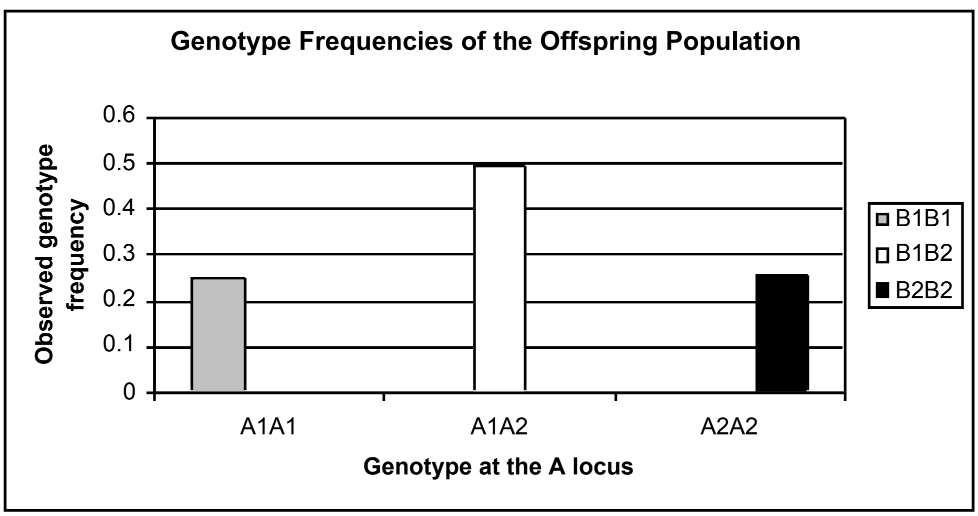


2. The offspring population is still in Hardy-Weinberg equilibrium, and *D* is close to 0. You might recall from your first exercise that, no matter what the initial genotypes are, the offspring population will return to Hardy-Weinberg conditions after a single generation of random mating. With the genotype frequencies of the adult population, the frequency of the A_1 allele is about 0.55 and the frequency of the A_2 allele is about 0.45 (these frequencies will change a bit depending on the genotypes of the 1000 individuals in the population). The frequency of the B_1 allele is about 0.85 and the frequency of the B_2 allele is about 0.15. With $B_1 = 0.85$ and $B_2 = 0.15$, we would expect that about 0.7225 (~72%) of the offspring population would be B_1B_1, that 0.255 (~25%) of the offspring population would be B_1B_2 ($2 \times p \times q$), and that 0.0225 (~2%) of the population would be B_2B_2. This is true. The B_1B_1 offspring are distributed among the A genotypes in more or less equal proportions, indicating that

the population is in linkage equilibrium.

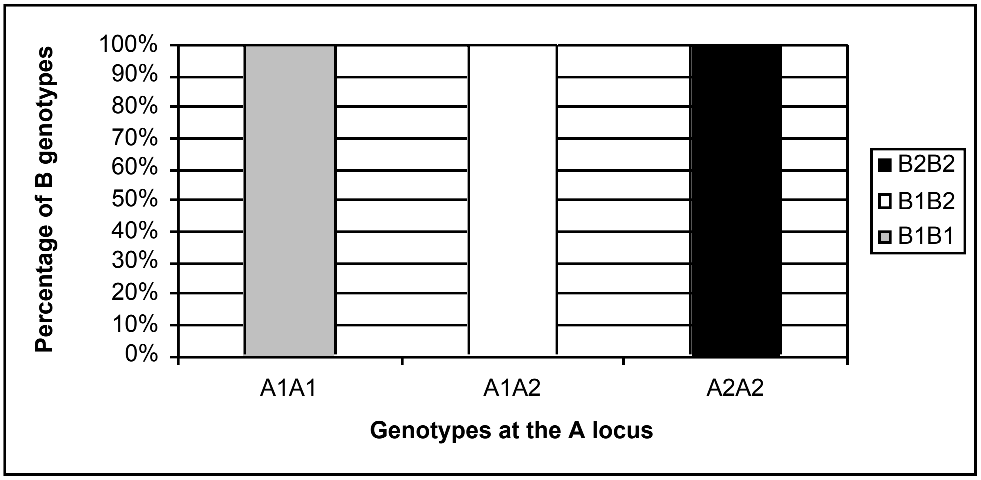


3. With $A_1A_1B_1B_1 = 0.5$ and $A_2A_2B_2B_2 = 0.5$, D should be nearly 0.25. Given that $A_1 = 0.5$, $A_2 = 0.5$, $B_1 = 0.5$, and $B_2 = 0.5$, roughly 25% of the offspring should have B_1B_1 genotypes, roughly 50% should have B_1B_2 genotypes, and roughly 25% should have B_2B_2 genotypes. This is appears to be true (graph below), indicating the population is in Hardy-Weinberg equilibrium.



However, inspection of the 100% column charts show the population is in linkage disequilibrium. All of the B_1B_1 genotypes are associated with the A_1A_1 genotype; all of the B_1B_2 genotypes are associated with the A_1A_2 genotype, and all of the B_1B_1

genotypes are associated with the A_2A_2 genotypes. In other words, the B alleles are not distributed independently among the A alleles.



4. You should see that, with random mating in the absence of natural selection, migration, mutation, or gene flow, that D decreases by one-half each generation. Although D changes over time, the frequencies of the A_1 and B_1 allele remain more or less constant, in Hardy-Weinberg equilibrium.