Testing for Understanding: Solving Hardy-Weinberg Problems

1. Galactosemia is inherited as a homozygous recessive trait (i.e., *gg*). You have sampled a population in which 36% of people have galactosemia.
   a. What is the frequency of the *g* allele?
   b. What is the frequency of the *G* allele?
   c. What is the frequency of the *GG* and *Gg* genotypes?

2. Suppose that in wasps, brown wings are dominant to white wings, and 40% of all wasps in a population you've sampled have white wings.
   a. What percentage of the wasps is heterozygous?
   b. What percentage of the wasps is homozygous dominant?

3. Suppose that you and 19 of your classmates (giving a final population of 10 males and 10 females) are on a cruise, and your ship sinks near a deserted island. You and all of your friends make it to shore and start a new population isolated from the rest of the world. Two of your friends carry the recessive allele (i.e., are heterozygous) for phenylketonuria. If the frequency of this allele does not change as the population on your island increases, what will be the incidence of phenylketonuria on your island?

4. Albinos produce very little of the pigment melanin in their skin and hair. Albinism is inherited as a homozygous recessive trait. In North America, about 1 in 20,000 people are albinos.
   a. What is the frequency of the dominant allele for albinism?
   b. What is the frequency of albinos?
   c. What is the frequency of heterozygotes?

5. People who are heterozygous recessive for the sickle-cell trait have some sickling of their blood cells, but not enough to cause death. Malarial parasites cannot infect these individuals' blood cells. People who are homozygous dominant for the sickle-cell trait have normal blood cells, but these cells are easily infected with malarial parasites. As result, many of these individuals are killed by sickle-cell anemia. People who are homozygous recessive for the sickle-cell trait resist infections by malarial parasites, but their sickled blood cells collapse when oxygen levels drop, thereby killing the individuals. As a result, homozygous individuals—be they homozygous dominant or homozygous recessive—are less likely to survive than are heterozygous individuals. Suppose that 9% of a population in Africa is homozygous recessive for sickle-cell anemia. What percentage of the population will be heterozygous (i.e., more resistant to the disease)?

6. What would be the frequency of the recessive allele in a population that produces twice as many homozygous recessive individuals than heterozygotes?

Answers to Hardy-Weinberg Problems

1*a*. 60%
1*b*. 40%
1*c*. *GG* = 16%; *Gg* = 48%
2*a*. 47%
2*b*. 14%
3. 0.25%
4*a*. 99.3%
4*b*. 0.005%
4*c*. 1.4%
5. 42%
6. $q = 0.8$

Questions for Further Thought and Study

1. How would selection against heterozygous individuals over many generations affect the frequencies of homozygous individuals? Would the results of such selection depend on the initial frequencies of p and q? Could you test this experimentally? How?

2. How are genetic characteristics associated with nonreproductive activities such as feeding affected by natural selection?

3. Although Charles Darwin wasn't the first person to suggest that populations evolve, he was the first to describe a credible mechanism for the process. That mechanism is natural selection. What is natural selection, and how can it drive evolution?

4. Does evolutionary change always leads to greater complexity? Why or why not?

5. Is natural selection the only means of evolution? Explain.

6. What change in a population would you expect to see if a selection pressure was against the trait of the dominant allele?

7. The application of evolution to understanding disease is widespread and productive. What is the benefit of applying Darwinian principles to medical practice?