The Hardy-Weinberg Equation

For each of the following problems in population genetics use the Hardy-Weinberg equation. Show all of your work and label each frequency, probability, and allele. ***Use a separate sheet of paper!***

1. A certain homozygous recessive genotype occurs in 4% of a population. What is the frequency of its two alleles, **T** and **t** ?

2. What percentage of the population is heterozygous **(Tt)** ?

3. If q = 0.3 and there are Hardy-Weinberg proportions, what is the most common genotype and what is its frequency? What is the least frequent genotype and its frequency?

4. Suppose that in a breeding experiment, 7,000 AA individuals and 3,000 aa individuals mate at random. In the first generation of offspring, what would be the frequencies of the three genotypes (AA, Aa, and aa)? What would be the frequencies of the two alleles? What would be the values in the second generation?

5. Among African-Americans, the frequency of sickle-cell anemia (which, as you will recall is a homozygous recessive condition) is about 0.0025. What is the frequency of heterozygotes? When on African-American marries another, what is the probability that both will be heterozygotes? If both are heterozygotes, what is the probability that their first child will have sickle-cell anemia?

6. In a large, randomly mating population with no forces acting to change gene frequencies, the frequency of homozygous recessive individuals for the character extra-long eyelashes is 90 per 1000, or 0.09. What percentage of the population carries this trait but displays the dominant phenotype, short eyelashes? Would the frequency of the extra-long-lash allele increase, decrease, or remain the same if long-lashed individuals preferentially mated with each other and no one else?

7. This is a classic data set on wing coloration in the scarlet tiger moth (***Panaxia dominula***). Coloration in this species had been previously shown to behave as a single-locus, two-allele system with incomplete dominance. Data for 1612 individuals are given below:

   White-spotted (AA) =1469— Intermediate (Aa) = 138 —Little spotting (aa) =5

   Calculate the following frequencies:
   A =
   a =
   AA =
   Aa =
   aa =

8. After graduation, you and 19 of your closest friends (lets say 10 males and 10 females) charter a plane to go on a round-the-world tour. Unfortunately, you all crash land (safely) on a deserted island. No one finds you and you start a new population totally isolated from the rest of the world (I hope you all liked each other). Two of your friends carry (i.e. are heterozygous for) the recessive cystic fibrosis allele (c). Assuming that the frequency of this allele does not change as the population grows, what will be the incidence of cystic fibrosis on your island?

9. In a population with two alleles for a particular locus, B and b, the allele frequency of B is 0.7. What would be the frequency of heterozygotes if the population were in Hardy-Weinberg equilibrium?

10. In the United States, 16% of the population is Rh-, due to a homozygous recessive pair of alleles. From this data, determine:

    a. the frequency of the recessive gene

    b. the frequency of the dominant gene

    c. the percentage of heterozygotes in the population

11. Tay-Sachs disease is caused by a recessive allele. The frequency of this allele is 0.1 in a population of 3,600 people. What is the frequency of the dominant allele, and how many of the 3,600 people will be heterozygous for the condition?

12. In a population of 2,000 earthworms, there is a condition governed by a recessive allele where the worms do not have any setae. Setae are tiny hair-like projections needed by the worm to move through the ground. 500 worms were found not having setae. What percent of the population were heterozygous for the setae? What was the actual number of earthworms containing setae?

13. In *Drosophilia*, the allele for normal length wings is dominant over the allele for vestigial wings. In a population of 1,000 individuals, 360 show the recessive phenotype. How many individuals would you expect to be homozygous dominant and heterozygous for this trait?

14. Cystic fibrosis is a recessive condition that affects about 1 in 2,500 babies in the Caucasian population of the United States. Please calculate the following.

    A.   The frequency of the recessive allele in the population.

    B.   The frequency of the dominant allele in the population.

    C.   The percentage of heterozygous individuals (carriers) in the population.

15. There were 130 students in AP Biology that took the AP exam last year. 125 did well in the course and passed the AP Exam, whereas five blew it totally and received a grade of 1.   (I know that this will not happen this year….right?).   In the highly unlikely event that these traits are genetic rather than environmental, if these traits involve dominant and recessive alleles, and if the five (5%) represent the frequency of the homozygous recessive condition, please calculate the following:
        a.   The frequency of the recessive allele.
        b.   The frequency of the dominant allele.
        c.   The frequency of heterozygous individuals.
        d.   Number of individuals that are heterozygous.