Hardy-Weinberg Mathematical Model

Description: The frequency of all the dominant R and recessive r alleles equals the total frequency and adds up to 1.0 or 100% of the alleles present. (In other words, remains constant)

The equation:

$$(p + q)^2 \qquad = \qquad p^2 + 2pq + q^2 \qquad = 1$$

Frequency of allele types
p = frequency of dominant allele A
frequency of recessive allele a

Frequency of allele combinations
p^2 = frequency of AA (homozygous dominant) q =
q^2 = frequency of aa (homozygous recessive)
2pq = frequency of Aa (heterozygous)

Helpful tips:
1. In most populations, the frequency of two alleles is calculated from the proportion of homozygous recessives (q2), since it is the only identifiable genotype directly from its phenotype. If only the dominant phenotype is known, q2 may be calculated (1-frequency of dominant phenotype) .

2. All calculations must be carried out using proportions, not percentages.

To solve Hardy Weinberg Problems follow these steps:
1. Examine the information to determine what piece of information you have been given about the population.
2. Find out the value of p or q. If this is achieved, then every other value in the equation can be determined by simple calculation.
3. Take the square root of q^2 to find q.
4. Determine p by subtracting q from 1 (i.e. p= 1-q).
5. Determine p^2 by multiplying p by itself (i.e. p^2 = p x p)
6. Determine 2 pq by multiplying p times q times 2.
7. Check that your calculations are correct by adding up the values for $p^2 + q^2 + 2pq = 1$.

Problem: In the American Caucasian population approximately 70% of people can taste the chemical phenylthiocarbamide (PTC) (the dominant phenotype), while 30% are non-tasters (the recessive phenotype). Determine the frequency of :
a. homozygous recessive phenotype (q^2) _____
b. The dominant allele (p) _____
c. Homozygous tasters (p^2) _____
d. Heterozygous tasters (2pq) _____

Population Genetics Worksheet   Name _____

1. In humans, attached ear lobes are caused by the inheritance of two recessive genes. Free ear lobes are the result of inheriting at least one dominant gene for free ear lobes. The frequency of the recessive gene is 70% (0.7). What would the frequencies of the following be?   RR _____   rr _____
Rr _____   R _____   r _____

2. From question 1, how many people in a population of 7000 would carry the allele for free ear lobes? _____.

3. Suppose the gene proportions for the autosomal gene for eye color in females were:
    B = 0.4   and   b = 0.6. What would be the gene proportions for:
    a. males   _____
    b. the total gene pool?   _____
    c. the genotypes of the population?   _____
    d. the phenotypes of the population?   _____

4. On an isolated Pacific Ocean Island, there exists a gene for psychic ability which enabled the lucky native to complete witch doctor school. This recessive allele was found in the population of 2000 natives at a frequency of 10%.
    a. How many witch doctors are there on the island? _____
    b. What proportion of the population would be hybrid? _____

5. If 18 out of 50 lizards sampled has the recessive trait for short tails,
   a. what would the proportion of t alleles in the lizard population be? _____
   b. what would be the proportion of dominant genes? _____
   b. what percent of the population would be heterozygous? _____

6. Assume that the gene for wool color is dominant for the allele for white. If 25% of the sheep in a large population have black wool, calculate:
   a. the gene frequencies of the two types of wool color? _____
   b. the percent of pure white sheep? _____
   c. the percent of hybrid sheep? _____
   d. the number of white sheep in a population of 750? _____