Genetic Equilibrium

I. Introduction

Sampling a large number of people for a genetic trait is often difficult and time consuming. A random list of numbers can be used instead of a human population. Using numbers, sampling for a trait is easier and faster. In this investigation, you are to use pages of a telephone directory as your population.

You are to represent random sampling of a genetic trait by using telephone numbers in which the last two numbers are 1 and 2. Possible genotypes are 11, 12 (or 21), and 22. Number 1 is dominant to number 2. The Hardy-Weinberg rule can be used to mathematically determine frequencies of each gene and genotype. The Hardy-Weinberg rule states that genes in a stable or unchanging population are in balance mathematically with one another. If the number of all phone numbers ending in 11, 12 (or 21), and 22 and the number of phone numbers ending in 22 are known, the frequencies of 11 and 12 or 21 can be determined.

II. Objective

(a) survey phone numbers for those ending in 11, 12, 21, and 22
(b) determine frequencies (occurrence) of the dominant and recessive genes, homozygous dominant genotype, homozygous recessive genotype, and heterozygous genotype
(c) change gene frequencies to actual numbers of phone numbers with these genotypes
(d) use the Hardy-Weingberg rule in a survey dealing with gene frequency and genotype frequencies for a human genetic trait.

III. Materials

1. telephone book
2. P.T.C. paper

IV. Procedure

1. Using the front and back sides of two telephone pages, count the number of people whose phone numbers end in 22 (homozygous recessive genotype). Record the total in Table 42-1.
2. Count and record the number of people whose phone numbers end in 22, 11, 12, and 21 (all genotypes).
3. Record class totals for the same information. (Sample data has been included in the table as an example.)
4. Determine and record the frequency of the homozygous recessive genotype (22) in your class totals. Divide the class total of homozygous recessive genotypes by the class total of all genotypes counted. For examp le, 217/1143 = 0.19. Carry your division to two decimal places.
5. Determine and record the frequency of the recessive gene (2) by calculating the square root of the recessive genotype frequency. For example, the square root of 0.19 is 0.44. (To determine square root, determine what two identical numbers when multiplied together give the recessive genotype frequency, 0.44 x 0.44 = 0.19.) Carry your answer to two decimal places.
   The Hardy-Weinberg rule indicates that the frequency of the recessive gene plus the frequency of the dominant gene equals 1. For example, if the frequency of the recessive gene is 0.44, the frequency of the dominant gene is 1-0.44 = 0.56.
6. Calculate the frequency of your dominant gene (1). Record the frequency in the proper row of Table 42-1.
   From the frequency of the dominant gene, you can determine the frequency of the homozygous dominant genotype. This is done by multiplying the frequency of the dominant gene by itself. For example, 0.56 x 0.56 = 0.31.
7. Calculate and record in Table 42-1 the frequency of the homozygous dominant genotype to two decimal places.
   In a real population, you would not be able to distinguish the 11 genotype from the 12 or 21 genotype because 1 is dominant over 2. However, the numbers of homozygous dominant and heterozygous genotypes can be calculated.
8. Calculate the number of homozygous dominant genotypes by multiplying the class total of people counted by the frequency of the homzygous dominant genotype. Record this figure in Table 42-1. For example, 1143 x 0.31 = 354.
   The frequency of the heterozygous genotype (phone number ending in 12 or 21) can be calculated by multiplying the recessive gene frequency by the dominant gene frequency. Then multiply by 2. For example, 0.44 x 0.56 = 0.25; 0.25 x 2 = 0.5.
9. Record the frequency of the heterozygous genotypes in Table 42.1
10. Calculate and record the number of heterozygous individuals in the class total. Multiply the class total by the frequency of the heterozygous genotype. For example, 1143 x 0.5 = 572.

V. Analysis

1. Conduct a classroom survey for the ability to taste P.T.C. (phenylthiocarbamide). Ability to taste P.T.C. is a dominant genetic trait.

2. Compute and list the following values for your class:

   (a) number of students participating in the survey _____

   (b) number of students who are nontasters _____

   (c) frequency of homozygous recessive genotype _____

   (d) frequency of recessive gene _____

   (e) frequency of dominant gene _____

   (f) frequency of homozygous dominant genotype _____

   (g) frequency of heterozygous genotype _____

   (h) number of students in class who are homozygous dominant _____

   (i) number of students in class who are heterozygous _____

Table 42-1. Survey Data and Calculations

	Sample data	Your data
Your number of 22 endings	**6**	
Your number of 22, 11, 21, and 12 endings	**26**	
Class total of 22 endings	**217**	
Class total of 22, 11, 21, and 12 endings	**1143**	
Frequency of homozygous recessive genotype	**0.19**	
Frequency of recessive gene (2)	**0.44**	
Frequency of dominant gene(1)	**0.56**	
Frequency of homozygous dominant genotype	**0.31**	
Number of people with homozygous dominant genotype	**354**	
Frequency of heterozygous genotype	**0.50**	
Number of people with heterozygous genotype	**572**	

Calculations: