Penguin Prof Helpful Hints: Solving Hardy-Weinberg Problems

Introduction

Hardy, Weinberg and Castle determined that the frequencies of alleles and genotypes in a population remain the same over time, given that certain assumptions are met:

- Organisms are diploid
- Generations are non-overlapping
- Population must be large
- No immigration or emigration
- No mutation in the gene of interest
- No natural selection occurs (individuals reproduce at equal rates)
- Mating is random

Overview

How to solve Hardy-Weinberg Problems:

1. Determine the alleles.
   1. Frequency of the dominant allele is designated as '**p**'
   2. Frequency of the recessive allele is designated as '**q**'

2. Allelic Frequency Rule (Frequency of a SINGLE ALLELE in the population):
   $p + q = 1$

3. Genotype Frequency Rule (Frequency of a GENOTYPE in the population):
   $(p+q)\ (p+q) = 1$

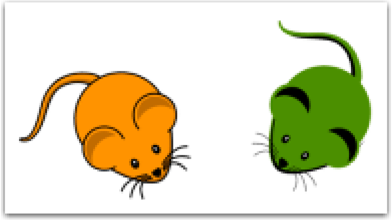
   Simplify this statement using the FOIL rule: $p^2 + pq + pq + q^2 = 1$
   $p^2 + 2pq + q^2 = 1$

   p^2 = frequency of homozygous dominant genotype
   $2pq$ = frequency of heterozygous genotype
   q^2 = frequency of homozygous recessive genotype

Sample Problem

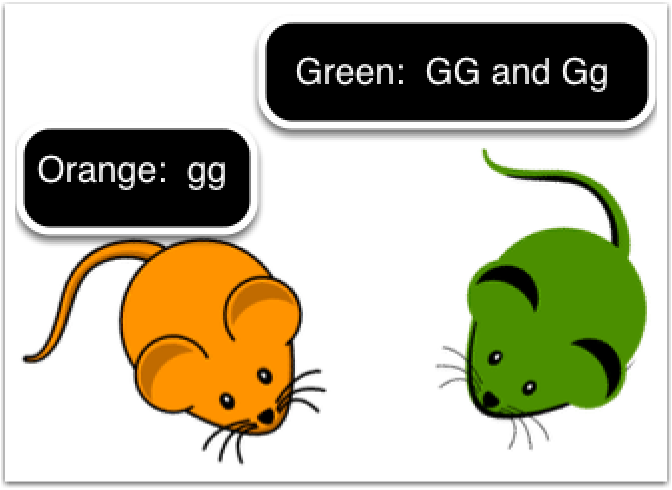
In a population of 130,000 magical mice, green fur is dominant over orange. If there are 300 orange mice in a population of 130,000, find the following (assume population is in Hardy-Weinberg equilibrium):

1. Frequency of dominant (green) allele
2. Frequency of recessive (orange) allele
3. Frequency of homozygous dominant, heterozygous and homozygous recessive genotypes



Step 1: Assign the Alleles

- By convention, we use the dominant phenotype to name the alleles. In this case, green is dominant over orange, so we'll use 'G' for green fur and 'g' for orange fur.
- Assign 'p' to be the frequency of G, the green fur allele
- Assign 'q' to be the frequency of g, the orange fur allele



Step 2: Calculate q

The number of homozygous recessive individuals is q^2, NOT q. To find q, take the square root of q^2.

$$q^2 = \frac{320}{130{,}000} = 0.002$$

$$q = \sqrt{q^2} = \sqrt{0.002}$$

$$q = 0.04$$

Step 3: Calculate p

Once you have **q,** finding **p** is easy! The sum of the frequencies of both alleles must equal 1.

$$p + q = 1$$

$$p = 1 - q$$

$$p = 1 - 0.04$$

$$p = 0.96$$

Step 4: Use p and q to calculate the remaining genotypes

I always suggest that you calculate q^2 even though that's what you started with. Realize that rounding will give you slightly different values and all 3 genotype frequencies may not EXACTLY equal 1 because of this. It's fine.

$$p^2 = 0.96^2 = 0.92$$

$$2pq = 2(0.96)(0.04) = 0.08$$

$$q^2 = 0.04^2 = 0.0016$$

$$(\approx 0.002)$$

That's it! Answer the questions:

1. Frequency of dominant (green) allele = 0.96
2. Frequency of recessive (orange) allele = 0.04
3. Frequency of each genotype:

- homozygous dominant = 0.92
- heterozygous = 0.08
- homozygous recessive = 0.002

Need More Help?

Check out my video "The Hardy-Weinberg Principle" on the Penguin Prof YouTube channel. Good luck!