

Hardy-Weinberg Problem Set: **KEY**

AP Biology

Biology 115 at Austin College, Sherman Texas

1. The ability to roll the tongue is controlled by a single gene with two alleles. The allele for being able to roll is dominant over the allele for not being able to roll. In a given population of 10,000 individuals there are 7399 tongue rollers and 2601 non-rollers. Assuming the population is at Hardy-Weinberg equilibrium, how many heterozygous tongue rollers are there in the population?

*Roll = $p^2 + 2pq$ (not helpful) Non-roll = $q^2 = 2601/10\,000 \rightarrow q=0.51 \therefore p=0.49$
 $2pq = .4998$, so 4 998 people are non-rollers.*

2. In a population of 100,000 human babies in a given locality: 20,460 babies were born with totally sickled red blood cells; 59,290 babies were born with partially sickled red blood cells; 20,250 babies were born with normal red blood cells. Is the baby population at Hardy-Weinberg equilibrium? Support your answer.

*$p^2 = 20\,460/100\,000 \rightarrow p=0.4523$ $q^2 = 20\,250/100\,000 \rightarrow q=0.4500$
 $p+q \neq 1$, so not at H-W equilibrium*

Evolution 111 at Indiana University, Bloomington, Indiana

3. If 98 out of 200 individuals in a population express the recessive phenotype, what percent of the population would you predict would be heterozygotes?

$q^2 = 98/200 = 0.49 \rightarrow q = 0.7 \therefore p = 0.3$ $2pq = 0.42$, so 42%

4. Your original population of 200 (from question 3 above) was hit by a tidal wave and 100 organisms were wiped out, leaving 36 homozygous recessive out of the 100 survivors. If we assume that all individuals were equally likely to be wiped out, how did the tidal wave affect the predicted frequencies of the alleles in the population? NOTE: assume the new population is at equilibrium—after the event—so you are comparing two populations that are at equilibrium to look for changes in allele frequencies.

$q^2 = 0.36 \rightarrow q = 0.6 \therefore p = 0.4$, change in allele frequency with q decreasing and p increasing

5. If 51% of the population carries at least one copy of the recessive allele what is the predicted frequency of individuals in the population that express the recessive phenotype?

*51% have at least one recessive (so are heterozygous or homozygous recessive, $2pq + q^2$) \therefore 49% are homozygous dominant (p^2)
 $p^2 = 0.49 \rightarrow p = 0.7 \therefore q = 0.3$, so $q^2 = 0.09$ or 9% of the population*

BS 110 at Michigan State University, East Lansing Michigan

6. Cystic fibrosis is a genetic disorder in homozygous recessives that causes death during the teenage years. If 4 in 10,000 newborn babies have the disease, what are the expected frequencies of the three genotypes in newborns, assuming the population is at Hardy-Weinberg equilibrium? Why is this assumption not strictly correct?

$$q^2=4/10\,000 \rightarrow q=0.02 \therefore p=0.98 \qquad p^2=.9604, 2pq=0.0392, q^2=0.0004$$

Bio 12 at Penn State University, University Park, Pennsylvania

7. After graduation, you and 19 friends build a raft, sail to a deserted island, and start a new population, totally isolated from the world. Two of your friends carry (that is, are heterozygous for) the recessive *cf* allele, which in homozygotes causes cystic fibrosis.

- A. Assuming that the frequency of this allele does not change as the population grows, what will be the instance of cystic fibrosis on your island?

Easiest way is to count alleles. There are 40 alleles (20 diploid people), 2 of which are cf, so $q=2/40=0.05$ ($\therefore p=0.95$) so $q^2=0.0025$ (0.25%)

- B. Calculate how many times greater cystic fibrous births on the island are versus the original mainland. The frequency of births on the mainland is .059%.

About 4.3 times higher on your island.

Biology 108 at Kansas State University, Manhattan, Kansas

8. Among a group of 730 Australian aborigines, the following blood types were determined for the M-N blood group:

M	22	MN	216	N	492
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This group has three blood types (phenotypes), M, N and MN, which are caused by a single locus with two codominant alleles, L^M and L^N . Individuals homozygous for L^M are blood type M; homozygotes for L^N are blood type N; heterozygotes express both alleles and are blood type MN. Using these data, calculate the frequency of the L^M and L^N alleles in this population.

Again, easiest to count alleles:

22 Type M ($L^M L^M$)=	44 M alleles
216 Type MN ($L^M L^N$)=	216 M alleles, 216 N alleles
492 Type N ($L^N L^N$)=	984 N alleles

$$\text{Frequency } L^M = 260/1460 = 0.1781$$

$$\text{Frequency } L^N = 1200/1460 = 0.8219$$