P8149 — Human Population Genetics: Homework 1

Yongyan Liu (yl6107)

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Question 1

Three allelic variants A, B, and C of the red cell acid phosphatase enzyme were found in a sample of 178 people. All genotypes were distinguishable by electrophoresis, and the frequencies in the sample were:

Genotype	AA	AB	BB	AC	BC	CC
Frequency (%)	9.6	48.3	34.3	2.8	5.0	0.0

What are the *gene (allele)* frequencies in the sample?

- P(A) = P(AA) + P(AB) / 2 + P(AC) / 2 = 35.15%
- P(B) = P(BB) + P(AB) / 2 + P(BC) / 2 = 60.95%
- P(C) = P(CC) + P(AC) / 2 + P(BC) / 2 = 3.9%

Question 2

What will be the genotypic composition of the next generation under random mating if the initial genotypic composition is $P_{11} = 0.2,\ P_{12} = 0.4,\ P_{22} = 0.4$?

From the genotype frequency, we can calculate the allele frequency:

- $P(1) = P_{11} + \frac{1}{2}P_{12} = 0.4$
- $P(2) = P_{22} + \frac{1}{2}P_{12} = 0.6$

Since it's random mating, the genotype frequency of the next generation P' is only decided by allele frequency:

- $P'_{11} = P(1)^2 = 0.16$
- $P'_{22} = P(2)^2 = 0.36$
- $P'_{12} = 2 * P(1) * P(2) = 0.48$

Question 3

About 30% of people do not recognize the bitter taste of phenyl-thiocarbamate (PTC). Inability to taste is due to a single autosomal recessive gene. Assuming HWE, what is the frequency of the non-tasting gene?

Let A/a be the tasting/non-tasting gene. From the question, we know $P(aa) = 30\%$.

Assuming HWE, $P(a) = \sqrt{30\%} = 54.8\%$ and $P(A) = 1 - P(a) = 45.2\%$.

Question 4

Albinism occurs with a frequency of about 1 in 20,000 in European populations. Assuming it is due to a single autosomal recessive gene and HWE, what is the approximate proportion of carriers?

Let A/a be the corresponding dominant/recessive gene.

From the question, we know the genotype frequency $P(aa) = \frac{1}{20000}$. So the allele frequency $P(a) = \sqrt{P(aa)} = 0.7\%$.

Since $P(a)$ is very small, the approximate proportion of carriers is $2P(a) = 1.4$.

Question 5

Observed counts:

Genotype	M	MN	N
Count	1787	3039	1303

(a) What genotype frequencies are observed?

The total observed count is 6129.

- $P(MM) = 1787/6129 = 29.16\%$
- $P(MN) = 3039/6129 = 49.58\%$
- $P(NN) = 1303/6129 = 21.26\%$

(b) What are the gene (allele) frequencies (M and N)?

- $P(M) = P(MM) + P(MN)/2 = 53.9\%$
- $P(N) = P(NN) + P(MN)/2 = 46.0\%$

(c) Test whether the genotypes are in HWE.

From the calculation above, we can see that

- $P(N) + P(M) \approx 1$
- $2 * P(N) * P(M) = 2 * 53.9\% * 46.0\% = 59.59\% \approx P(MN)$

So the genotypes are in HWE.

Question 6

A certain population is *triploid*. A locus has two alleles A_1 and A_2 with frequencies p and $q = 1 - p$. Calculate the genotypic composition after one generation of random mating (assume HWE conditions).

From the binomial expansion $(pA_1 + qA_2)^3 = p^3A_1^3 + 3pq^2A_1A_2^2 + 3p^2qA_1^2A_2 + q^3A_2^3$, we have:

- $P(A_1A_1A_1) = p^3$
- $P(A_1A_1A_2) = 3p^2q$
- $P(A_1A_2A_2) = 3pq^2$
- $P(A_2A_2A_2) = q^3$