Answers Assignment 1, BIOL 434

1. In we class we saw that the genotype frequencies expected after one generation of random mating should be

AA: $P_{AA}^{\ 2}(1) + 2P_{AA}P_{Aa}(1/2) + P_{Aa}^{\ 2}(1/4)$

Aa: $2P_{AA}P_{Aa}(1/2) + 2P_{AA}P_{aa}(1) + P_{Aa}^{\ 2}(1/2) + 2P_{Aa}P_{aa}(1/2)$

aa: $P_{aa}^{\ 2}(1) + 2P_{aa}P_{Aa}(1/2) + P_{Aa}^{\ 2}(1/4)$

and we asserted that these three equaled $p_A^2, 2p_Ap_a$ and p_a^2, respectively. To show that theses are correct, let us remember that

$$p_A = P_{AA} + P_{Aa}/2.$$

Squaring both sides, we see that

$$p_A^2 = \left(P_{AA} + \frac{P_{Aa}}{2}\right)^2 = P_{AA}^{\ 2} + 2P_{AA}\frac{P_{Aa}}{2} + \frac{P_{Aa}^{\ 2}}{4},$$

so the equation for AA is true. (The equation for aa is basically the same thing but with different subscripts, so you can see that it must be true as well by this.)

By the same logic, if $p_A = P_{AA} + P_{Aa}/2$ and $p_a = P_{aa} + P_{Aa}/2$, then

$$\begin{aligned} 2p_Ap_a &= 2\left(P_{AA} + \frac{P_{Aa}}{2}\right)\left(P_{aa} + \frac{P_{Aa}}{2}\right) \\ &= 2P_{AA}P_{aa} + P_{Aa}P_{aa} + P_{AA}P_{Aa} + P_{Aa}^{\ 2}/2 \end{aligned}$$

which is equal to the formula above after rearrangement.

2. a. The frequency of PGI-2a = $\frac{19 + 2(35)}{2(57)} = 0.781$. The frequency of the A alleles is 1-0.781 - 0.219.

b. We expect 57 x $(0.781)^2$ = 34.74 aa homozygotes, 2.74 aa homozygotes, and 19.52 heterozygotes.

3. 1 in 10,000 (q^2= 0.0001) are affected, and only recessive homozygotes are affected. Therefore the allele frequency is the $\sqrt{0.0001} = 0.01$. Therefore we expect the frequency of carriers to be 2 p q = 2 (0.99)(0.01) = 0.0198.

4.

Genotype	Expected frequency
A1 A1	0.01
A2 A2	0.04
A3 A3	0.09
A4 A4	0.16
A1 A2	0.04
A1 A3	0.06
A1 A4	0.08
A2 A3	0.12
A2 A4	0.16
A3 A4	0.24

5. Without linkage, the recombinant and nonrecombinant offspring should be produced in equal frequencies (50:50) rather than 60:40. (If you tested this with a binomial test, the *P*-value would be 0.028, so significantly different from. equality expected from no linkage.)

6. The expected frequency of A1 A1 genotypes is $0.3^2 = 0.09$, and the expected frequency of B1 B3 genotype is 2 (0.2) (0.5) = 0.2. So the expected frequency of A1 A1 B1 B3 at equilibrium is (0.09)(0.2) = 0.018.