COLUMBIA UNIVERSITY

DEPARTMENT OF BIOSTATISTICS

P 8149 - HUMAN POPULATION GENETICS

exercise sheet 2 (covers chapter 3 and 4)

Date due: Saturday OCT 18, 2025 (*SUBMIT ONLINE ON CANVAS*)

Question 1 (3 marks)

If one gene has alleles A_1, A_2 with frequencies $p_1, q_1,$ and another gene has alleles B_1, B_2 , B_3 with frequencies $p_2, q_2, r_2,$ what are the frequencies of gametes with linkage equilibrium, assuming that $p_1 = .3, p_2 = .2$ and $q_2 = .3$?

Question 2 (3 marks)

Consider a locus L_1 with two alleles *A* and *a* having frequencies p_A and $p_a,$ and a second locus L_2 with two alleles *B* and *b* having frequencies p_B and p_b. Show that

$$p_A p_B + p_A p_b + p_a p_B + p_a p_b = 1.$$

Question 3 (4 marks)

If it is known that two loci (L_1 and L_2) have two alleles each (A, a and B, b)and that the alleles occur at equal frequencies in a certain population (i.e. $p_A = p_a = 1/2$ and $p_B = p_b = 1/2$). Assume that $g_{AB} = 1/3.$

(a) Determine the frequency of the remaining three gamete types in the population.
(b) If mating is at random and the two loci are on different chromosomes, what would be the gametic frequencies in the next generation?
(c) If mating is at random but the loci are linked with 30% recombination, what would be the gametic frequencies in the next generation?
(d) What will be the limiting gametic frequencies, allowing random mating for a long period of time.

Question 4 (4 marks)

The body weight of mice is affected by the pygmy (pg) gene; the following shows mean weights of mice with three possile genotypes (A_1 is the wild type and A_2 is the pg allele)

genotype	mean weight (g)
A_1A_1	14
A_1A_2	12
A_2A_2	6

(a) Find the effect of allele A_1 and of allele A_2 when (i) q = freq(A_2) = .1, (ii) q = .4

(b) Find the breeding values when (i) $q = .1$, (ii) $q = .1$

(c) Find the dominance deviations when (i) $q = .1$, (ii) $q = .4$

Question 5 (6 marks)

Let X_P and Y_P be values of some quantitative trait on two first-cousins. A regression of Y_P on X_P gives a slope *b*. Show that the heritability of the quantitative trait can be estimated by

$$h^2 = 8b.$$

ANSWERS

Q1 freq(A_1B_1) = .06, freq(A_1B_2) = .09, freq(A_1B_3) = .15, freq(A_2B_1)=.14,freq(A_2B_2) = .21, freq(A_2B_3)=.35, Q3: (b) g_{AB}=7/24 , (c) g_{AB} =37/120, (d) g_{AB}=1/4; Q4 (a) For $q = .1$, average effect of A_1 = .24, average effect of A2 = -2.16; for $q = .4$, average effect of A_1 = 1.44, average effect of A_2 = -2.16 (b) For $q = .1$, breeding values are A_1A_1 =.48, A_1A_2 = -1.92, A_2A_2 = -4.32; for $q = .4$, breeding values are A_1A_1 = 2.88, A_1A_2 = -.72, A_2A_2= -4.32; (c) For $q = .1$, dominance deviations are A_1A_1 = -.04, A_1A_2= .36, A_2A_2= -3.24; for $q = .4$, dominance deviations are A_1A_1 = -.64, A_1A_2 = .96, A_2A_2 = -1.44