Genetics 320, Problem Set 9 (10 points)

Due Wes. 23 Nov 2005 at 11 am

1 (2 points): Consider a cross between an M_2M_3 father and a M_2M_4 mother. In the offspring, the marker genotype is scored, along with nose length and the following data are observed.

Genotype	Mean nose lenght
M_2M_2	100
M_2M_3	100
M_2M_4	300
M_3M_4	300

(a) Is there evidence that the marker is linked to a segregating QTL for nose length in the father?

$M_2 - M_3 = (100 + 300)/2 - (100 + 300)/2 = 0$. *No evidence*

(b) Is there evidence that the marker is linked to a segregating QTL for nose length in the mother?

$M_2 - M_4 = (100+100)/2 - (300+300)/2 = -200$. *Evidence that the mother is heterozygous for a QTL linked to the marker. Given this result, father is homozygous at this QTL.*

2 (2 points): Consider a locus with four alleles (A_1 to A_4) at the following frequencies: $p_1 = 0.1$, $p_2 = 0.2$, $p_3 = 0.3$, $p_4 = 0.4$. Assume random mating and all other Hardy-Weinberg conditions. What is the frequency of

(a) A_2A_3? $2\,p_2\,p_3 = 0.12$

(b) A_4A_4? $p_4^2 = 0.16$

(c) All heterozygotes involving allele A_2? $2\,p_2\,(1 - p_2) = 0.32$

(d) All heteroyzgotes? $1 - (p_1^2 + p_2^2 + p_3^2 + p_4^2) = 0.70$

(e) Of a mating between A_1A_2 and A_3A_3 parents.

Prob(A_1A_2) =$2\,p_1\,p_2 = 0.04$, *Prob(A_3A_3)* $= p_3^2 = 0.09$, *Hence, Prob($A_1A_2 \times A_3A_3$ mating) = Prob(father = A_1A_2, mother = A_3A_3) + Prob(father = A_3A_3, mother = A_1A_2)* $= 2\,(0.04 \cdot 0.09) = 0.0072$.

3 (2 points): This problem examines what happens when there are different allele frequencies in the two sexes (as would occur if one mates males from one population with females from a second). Assume an autosomal locus, where the frequency of allele A in the male and female founding populations is p and r, respectively. Assuming all other Hardy-Weinberg conditions hold,

(a) What is the frequency of AA homozygotes in their offspring? $p \cdot r$

(b) What is the frequency of $A-$ heterozygotes? $p \cdot (1 - r) + (1 - p) \cdot r$

(c) What is the frequency of allele A in their male offspring? In their female offspring?

The frequency of A in the next generation is freq(AA) + (1/2)freq($A-$). Since we are dealing with an autosomal locus, these frequencies are the same in both sexes. Hence, freq(A in males) = freq(A in females) = $p \cdot r + (1/2)[p \cdot (1 - r) + (1 - p) \cdot r] = p \cdot r + (p + r)/2 - p \cdot r = (p + r)/2$.

(d) What happens to the allele and genotype frequencies in subsequent generations?

In the next generation, both sexes have the same allele frequencies, so the genotypes follow Hardy-Weinberg frequencies with freq(A) = $(p+r)/2$.

4 (2 points): Consider alleles A and B at linked loci (with $c = 0.2$). Suppose $D_{AB} = 0.1$, freq(A) = 0.4, freq(B) = 0.5.

(a) What is freq(AB)?

*freq(AB) = freq(A) * freq(B) + D_{AB}* = $0.4 \cdot 0.5 + 0.1 = 0.3$

(b) After ten generations of recombination, what is freq(AB)?

$D_{AB}(10) = (1-c)^{10} D_{AB}(0) = 0.8^{10} \cdot 0.1 = 0.0107$

*freq(AB)(10) = freq(A) * freq(B) + $D_{AB}(10)$* = $0.4 \cdot 0.5 + 0.01071 = 0.2107$

5 (2 points): Consider the $M/N, S/s$ blood group data from the Ugandan population in the Table in lecture 48. Suppose the recombination frequency between these two loci is $c = 0.05$.

(a) If these gametes combine at random, what is the frequency of MM individuals? Of Ss individuals? Of $MMSs$ individuals?

freq(M) = freq(MS) + freq(Ms) = 0.134 + 0.357 = 0.491, freq(N) = 1-freq(M) = 0.509

freq(S) = freq(MS) + freq(NS) = 0.134 + 0.071 = 0.205, freq(s) = 1-freq(S) = 0.795

freq(MM) = freq(M)$\cdot$ freq(M) = $0.491^2 = 0.241$

freq(Ss) = 2 freq(S)$\cdot$ freq(s) = $2 \cdot 0.205 \cdot 0.795 = 0.326$

freq($MMSs$) = freq(MS from father) $\cdot$ freq(Ms from mother) + freq(Ms from father)$\cdot$ freq(MS from mother) $= 2 \cdot 0.134 \cdot 0.357 = 0.097$

(b) For these gamete frequencies, what is the disequilibrium (if any) for MS gametes? For Ms gametes?

$D_{MS} =$ *freq(MS) - freq(M)$\cdot$ freq(S)* = $0.134 - 0.491 \cdot 0.205 = 0.033$

$D_{Ms} =$ *freq(Ms) - freq(M)$\cdot$ freq(s)* = $0.357 - 0.491 \cdot 0.795 = -0.033$

(c) After ten generations of random mating, what is the expected disequilibrium for MS gametes? For Ms gametes?

$D_{MS}(10) = (1-c)^{10} D_{MS}(0) = 0.95^{10} \cdot 0.033 = 0.0198$

$D_{Ms}(10) = (1-c)^{10} D_{Ms}(0) = 0.95^{10} \cdot (-0.033) = -0.0198$

(d) After ten generations of random mating, what is the expected frequency of $MMSs$ individuals?

freq(MS gamete in gen 10) = freq(M) $\cdot$ freq(S) + $D_{MS}(10)$ $= 0.491 \cdot 0.205 + 0.0198 = 0.1205$

freq(Ms gamete in gen 10) = freq(M) $\cdot$ freq(s) + $D_{Ms}(10)$ $= 0.491 \cdot 0.795 + (-0.0198) = 0.3705$

freq($MMSs$) = 2$\cdot$ freq(MS) $\cdot$ freq(Ms) = $2 \cdot 0.1205 \cdot 0.3705 = 0.0893$