ANSC 446 / IB 416
Population Genetics
Exam 3, November 20, 2009

Name _____

(5 pages) Please underline or indicate your answer. If rounding, use 3 significant digits. Show your work or describe your logic to earn partial credit for incomplete answers.

(9) 1. The ostrich farm on Route 57, owned by Mr. Jones, still only has single combed birds. Single comb is recessive to double comb. However, the Jones farm has now decided to double their flock size, by adding individuals from the ostrich farm on Route 47, owned by the Patels. Mrs. Patel has estimated the allele frequency of single comb in their flock as 0.4

(3) a. Estimate the allele frequency of single comb in the new Jones flock.

(3) b. What would be the migration rate for the first generation?

(3) c. Would this represent an example of the continent-island model of migration, or of the general model of migration. Why?

(3) 2. What is the approximate probability of loss of a new neutral mutation in the first generation if the number of offspring per family follows a Poisson distribution and averages 2 offspring per family.

(4) 3. What is the difference between orthologous and paralogous genes?

(15) 4. Only 40 Javan rhinoceros survive in the island of Java.
Assume that this population size is constant across generations.

(3) a. For a population of this size, how much of the current generation's heterozygosity will be lost in the next generation due to drift?

(3) b. If drift is the only force operating to alter genotypic frequencies, how many generations will it take for a reduction in heterozygosity to approximately 50% of the initial value in populations of size 40?

(3) c. If drift is the only force operating to alter allele frequencies, how many generations will it take to reach fixation for an allele with an initial frequency of .5 when the population size is 40?

(3) d. Assuming that the effective population size equals the census size of 40, and assuming no selection or migration. How long is it expected to take on average for a new neutral mutant allele to become fixed in this population?

(3) e. For a new neutral mutation in this population, what is the probability that it will become fixed in the population?

(4) 5. Name a type of transposable element present in the human genome

(10) 6. Give the best definition for the following terms:

(2) a. Frameshift mutant:

(2) b. Metapopulation:

(2) c. Cline:

(2) d. Mutation load:

(2) e. Admixture:

(12) 7. The Seeing Eye maintains a kennel of approximately 20 female German Shepherds and 20 male German Shepherds in their breeding population.

(3) a. What is the effective population size for an autosomal gene?

(3) b. What is the effective population size for an mtDNA gene?

(3) c. What is the effective population size for a Y-chromosome gene?

(3) d. What is the effective population size for an X-chromosome gene?

(4) 8. Why is the hypothetical fitness curve of mutations said to be bimodal?

(4) 9. According to Dr.Stanley Ambrose, what event occurring 70,000 years ago may have shaped human evolution through bottlenecks or founder effects?

(4) 10. What are the similarities and differences between the stepping-stone model of gene flow, and isolation by distance?

(6) 11. Describe 3 tests of selection (or neutrality)

(5) 12. Two populations are similar except in terms of inbreeding coefficient. The first population has no inbreeding, while the second population has an inbreeding coefficient of $f = 0.2$. The first population has an effective population size of 100. What is the effective population size of the second population?

(20) 13. Assume that for two isolated subpopulations of the same size, frequencies of alleles A_1 and A_2 are 0.4 and 0.6, respectively, in the first subpopulation; and frequencies of alleles A_1 and A_2 are 0.6 and 0.4, respectively, in the second subpopulation.

(4) a. Assuming Hardy-Weinberg proportions, what is the frequency of heterozygotes in the first subpopulation?

(4) b. Assuming Hardy-Weinberg proportions, what is the frequency of heterozygotes in the second subpopulation?

(4) c. If the two subpopulations were merged into a single panmictic (freely interbreeding) population, what would be the frequency of heterozygotes after Hardy Weinberg equilibrium was reached in the combined population?

(4) d. What is the term used in cases where subpopulation structure results in a reduction in overall heterozygosity, even though the subpopulations themselves are in Hardy-Weinberg equilibrium?

(4) e. Calculate G_{ST} between the two subpopulations (before they were merged)