Genetics (BIL-250)
Problem Set #3

(14-1) Explain the basis of quantitative traits and how they differ from discrete traits?

(15-1) Explain how Harriet Creighton's and Barbara McClintock's studies of corn in 1931 provided the first convincing experimental evidence for Morgan's hypothesis of recombination and chromosomal exchange?

(15-2) Describe the formation of the Holliday intermediate and explain how cleavage of this molecular structure can result in parental and recombinant allele combinations.

(15-3) Use the two-point recombination frequency data from question 15.6 at the back of your book to map the genes a, b, c, d, and e.

(16-1) Order tetrad experiments indicate that crossing over occurs at the 4-chromatid stage, prophase I of meiosis. What is the alternative? What features of the ordered tetrad experiments make them ideally informative in this respect?

(16-2) What is the process of gene conversion?

(17-1) What is a polytene chromosome, where do they occur, and why are they important for study of chromosome mutations?

(17-2) Distinguish between chromosome deletion, duplication, inversion (including paracentric and pericentric), and translocation?

(17-3) How can unequal crossing-over result in chromosome duplication?

(17-4) How might presence/absence of chromosome inversions influence speciation?

(17-5) Explain how non-disjunction might lead to alternate forms of aneuploidy such as XO, XXX, XXY, XXXY, XXYY, and XYY?

(17-6) If a trisomy-21 carrier and normal parent mate and produce offspring, what percent of the zygotes are expected to be inviable? What percent of viable offspring have trisomy-21? What fraction are carriers for trisomy-21? What fraction are normal?

(17-7) What is the difference between aneuploidy and monoploidy? Distinguish between haploid, diploid, monoploid, and triploid?

(18-1) Compare and contrast three different methods used for mapping genes in bacteria. How do the types of data that result from these methods differ?

(19-1) Describe the organization and control of the lac operon of *E. coli.*

(19-2) Describe the organization and control of the Trp operon of *E. coli.*

(20-1) Eukaryotic gene expression is regulated at six levels. What are these levels, and how do they operate? Give some examples to illustrate your answers.

(21-1) How do maternal effect genes, segmentation genes, and homeotic genes regulate development and differentiation of *Drosophila*? How do mutations in segmentation and homeotic genes affect the phenotype of *Drosophila*?

(22-1) Contrast sporadic and hereditary retinoblastoma? How does the existence of these two forms of cancer support Alfred Knudson's (1971) "two-hit mutation model"?

(22-2) Describe the steps in the life cycle of a transducing retrovirus and explain how a retrovirus acquires an oncogene? Proto-oncogenes are highly conserved among animal species. What generalization can you make about the function of proto-oncogenes?

(23-1) Compare <u>vertebrate mtDNA</u>, <u>plant mtDNA</u>, and <u>plant cpDNA</u> in terms of inheritance (typical and exceptional), genome size, the types of genes they contain, and structural elements such as position of tRNAs, coding/non-coding regions, presence or absence of introns, types of genetic codes, and transcriptional/translational control.

(23-2) What is the difference between maternal inheritance and maternal effect?

(24-1) How do mutation, selection, genetic drift, migration, and non-random mating generally influence genetic diversity?

(24-2) What is the equation for Hardy-Weinberg equilibrium? What does it predict?

(24-3) What assumptions are made for Hardy-Weinberg equilibrium? Are these assumptions realistic? If not, what is the consequence for fit to H-W proportions?

(24-4) How might assortative mating, sex ratio, inbreeding, variable fecundity, and age structure influence the effects of genetic drift? Why are these factors important for maintenance of genetic variation?

(24-5) What is Wright's Fst? How is it useful?

(24-6) How do genetic drift and mutation balance? What is the expected relationship between effective population size and heterozygosity of mutation is constant?

(24-7) How are fitness (W) and the selection coefficient (s) related?

(24-8) If W_{AA} *and* $W_{aa} < 1.0$ *and* $W_{Aa} = 1.0$, what can you conclude?

(24-9) Describe the balance between selection and mutation? What can you conclude about the frequency of lethal alleles and about the balance from the equation $q = \sqrt{(\mu/s)}$?

(24-10) What is Haldane's rule?

(25-1) Explain the concept of homology? What types of homology exist for DNA sequence?

(25-2) How are generation time and metabolic rates correlated with rates of substitution?

(25-3) What is the difference between mutation and substitution?

(25-4) Which of the following are expected to have the lowest and highest rates of substitution: intron, exon, 5'-promoter, 3'—flanking region, pseudogene?

(25-5) What is the difference between a taxon and a category?

(25-6) Contrast monophyly and polyphyly:

(25-7) Distinguish between homology and homoplasy?

(25-8) What is the difference between convergence and parallelism?

(25-9) Why does searching for the "best" phylogenetic tree present a potential problem when more than ten taxa are involved?

(25-10) Which of the following are useful types of characters for the cladist: synapomorphy, symplesiomorphy, autapomorphy? Why are the some of these types of characters not useful?

(25-11) Gene trees and species trees do not always match? Why might this occur?