

**Principles of Genetics (BIOL-362), Spring 2009
Problem Set #3**

(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 vertebrate mtDNA, plant mtDNA, and plant cpDNA 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 F_{st} ? How is it useful?

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