Exam 2 Extra Credit Problem Set

**Problem 1:**

The following cross is performed: D/D ⋅ E/E x d/d ⋅ e/e, then the F1 progeny are testcrossed. What percentage of the offspring from the testcross will be d/d ⋅ e/e if the two genes are:

a) unlinked?

b) linked and10 m.u. apart?

Show your work and provide a very brief explanation for your response.

a) if the genes are unlinked, all four progeny including d/d ; e/e would be equal, so 25%

b) If the two genes are linked by 10 m.u., the recombination frequency (RF) is 10%, and the parental types would be 90%. d e / d e is a parental type, so it will make up half of the total parental types, so 45%.

**Problem 2:**

Sickle cell anemia is an autosomal recessive condition caused by a single mutation within the oxygen-carrying protein hemoglobin. Interestingly, individuals with the mutant hemoglobin allele are protected against infection from the malaria parasite. While sickle cell disease is highly dangerous and can be lethal, the mutant hemoglobin allele is found at a very high frequency in populations in many locations where malaria is a constant health threat.

Is this an example of polygenic inheritance, incomplete dominance, pleiotropy, or incomplete penetrance?

Explain your response.

pleiotropy, because one gene (hemoglobin) has two phenotypes (sickle cell and malaria resistance)

An argument can be made for incomplete dominance at the molecular level, because the Ss heterozygote can have irregular hemoglobin (which is why the malaria parasite cannot infect the cell) which is an intermediate between totally normal and totally sickled hemoglobin.

**Problem 3:**

Coat color in sheep can be white, black, or brown. The pigment that adds color to the coat is controlled by gene F, black being the dominant coat color, and brown being recessive. A second gene, gene W, controls the deposit of the pigments in the coat. A dominant mutation in gene W prevents deposit of pigment in the hair shaft. (assume independent assortment)

a) A pure breeding white female is mated with a pure breeding brown male. What is the phenotype of the F1 offspring? (include the genotypes of the parental generation in your response).

b) When the F1 offspring are crossed with each other, what are the resulting phenotypes and in what ratios?

**female: W/W; F/F (we assume unaffected genes are homozygous WT) x male: w/w; f/f**

**F1: W/w; F/f = all offspring are heterozygous, and all are white**

**12 white (any offspring with a W allele will be white)**

**3 black (offspring that are w/w; F/-)**

**1 brown (w/w; f/f only)**

**Problem 4:**

The biosynthetic pathway for the production of purple pigment in sweet pea flowers is as follows:

reactant (white) 🡪 intermediate (pink) 🡪 product (purple)

Enzyme Q catalyzes the first reaction, and Enzyme R catalyzes the second reaction.

a) Give the genotype and phenotype of a pure-breeding plant unable to catalyze the first reaction (white reactant to pink intermediate pigment).

b) Give the genotype and phenotype of a pure-breeding plant unable to catalyze the second reaction (pink intermediate to purple product).

c) If the plants from parts a and b were crossed, what phenotype and genotype will the F1 offspring have? Briefly explain your response.

**ppQQ, white**

**PPqq, pink**

**All offspring will be PpQq (purple) because the mutations will complement.**