Biology 3
Problem Set: Polygenic Inheritance, Sex-Related Inheritance and Pedigree Analysis

Answer the following problems. Show all pertinent solutions and box your final answers when appropriate.

POLYGENIC INHERITANCE

1. In common wheat (Triticum aestivum) kernel color varies from dark red to white, the genes for kernel color acting additively.
   a. A cross was made between a dark red kernel, $R_1R_1R_2R_2$, and a white kernel, $r_1r_1r_2r_2$, variety. Give the genotypes and phenotypes of the $F_1$ and $F_2$ and the ratios for the phenotypes: dark red, red, medium red, light red and white in the $F_2$.
   b. Different $F_2$ plants were crossed with the white parent. Give the $F_2$ genotypes that will give the following kinds of progeny:
      (1) 1 colored: 1 white
      (2) 3 colored: 1 white
      (3) 7 colored: 1 white

X-LINKED GENES – genes found on the X chromosome

2. In humans, green defective color vision results from the sex-linked (x-linked) recessive allele ($g$) and normal vision from its dominant allele ($G$). A man (a) and woman (b), both with normal vision, have the following three children, all of whom are married to people with normal vision: a colorblind son (c) who has a daughter with normal vision (f); a daughter with normal vision (d) who has one colorblind son (g) and two normal sons (h); and a daughter with normal vision (e) who has six normal sons (i). Give the probable genotypes of all the individuals (a to l) in the family.

3. If a mother was a carrier for the sex-linked gene for green defective color vision and the father was normal, would their sons or daughters be defective in color vision?

4. If a father and son are both defective in green color vision, is it likely that the son inherited the trait from his father?

Y-LINKED OR HOLANDRIC GENES – genes found on the Y chromosome

5. In humans, the presence of long hair in the external ear is a Y-linked trait. This condition is called hypertrichosis of pinnae (ear). A woman is married to a man with hypertrichosis of the ear. Is it possible for her to have:
   a. an affected son?
   b. an affected daughter?
   c. an affected granddaughter by her daughter?
   d. an affected grandson by her daughter?

SEX-INFLUENCED TRAITS – autosomal but expression of dominance is affected by the sex of the individual involved

6. Pattern baldness is a sex-influenced trait that is dominant in men and recessive in women. A heterozygous bald man marries a bald woman. Determine the phenotypic expectations for their children and their corresponding probabilities.
SEX-LIMITED TRAITS – carried by autosome genes which are found in both sexes, BUT the trait is only manifested in one sex because of physiological or anatomical reasons

7. Rooster feathering in chickens is a trait limited to expression only in males and determined by the autosomal recessive genotype \( hh \). The dominant allele \( H \) produces hen-feathered males. All females are hen-feathered regardless of genotype.

A rooster-feathered male is mated to two females, each of which produces a dozen chicks. Among the 24 progeny are 12 hen-feathered females, 9 rooster-feathered males and 3 hen-feathered males. What are the most probable genotypes of the two parental females?

PEDIGREE ANALYSIS – Circles represent females, squares represent males.

8. The following pedigree is concerned with an inherited dental abnormality, amelogenesis imperfecta.

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I
      1  2  3

II
  1  2  3  4  5  6
  7  8  9  10
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a. What mode of inheritance best accounts for this trait?

b. Write the genotypes of all the family members according to your hypothesis.

9. Given the pedigree below involving hemophilia in a certain family, answer the questions that follow:

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I
  1  2

II
  1  2  3  4
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a. If individual II-2 marries a normal man, what is the chance of her first child being a hemophilic boy?

b. Suppose her first child is actually hemophilic. What is the probability that her second child will be a hemophilic boy?