ALE #8. Mendelian Genetics and Inheritance Practice Problems

Answer Key

Monohybrid Crosses

10. Jack and Jill are both heterozygous for cystic fibrosis, a recessive trait. What fraction of their offspring is predicted to have cystic fibrosis? What fraction would be expected to be healthy?

25% chance of the couple having a child with CF—hence ¼ of their children.

75% chance of a child without CF—hence ¾ of their children.

11. Assume that a single gene determines hair color in humans as follows: BB individuals have black hair; Bb has brown hair; and bb has blonde hair. *Clearly show/explain how you arrived at your answers to the questions below!*
    a. If two brown hair people have a child, what is the probability that their first child will have brown hair?

50% chance (or 1 in 2 chance) of having a child with brown hair

    b. Assume that their first child had black hair. What is the probability that the next child will also have black hair?

25% chance (or 1 in 4 chance) of having a child with black hair

12. a. A red tomato plant is self-fertilized. 25% of the offspring are green. What is the genotype of the plant? (Indicate the genotype and dominant allele. *Clearly show/explain how you arrived at your answers to the questions a-c, below!*

P = Heterozygous: Rr (R = red; r = green)

    b. If a plant heterozygous for the red/green alternative alleles is crossed to another tomato plant and all the progeny are red, what is the genotype of the second plant?

Homozygous dominant: RR (R = red; r = green)

    c. In a cross between a red tomato plant and a green tomato plant, if 50% of the progeny (offspring) are red and 50% are green, what are the genotypes of the two parents?

P = Rr x rr (R = red; r = green)

13. In cattle the polled (hornless) trait is dominant and is determined by the dominant ***allele D***. The horned trait is recessive and is determined by the ***allele d***. A certain polled bull is mated to three cows. Cow A, which is horned, gives birth to a polled calf. Cow B, also horned, produces a horned calf. Cow C, which is polled, produces a horned calf—this data is summarized in the table below. Determine the genotypes of the four parents. *Clearly show/explain how you arrived at your answers*!

Critter	Phenotype	Parent's Genotype	Phenotype of Calf produced with Bull
Cow A	Horned	**dd**	Polled
Cow B	Horned	**dd**	Horned
Cow C	Polled	**Dd**	Horned
Bull	Polled	**Dd**	

14. In summer squash, *white fruit color is dominant*; *yellow is recessive*.
    a. If a squash plant that is homozygous for white is crossed with a homozygous yellow, what will be the phenotype of the F_1 generation**?** ***Clearly show/explain how you arrived at your answers*!**

F_1 = 100% White

    b. What phenotypes and their fractional amounts would be expected in the F_2 generation?

F_2 = ¾ White, ¼ Yellow

c. Suppose a *yellow squash plant* is crossed with *the white plants of the F_2*. What would be the appearance and fractional amount of the offspring from each cross—i.e. what would be the expected phenotypic ratio of each cross? Note: this question involves two *different* crosses!

The two crosses involved:

homozygous yellow individual x heterozygous individual from F_2 → ½ white, ½ yellow

homozygous yellow individual x homozygous dominant individual from F_2 → 100% white

d. What is the name of the type of cross that was performed in c? **Test Cross**

Dihybid and Sex-Linked Crosses

15. In the land of Magumba there grows the fabled Bungula. In Bungulas, *Red Fur color*, ***A***, *is incompletely dominant* over *Purple Fur*, ***a***, the *heterozygous condition being Green Fur*. Long Wings, ***B***, are dominant over short wings, ***b***. *Clearly show/explain how you arrived at your answers below*!
    a. If a pure breeding Red, short-winged Bungula is mated with a pure breeding Purple, long-winged one, what will be the Phenotypes and their expected occurrences in the F_1 generation?

F_1: 100% with Green fur – Long wings

    b. What will be the phenotypes and their expected occurrences in the F_2?

Red fur – Long wings: 3/16
Green fur – Long wings: 6/16 = 3/8
Red fur – Short wings: 1/16
Green fur – Short wings: 2/16 = 1/8
Purple fur – Long wings: 3/16
Purple fur – Short wings: 1/16

16. In *Drosophila* (fruit fly) yellow body color is sex linked—yellow is recessive to normal body color. If a yellow bodied female is crossed with a normal male and **(a)** an F_1 female from this cross is mated with her father and **(b)** an F1 male is mated with his mother, what will be the phenotypes (as to body color) and their expected occurrences in the offspring of cross (a) and cross (b)? Don't Panic! State results for the two sexes separately. *Clearly show/explain how you arrived at your* answers below!

Cross a: X^NX^n x X^NY → 50% offspring: Normal Females (half of which are carriers)
25% offspring: yellow males
25% offspring: Normal males

Cross b: X^nX^n x X^nY → 50% of offspring: yellow bodied females
50% offspring: yellow bodied males

Multiple Alleles and Blood Groups

17. What are the possible blood types of the children in the following families? *Clearly show/explain how you arrived at your* answers below!
    a. Mother: Type A blood and Father: Type A.

Possible blood types for their children = A, O

    b. Mother: Type B blood and Father: Type AB.

Possible blood types for their children = A, B, AB

    c. Mother: Type A blood and Father: Type O.

Possible blood types for their children = A, O

18. A man is suing his wife for divorce on the grounds of infidelity. Their first child and second child, whom they both claim to be their children, are blood groups O and AB respectively. The third child, whom the man disclaims, is blood type B. Can this information be used to support the man's case? Why? *Clearly show/explain how you arrived at your* answer below!

This information could be used to support the man's case if and only if the couple were not blood types A and B. It would be impossible for one couple to produce all three blood types (O, AB and B) unless the couple had blood types A and B.

19. A mother has Type A, Rh- blood and the father has A, Rh+ blood. *Clearly show/explain how you arrived at your* answers below!
    a. What are all the possible genotypes of the offspring these two could produce?

Possible genotypes of children: I^AI^ARr I^AI^Arr I^AiRr I^Airr iiRr iirr

Where: I^A = type A allele; i = type O allele; R = Rh positive allele; r = Rh negative allele

    b. What are all the possible phenotypes of their potential offspring?

A+, A-, O+, O-

20. A mix-up happened in the maternity ward of a hospital. **Baby X** (Blood type A) and **Baby Y** (Blood type O) lost there ID tags!! If the suspected parents have the following blood types, match the babies with the correct parents.

Couple 1: Type B and Type A **Couple 2**: Type A and AB

Clearly show/explain how you arrived at your answer below!

- **Baby "X" could belong to couple 1 or couple 2, but baby "Y" can't belong to couple 2.**
- **Therefore, Baby "X" belongs to couple 2 and Baby 'Y" belongs to couple 1.**

Probability Method

21. How many different types of gametes could be generated from individuals with the following genotypes?

Clearly show/explain how you arrived at your answers below!

a. AaBb **4**

b. AaBbCc **8**

c. AABBCC **1**

d. AABBCc **2**

22. Given AaBbCC x AabbCc what are the chances of producing the following genotypes?

Clearly show/explain how you arrived at your answers below!

a. AabbCC **1/8**

b. aaBBCc **0**

c. aabbCc **1/16**

d. AaBbCc **1/8**

23. Suppose A = Red and a = White. B = Tall and b = Short. Given the following cross AaBb x aaBb what are the chances of producing the following phenotypes? *Clearly show/explain how you arrived at your* answers below!

a. Red Tall **3/8**

b. Red Short **1/8**

c. White Short **1/8**

24. Suppose A = Red and a = White; B = Tall and b = Short: C = Round seed and c = wrinkle seed. Given the cross of AaBbcc x AabbCc what are the chances of producing the following phenotypes? *Clearly show/explain how you arrived at your* answers below!

a. Red, Tall, and Round Seed **3/16**

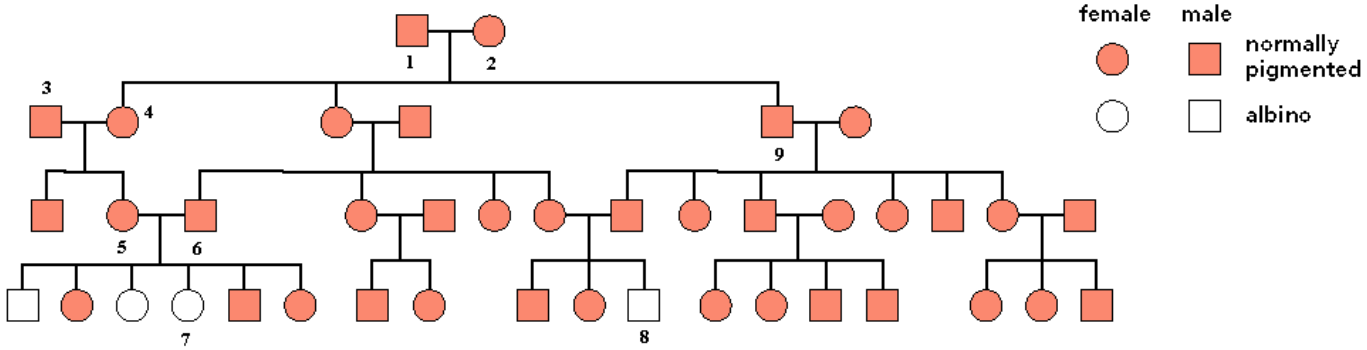
b. White, Short, and Wrinkled Seed **1/16**

c. Red, Short and Wrinkled Seed **3/16**

Pedigree Analysis

25. Examine the human pedigree for a family with albinism. On this pedigree, individuals that are shaded represents that they have normal skin pigmentation, while those that are not shaded in are albino—that is, they are unable to produce melanin, the substance responsible for skin pigmentation. The squares indicate the condition of the males; the circles indicate the condition of the females. Use this pedigree to answer the following 5 questions.

Family Pedigree for Albinism



a. Could this characteristic be due to a sex-linked recessive allele? *Defend your response*. **No**

b. Could this characteristic be due to a sex-linked dominant allele? *Defend your response.* **No**

c. Could this characteristic be due to an autosomal dominant allele? *Defend your response*. **No**

d. Could this characteristic be due to an autosomal recessive allele? *Defend your response.* **Yes**

e. Determine the genotypes of the individuals below from this pedigree. Define the allele symbols below.

Clearly show/explain how you arrived at your answers below

Allele Symbols: A = Normal Pigmentation a = Albino

Genotype of Individual

Individual #1 **A? (A? = AA or Aa)**

Individual #2 **A?**

(either #1 or #2 is probably Aa, but we can't tell which one!)

Individual #3 **A? (but most likely AA)**

Individual #4 **A? (but most likely Aa)**

Individual #5 **Aa**

Genotype of Individual

Individual #6 **Aa**

Individual #7 **aa**

Individual #8 **aa**

Individual #9 **A? (but most likely Aa)**