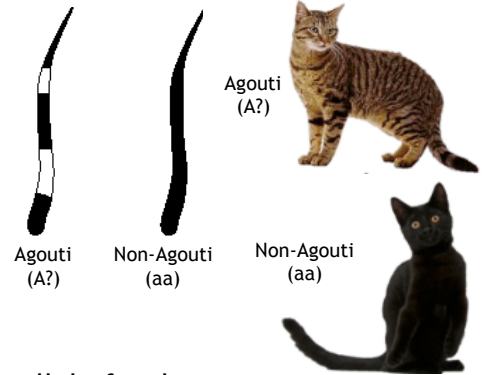


**Genetics Worksheet #3**

**Part 1: The Dihybrid Cross**

Some cats have hairs in which there is more than one color distributed along the hair shaft. Banded hairs of this type are termed “agouti.” They produce a ticked coat with multiple colors per hair shaft, as shown in the image on the right. Agouti is the typical fur color found in many wild animals such as mice, squirrels, and rabbits, and is thought to be important in their ability to blend into the background. The *agouti* gene has a dominant agouti allele, **A**. In contrast, hairs on non-agouti cats are unbanded, producing a solid-colored hair shaft. Such a cat is homozygous for the non-agouti allele, **a**.



As we learned earlier, the gene for hair length in cats has two alleles. The allele for short hair, **L**, is dominant to the allele for long hair, **l**.

Imagine a mating in which both cats have short, agouti hair, but their mothers had long, non-agouti hair. (In other words, both cats in this cross are heterozygous for both genes.)

1. Give the genotypes for each parent cat:

Male Cat : \_\_\_\_\_ Female Cat : \_\_\_\_\_

2. Give the possible gametes for each parent cat using the FOIL method:

Male Cat : \_\_\_\_\_ Female Cat : \_\_\_\_\_

3. Complete the 4 x 4 Punnett square below based on the above information:

		Male Cat's Gametes			
Female Cat's Gametes					

4. Identify the possible phenotypes and genotypes of the offspring of this cross.

**Possible Phenotypes**

**Possible Genotype(s) Creating the Phenotype**

short, agouti hair : \_\_\_\_\_ out of 16

\_\_\_\_\_

short, non-agouti hair : \_\_\_\_\_ out of 16

\_\_\_\_\_

long, agouti hair : \_\_\_\_\_ out of 16

\_\_\_\_\_

long, non-agouti hair : \_\_\_\_\_ out of 16

\_\_\_\_\_

## Part 2: Complex Multi-Gene Inheritance

### A. Genotypes & Phenotypes

The *dilute* gene in cats causes a cat's fur color to be lighter than normal. The effect of this gene can make a black cat look gray, a brown cat look tan, and a cinnamon cat look peach. The *dilute* gene has two alleles. The dominant allele, *D*, has no effect on the cat's fur color. The recessive allele, *d*, causes the cat to have lighter fur.



"Gray" ( $B?dd$ )



"Tan" ( $bbdd$  or  $bb'dd$ )



"Peach" ( $b'b'dd$ )

5. To demonstrate your understanding of the relationship between these two genes, list all of the possible genotypes for each phenotype.

Black : \_\_\_\_\_

Brown : \_\_\_\_\_

Cinnamon : \_\_\_\_\_

Gray : \_\_\_\_\_

Tan : \_\_\_\_\_

Peach : \_\_\_\_\_

6. A black cat had one parent with black fur and one parent with peach fur. Is it possible to determine this cat's genotype? Explain.

7. The black cat described above is a male cat. It mates with a peach female cat. Identify their genotypes.

Black Male Cat : \_\_\_\_\_ Peach Female Cat : \_\_\_\_\_

8. What are the possible allele combinations (FOIL) in the gametes produced by each cat? List them below.

Black Male Cat : \_\_\_\_\_ Peach Female Cat : \_\_\_\_\_

9. If these cats had kittens, what are the kittens' possible genotypes? Write out the genotypes below.

10. What are these kittens' possible phenotypes? List the phenotypes below.

## B. Two-Factor Cross Problem

11. A cat with the genotype BbDd has kittens with another cat with the genotype BbDd.

Use the 4 x 4 Punnett square below to predict the phenotypes and genotypes of the kittens.

		Male Cat's Gametes			
Female Cat's Gametes					

### Possible Phenotypes

Black : \_\_\_\_\_ out of 16

Brown : \_\_\_\_\_ out of 16

Cinnamon : \_\_\_\_\_ out of 16

Gray : \_\_\_\_\_ out of 16

Tan : \_\_\_\_\_ out of 16

Peach : \_\_\_\_\_ out of 16

### Possible Genotype(s) Creating the Phenotype

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

12. Explain why some of the possible coat colors were not seen in this cross.

## C. Epistasis Problem

Epistasis is when one gene overrides the expression of another gene. This is different from dominance because it occurs due to the interaction between different genes, instead of between alleles for the same gene. To explore this, we will look at another potential cause of white fur in cats.

The *all-white* gene, **W**, causes all of the fur on a cat to be white. This gene is epistatic because no matter what other genes for fur color that the cat has, this gene will mask those other genes and make all of a cat's fur white. The dominant allele, **W**, leads to white fur. The recessive allele, **w**, has no effect on the cat's fur color, allowing the cat's other genes to be expressed.

13. Imagine a cross between a cinnamon cat (b'b'ww) and a white cat (Bb'Ww). What are the possible allele combinations (FOIL) in the gametes produced by each cat? List them below.

Cinnamon Cat : \_\_\_\_\_ White Cat : \_\_\_\_\_

14. Complete the 4 x 4 Punnett square below to represent the cross described in question 13. Use the completed Punnett square to predict the phenotypes and genotypes of the kittens.

Cinnamon Cat's Gametes

White Cat's Gametes


Possible Phenotypes

Possible Genotype(s) Creating the Phenotype

Black : \_\_\_\_\_ out of 16

\_\_\_\_\_

White : \_\_\_\_\_ out of 16

\_\_\_\_\_

Cinnamon : \_\_\_\_\_ out of 16

\_\_\_\_\_

**Part 3: Lethal Alleles**

Sometimes, there are alleles that can create a form of a protein that is not only dysfunctional, but also harmful to the animal. An example of this is the *Manx* gene in cats. The *Manx* gene affects the development of the back end of the cat's body. The *Manx* gene has two alleles, **M** and **m**. The **M** allele is incompletely dominant to the **m** allele. When a cat is homozygous for the **M** allele, its development is so damaged that it always dies before birth. When a cat is heterozygous, the only effect is that the cat has a very short tail. Finally, when a cat is homozygous for the **m** allele, it has a normal tail.



MM (lethal)



Mm ("manx")



mm (normal tail)

15. Two cats with very short tails have kittens. Use a Punnett square to determine the kittens' possible phenotypes. (Be sure to only count kittens that would actually be born.)

"Manx" : \_\_\_\_\_ out of \_\_\_\_\_ or \_\_\_\_\_%

Normal Tail : \_\_\_\_\_ out of \_\_\_\_\_ or \_\_\_\_\_%
