Name _____

Genetics Worksheet #2

Part 1: Incomplete Dominance

When a heterozygous individual has a different phenotype than a homozygous dominant or homozygous recessive individual, it may be because the alleles exhibit "incomplete dominance."

One of the genes for white fur in cats causes a certain amount of the cat's fur to be white. We call this pattern Piebald Spotting. The $\mathbf{P^WP^W}$ genotype produces white fur on >50% of the cat's body (white with black splotches). When a cat has the genotype $\mathbf{P^WP^B}$, it has white fur on <50% of its body (black with white splotches). The $\mathbf{P^BP^B}$ genotype does not produce white fur (all black).

1. Based on the information above, write out the genotype for each of the cats shown below.

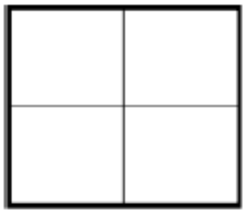
_____ _____ _____

2. Two heterozygous cats have kittens. Use a Punnett square to determine the proportions of genotypes present in the kittens.

   P^WP^W : _____ out of _____ or _____%

   P^WP^B : _____ out of _____ or _____%

   P^BP^B : _____ out of _____ or _____%



3. Could a black cat ever have an offspring that is mostly white? Use a Punnett square to help explain your answer.

4. A black kitten has one sibling that is mostly white and one sibling that is mostly black. What are their parents' genotypes? How can you tell? Use a Punnett square to help explain your answer.

   Write out the parental cross: _____ x _____

Part 2: Codominance

Another way that a heterozygous individual can have a different phenotype than a homozygous individual is through the pattern of codominance. In cats, the color gene, **C**, is responsible for making cats able to have fur colors other than white. There are two particular alleles of this gene that cause the color-producing cells to make color proteins that are temperature sensitive. These dark brown proteins lose their color when it is too warm.

Siamese

Tonkinese

Burmese

One of these alleles, $\mathbf{C^S}$, causes extreme sensitivity on the hotter parts of the body, leading to a mostly white cat with dark brown fur only on its extremities. We call these "Siamese" cats. Another allele, $\mathbf{C^B}$, causes much less sensitivity, leading to a mostly dark brown cat. We call these "Burmese" cats. When a cat has both alleles, its cells produce both proteins. This results in a mix of both white and brown hair. We call these "Tonkinese" cats. You can see a picture of this mix on the right.

5. What are the phenotypes for each of the following genotypes?

   C^SC^S : _____ C^SC^B : _____ C^BC^B : _____

6. If two Tonkinese cats have kittens, what are the possible genotypes for those kittens? Use a Punnett Square to support your answer.

   C^SC^S : _____ out of _____ or _____%

   C^SC^B : _____ out of _____ or _____%

   C^BC^B : _____ out of _____ or _____%

7. If a Siamese cat has offspring with a Burmese cat, will any of their offspring have the same coat color as either parent? Explain your answer.

8. How would you explain the difference between incomplete dominance and codominance?

Part 3: Multi-allele Simple Traits

Black

"Chocolate" Brown

"Cinnamon" Brown

The gene for darker fur color in cats has three alleles. The first, **B**, gives the cat black fur. The second, **b**, gives the cat chocolate brown fur. The third, **b'**, gives the cat lighter, cinnamon brown fur.

In general, darker fur color is dominant to lighter fur color for this gene. Therefore, **B** is the most dominant, followed by **b**, and finally **b'**. A cat with at least one **B** allele will always be black. A cat without the **B** allele will be whatever color is determined by the relationship between the other two alleles.

9. Write the phenotypes for each of the genotypes below.

BB : _____ Bb' : _____ bb' : _____

Bb : _____ bb : _____ b'b' : _____

10. Write some possible genotypes for each of the phenotypes below. Try to include more than one answer.

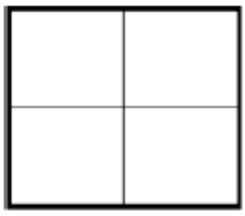
Black : _____ Chocolate : _____ Cinnamon : _____

11. A black-furred cat with the genotype Bb' has kittens with a chocolate-furred cat with the genotype bb'. Use a Punnett square to find what their kittens' genotypes and phenotypes would be. Once you have completed the Punnett square, determine the proportions of each phenotype in the kittens.

Black : _____ out of _____ or _____%

Chocolate : _____ out of _____ or _____%

Cinnamon : _____ out of _____ or _____%



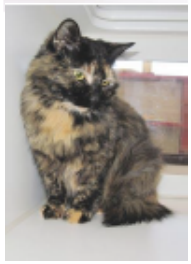
12. Choose one of the kittens from the question above to cross with a b'b' genotype cat when it grows up. Use a Punnett square to find what their kittens' genotypes would be. Once you have completed the Punnett square, determine the proportions of each phenotype in their offspring.

Black : _____ out of _____ or _____%

Chocolate : _____ out of _____ or _____%

Cinnamon : _____ out of _____ or _____%

Part 4: Sex-Linked Traits



The gene for orange fur in cats works by changing the darker eumelanin (a dark color protein) found in black and brown fur into the lighter pheomelanin (a light color protein) found in orange fur. This gene has two alleles. The allele for making orange fur, X^O, is codominant with the allele for non-orange fur, X^o. The exact pattern of orange and non-orange splotches is caused by X-chromosome inactivation, a process by which one of a female's two X chromosome is randomly inactivated in the each of the cells that make up the embryo. As the embryo goes on to develop, some of the cells in a heterozygous female will express the orange allele and some of the cells will express the non-orange allele. Therefore, for any given patch of fur, the inactivation of an X chromosome that carries one allele results in the fur color of the other, active allele.

The genotypes X^OX^O and X^OY result in orange fur, the genotypes X^oX^o and X^oY result in black or brown fur, and the genotype X^OX^o results in a "tortoiseshell" cat, in which some parts of the fur are orange and others areas non-orange.

13. A male cat with the genotype X^OY and a female cat with the genotype X^OX^o have kittens. Complete a Punnett square and determine the proportions or each phenotype in the offspring.

Orange Male : _____ out of _____ or _____%

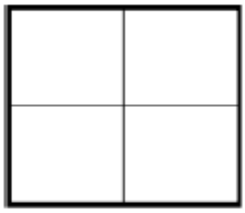
Black Male: _____ out of _____ or _____%

Tortoiseshell Male : _____ out of _____ or _____%

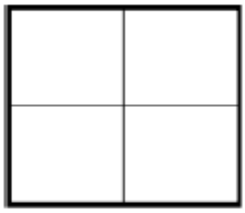
Orange Female : _____ out of _____ or _____%

Black Female: _____ out of _____ or _____%

Tortoiseshell Female : _____ out of _____ or _____%



14. When the male kittens from the cross above grow up, would it be possible to cross one of them with an X^OX^O female and get an orange female offspring? Justify your answer using a Punnett square.



15. Would it be possible to get a male tortoiseshell cat from any combination of parents? Why or why not?

Reflection:

Rate your understanding of genetics so far 1 2 3 4 5

I have no idea — I could teach this

What questions do you still have?