Punnett Squares – Monohybrid and Dihybrid

Name: *Period:*

Background

Original parents in any given set of crosses are called the **parent generation or parentals**, while the two subsequent generations are denoted with the symbols **F1** and **F2** (a cross of two F1 individuals). Punnett Squares are one method for visually demonstrating the probability of offspring **genotypes** and offspring **phenotypes**.

Example 1: (*Monohybrid Cross*)

For humans, brown eyes are dominant (B) over blue eyes (b). A heterozygous brown-eyed man marries a heterozygous brown-eyed female. What are the possible genotypes and phenotypes of the offspring?

Parents: Male = Bb; Female = Bb

	B	b
B		
b		

The separation of the parental genotype from Bb and Bb on either side of the Punnett square represents meiosis. Each single letter represents a possible haploid condition in either an egg or a sperm, whereas the double letters represent a diploid condition.

Conventions

1.Male alleles on top of punnett square - female alleles on the left
2.Dominant allele (upper case) written before recessive allele (lower case)

Record the probabilities for genotypes and phenotypes of the offspring (F_2 generation) as percents and ratios. *Use the following format to write genotypic ratios: homozygous dominant: heterozygous: homozygous recessive. Use the following format to write phenotypic ratios: dominant phenotype: recessive phenotype.*

Genotypic Percents	Phenotypic Percent s

Monohybrid Practice Problems

1. Cystic fibrosis is a recessive genetic disorder. Ron is homozygous dominant (FF) and Nancy is a carrier (Ff) of cystic fibrosis. Use a Punnett square to predict the probability that one of their children will have cystic fibrosis? **Show all work and box your final answer.**

Genotypic Percents	Phenotypic Percents

2. Patty is homozygous dominant for freckles (SS), while Charlie is homozygous for no freckles (ss). Draw a Punnett square predicting the probability if their children will have freckles.

Genotypic Percents	Phenotypic Percents

3. Eddie has brown eyes, while Cybil has blue. If brown eyes are known to be dominant, and blue eyes are recessive, use a Punnett square to predict their offspring. Assume Eddie doesn't carry a recessive allele.

Genotypic Percents	Phenotypic Percents

4. Larry and Lola Little have achondroplasia, a form of dwarfism. Both are heterozygotes. Their son, Big Bob Little, is 7'1". Use a Punnett square to show how Big Bob got his genotype.

Genotypic Percents	Phenotypic Percents

5. Woody Guthrie, who wrote *This Land is Your Land*, was heterozygous for Huntington's disease (Hh). His wife was homozygous recessive and perfectly normal (hh). Huntington's disease is caused by a latent dominant gene, meaning that it is not phenotypically (physically) expressed until later in life. Dominant disease genes are expressed in homozygous dominant and heterozygous people (HH or Hh). Draw a Punnett square for Woody ad his wife.

Genotypic Percents	Phenotypic Percents

Example 2: (*Dihybrid Cross*)

Dihybrid crosses use Punnett squares to distribute parental alleles from *two* genes into gametes (eggs and sperm or pollen and ovum) as would be predicted by meiosis.

➢ In garden peas, tallness (T) is dominant to shortness (t) and axillary flowers (A) are dominant to terminal flowers (a). What are the expected ratios for the genotypes and phenotypes of the offspring if a heterozygous tall, heterozygous axillary plant is crossed with a heterozygous tall, terminal plant?

Guidelines for Dihybrid Punnett Squares

1. Dihybrid crosses - use the *FOIL* method from the binomial distributive property of multiplication.
   ex: gamete distribution for AaBb:
   AB Ab aB ab
2. Dominant alleles (upper case) are written before recessive allele (lower case) - except for distributing alleles in dihybrid crosses.
3. Alleles of the same gene always stay together (important in dihybrid problems)

Genotypes:

Genotypic Ratios	Phenotypic Ratios

Phenotypes:

Dihybrid Practice Problems

1. In horses, the coat color black is dominant (B) over chestnut (b). The trotting gait is dominant (T) over the pacing gait (t). If a homozygous black pacer is mated to a homozygous chestnut, heterozygous trotter, what will be the ratios for genotype and phenotype of the F_1 generation?

Genotypes:

Phenotypes

Genotypic Ratios	Phenotypic Ratios

2. In rabbits, the coat color black dominant (B) over brown (b). Short hair is dominant (S) over long (s). In a cross between a homozygous black short-haired male and a brown homozygous long-haired female, what would be the ratios for genotype and phenotype of the F_1 generation?

Genotypes:

Phenotypes

Genotypic Ratios	Phenotypic Ratios

3. Imagine that a couple is planning to have children. The male is heterozygous for Huntington's disease and homozygous dominant for Tay-Sachs. The female is homozygous recessive for Huntington's disease and heterozygous for Tay-Sachs. The couple is curious about the possibility and probability of their offspring inheriting Tay-Sachs and/or Huntington's. For humans, Huntington's disease is dominant (H) over the "normal" condition (h), and the "normal" condition is dominant (T) over Tay-Sachs (t). Complete a Punnett square for this cross and record the probabilities for genotypes and phenotypes of the offspring as ratios.

Genotypes:

Phenotypes

Genotypic Ratios	Phenotypic Ratios

Name_____ Period:_____ Date:_____

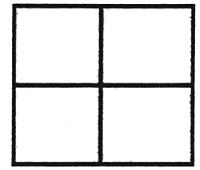
CODOMINANT/INCOMPLETE DOMINANCE PRACTICE WORKSHEET

1. Explain the difference between incomplete and codominance.

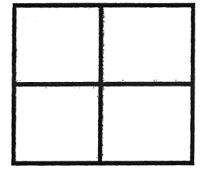
Co-Dominance Problems

2. In a certain fish, blue scales (BB) and red scales (bb) are codominant. When a fish has the hybrid genotype, it has a patchwork of blue and red scales. (Use the letter B)
   a. What is the genotype for blue fish? _____
   b. What is the genotype for red fish? _____
   c. What is the genotype for patchwork fish? _____

3. What happens if you breed a patchwork fish with a fish that only has Blue Scales?
   a. What is the probability of having fish with red scales? _____%
   b. What is the probability of having fish with patchwork scales? _____%



4. Two patchwork fish are crossed. What is the probability that they will have patchwork fish? _____%

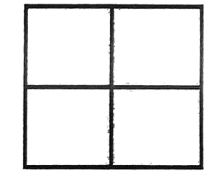


5. Two short-tailed (Manx) cats are bred together. They produce three kittens with long tails, five short tails, and two without any tails. From these results, how do you think tail length in these cats are inherited? Show the genotypes for both the parents and the offspring to support your answer.

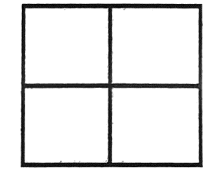
Incomplete Dominance Problems

6. In snapdragons, flower color is controlled by incomplete dominance. The two alleles are red (R) and white (r). The heterozygous genotype is expressed as pink.
   a. What is the phenotype of a plant with the genotype RR? _____
   b. What is the phenotype of a plant with the genotype Rr? _____
   c. What is the phenotype of a plant with the genotype rr? _____

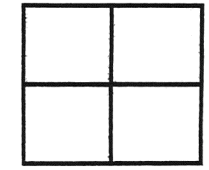
7. A pink-flowered plant is crossed with a white-flowered plant. What is the probability of producing a pink-flowered plant? _____%



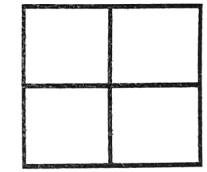
8. What cross will produce the most pink-flowered plants? Show a Punnett square to support your answer and explain.



9. In Andalusian fowls, black individuals (BB) and white individuals (bb) are homozygous. A homozygous black bird is crossed with a homozygous white bird. The offspring are all bluish-gray. Show the cross as well as the genotypes and phenotypes of the parents and offspring.



10. What results if a black individual is crossed with a bluish-gray individual? (SHOW YOUR WORK)



Codominance (Blood types)

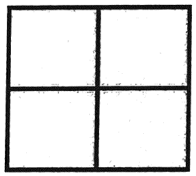
Human blood types are determined by genes that follow the CODOMINANCE pattern of inheritance. There are two dominant alleles (I^A and I^B) and one recessive allele (i).

Blood Type (Phenotype)	Genotype	Can donate blood to:	Can receive blood from:
O	ii	A,B,AB and O (universal donor)	O
AB	I^AI^B	AB	A,B,AB and O (universal receiver)
A	I^AI^A or I^Ai	AB, A	O,A
B	I^BI^B or I^Bi	AB,B	O,B

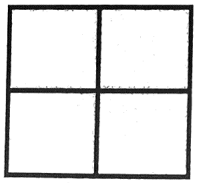
1. Write the genotype for each person based on the description:

   a. Homozygous for the "B" allele _____
   b. Heterozygous for the "A" allele _____
   c. Type O _____
   d. Type "A" and had a type "O" parent _____
   e. Type "AB" _____
   f. Blood can be donated to anybody _____
   g. Can only get blood from a type "O" donor _____

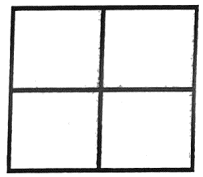
2. Pretend that Drake is homozygous for the type B allele, and Nicki Minaj is type "O." **What are all the possible blood types of their baby?** (show your work)



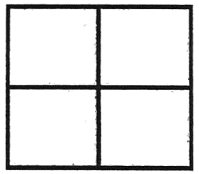
3. Draw a Punnett square showing all the possible blood types for the offspring produced by a type "O" mother and an a Type "AB" father



4. Mrs. Clink is type "A" and Mr. Clink is type "O." They have three children named Matthew, Mark, and Luke. Mark is type "O," Matthew is type "A," and Luke is type "AB." Based on this information: SHOW WORK TO PROVE YOUR ANSWERS!
   a. Mr. Clink must have the genotype _____
   b. Mrs. Clink must have the genotype _____ because _____ has blood type _____
   c. Luke cannot be the child of these parents because neither parent has the allele _____.



5. Two parents think their baby was switched at the hospital. Its 1968, so DNA fingerprinting technology does not exist yet. The mother has blood type "O," the father has blood type "AB," and the baby has blood type "B."
   a. Mother's genotype: _____
   b. Father's genotype: _____
   c. Baby's genotype: _____ or _____
   d. Punnett square showing all possible genotypes for children produced by this couple
   e. Was the baby switched?



6. Two other parents think their baby was switched at the hospital. The mother has blood type "A," the father has blood type "B," and the baby has blood type "AB."
   a. Mother's genotype: _____ or _____
   b. Father's genotype: _____ or _____
   c. Baby's genotype: _____
   d. Punnett square that shows the baby's genotype as a possibility:
   e. Was the baby switched?