

Practice Solving Genetics Problems

Background: Solving genetics problems requires that you be familiar with the various allele combinations, and that you are able to successfully translate genetic conditions (such as being homozygous dominant or heterozygous dominant) into a **genotype (the combination of alleles)** and the resulting **phenotype (what an organism looks like)**.

The following problems are designed to help you practice making these translations comfortably and confidently. There are a few simple rules to follow, and following them in order will assist you in figuring out the correct answer.

First, you need to make sure you know that the terms **homozygous** and **heterozygous** refer to whether the alleles in the gene are the **same (homozygous)** or **different (heterozygous)**. In **heterozygous genotypes**, there will always be one dominant allele (indicated by a capital letter) and one recessive allele (indicated by a lowercase letter). Since the alleles in the homozygous genotypes will have two matching alleles, homozygous dominant simply means there are two dominant alleles (two capital letters) and homozygous recessive means there are two recessive alleles (two lowercase letters) in the genotype.

Also remember that, ALL recessive traits will only have a homozygous genotype (two small letters/alleles).

Here are a few practice problems to get used to these terms and writing out the genotype. This is very important because it is the first step in solving a genetics problem correctly: determining the genotype.

1. Brown eyes (**B**) are dominant over blue eyes (**b**).
 - a. What is the only possible genotype for a person who has blue eyes? _____
 - b. There are two possible genotypes for a person who has brown eyes. If a person is **heterozygous dominant** for brown eyes, what is their genotype? _____
 - c. If a person is **homozygous dominant** for brown eyes, what is their genotype? _____
 2. Using the information from your GENETICS CHEAT SHEET on the ABO Blood system, answer the following:
 - a. Patricia has Blood Type AB. What is her genotype? _____
 - b. Samuel has Blood Type O. What is his genotype? _____
 - c. Lorenzo is **homozygous dominant** for Type A Blood. What is his genotype? _____
 - d. Ann Marie is **heterozygous dominant** for Type B Blood. What is her genotype? _____
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Check your answers on the answer sheet. Now that you've had some practice writing out the genotypes based on information given about which alleles are dominant and recessive in a trait, let's practice using the Punnett Square to predict possible genotype and phenotype outcomes.

PROBLEM 1: Assume that one gene controls whether a person has brown hair or red hair. Brown hair (**H**) is dominant over red hair (**h**). Barbara is **homozygous dominant**. Her husband, Bob, has red hair. Will any of their children have red hair?

- **Step 1.** Figure out the genotypes (the combination of alleles an individual possesses) for each individual.

What is Barbara's genotype? _____ What is her phenotype (what color hair does she have)? _____

What is Bob's genotype? _____

- **Step 2.** Use the Punnett square to separate the alleles in each individual's genotype by putting one allele in one box along the top or side, and the other allele in the other box along the top or the side of the square.

This process represents the segregation of alleles during *meiosis* (the process by which the sex cells replicate and divide). These sex cells (sperm in males, eggs in females) contain half the genetic information necessary to create a new individual. Thus, the baby will receive half their genetic information from the father, and half from the mother.

	Barbara		
Bob			

- **Step 3.** In the blank squares of the Punnett square, combine the alleles on the side with the alleles on the top so that you have two allele genotypes in each square.

Will any of their children have red hair? _____

Check your answer on the answer sheet.

PROBLEM 2: Using the information on the ABO Blood Types from your CHEAT SHEET, answer the following:

Shane is **heterozygous dominant** for Type A blood. His wife, Sharon, is **heterozygous dominant** for Type B blood. What are the possible genotypes for their children?

Shane's genotype = _____

Sharon's genotype = _____

Sharon

Shane			

Check your answer on the answer sheet.

This next problem is a bit more challenging because you need to determine the genotypes and phenotypes for TWO generations based on the background information given.

PROBLEM 3: Assume one gene determines whether or not you have big feet or small feet. Having big feet is the dominant trait (**F**) and having small feet is the recessive trait (**f**). Given this information, solve the following problem:

David and his mother both have small feet. David's sister, Julie, has big feet and so does their father. What are the genotypes for David, Julie, and their father AND mother?

- **Step 1.** Figure out the genotypes (the combination of alleles an individual possesses) for each individual.

In this case, we know that David and his mother have only one possible genotype, since having small feet is the recessive trait, and recessive traits are only expressed in the homozygous (matching alleles) condition.

David's genotype is: ff Mother's genotype: ff

We are able to figure out the father's genotype because we know he must have one recessive allele to pass on to David, and he must have one dominant allele to pass on to Julie, so the father has a heterozygous dominant genotype. Her phenotype then is big feet. The same goes for the Mother. Julie, therefore, could only have one possible genotype since she can only receive a recessive (f) allele from her mother. In order to have big feet, she must have gotten the dominant (F) allele from her father. Look at the Punnett square below to see how this could happen.

Parents:	<u>Dad</u> Phenotype = Big Feet Genotype = Ff	<u>Mom</u> Phenotype = Small feet Genotype = ff
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Children:	<u>David</u> Phenotype = Small Feet Genotype = ff	<u>Julie</u> Phenotype = Big Feet Genotype = Ff
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MOTHER

FATHER		f	f
	F	Ff	Ff
	f	ff	ff

Now you try one on your own.

PROBLEM 4: Brown eyes are dominant (**B**) and blue eyes are recessive (**b**). Mark and Elizabeth both have brown eyes. Their son Travis has blue eyes, and their other son, Jacob, has brown. Complete the information below.

Parents:

Mark

Phenotype =
Genotype =

Elizabeth

Phenotype =
Genotype =

Children:

Travis

Phenotype =
Genotype =

Jacob

Phenotype =
Genotype =

		Elizabeth	
Mark			

Check your answer on the answer sheet.

MORE PRACTICE WITH BLOOD TYPES (Refer to your Genetics Cheat Sheet Hand out)

1. If a person has Type A blood, what possible genotypes could they have? _____
2. If a person is *heterozygous* for Type A blood, what is their genotype? _____
3. If a person has Type O blood, what is their genotype? _____
4. What are the possible genotypes for Type B blood? _____
5. If a person's genotype contains an A and a B allele, what is their genotype? _____
 - a. What is this person's phenotype? _____

PROBLEM 5

Jenna is *homozygous dominant* for Blood type B. Her husband, Gerald, is *homozygous dominant* for Blood type A. What is the ONLY genotype (combination of alleles) and phenotype (Blood type) their children could have? Complete the info below and use the Punnet square to show your work.

Jenna's genotype = _____

Gerald's genotype = _____

Jenna's phenotype = _____ Gerald's phenotype = _____

Jenna

Gerald			

Genotype of children = _____

Phenotype of children = _____ (Write out the physical trait, in this case, blood type)

ANSWER SHEET

Practice with genotypes

- 1a. bb 2a. AB
- 1b. Bb 2b. OO
- 1c. BB 2c. AA
- 2d. BO

Practice solving genetics problems

Problem 1:

Barbara's genotype = HH Barbara's phenotype = Brown hair

Bob's genotype = hh

Barbara

		H	H
Bob	h	Hh	Hh
	h	Hh	Hh

Will any of their children have red hair?

Answer = NO. All of the genotypes in the punnett square result in brown hair.

Problem 2:

Shane's genotype = AO

Sharon's genotype = BO

Sharon

		B	O
Shane	A	AB	AO
	O	BO	OO

Answer = Four different genotypes (AB, AO, BO and OO) and four different blood types (Type AB, Type A, Type B, and Type O)

Problem 4:

Parents:

Mark

Phenotype = brown eyes
Genotype = Bb

Elizabeth

Phenotype = brown eyes
Genotype = Bb

Children:

Travis

Phenotype = blue eyes
Genotype = bb

Jacob

Phenotype = brown eyes
Genotype = BB or Bb

Elizabeth

		B	b
Mark	B	BB	Bb
	b	Bb	bb

Practice with Blood Types.

1. AA, AO
2. AO
3. OO

4. BB, BO

5. AB

5a. Type AB blood*

*NOTE: Be sure to write out the physical trait, in this case, blood type

Problem 5

Jenna's genotype = BB
Jenna's phenotype = Type B blood

Gerald's genotype = AA
Gerald's phenotype = Type A Blood

		Jenna	
		B	B
Gerald	A	AB	AB
	A	AB	AB

Genotype of children = AB

Phenotype of children = Type AB blood (Write out the physical trait, in this case, blood type—not just the alleles)
