Name:

Analyzing Inheritance of Traits Using Punnett Squares and Pedigrees

Part I: Genetics Vocabulary

WORD BANK

Homozygous
Heterozygous
Genotype
Phenotype
Recessive
Dominant
Alleles

Use the word bank to complete the sentences below.

1. _____ is the *physical, observable trait* that a person exhibits based on the combination of his or her genes.
2. _____ is the *genetic make-up* (instructions) of an individual, which includes alleles (instructions) from the person's mom and dad. For example, a person could have "BB", "Bb" or "bb".
3. _____ are the *genetic instructions* for a particular trait. A person gets two alleles for every single trait—one from mom and one from dad. In genetics, we represent these using a letter—either a capital letter (B) for a dominant trait or a lower case letter (b) for a recessive trait.
4. A _____ allele (trait) is one that *dominates other alleles*. Even if a person has just one copy of a dominant allele, his or her phenotype will show the dominant trait. We represent this allele with a capital letter (eg, "B").
5. A _____ allele (trait) is *dominated by* other alleles. In other words, unless a person has two copies of the recessive allele, it will not be strong enough to influence his or her phenotype. We represent this allele with a lower case letter (eg, "b").
6. A _____ genotype is when a person's two alleles (genetic instructions from mom and from dad) for a trait are *identical (the same)*—for example, "BB" or "bb".
7. A _____ genotype is when a person's two alleles (genetic instructions from mom and from dad) for a trait are *different*—for example, "Bb".

Match the vocabulary word with the image/example that best shows the word's meaning. Fill in the letter for the image next to the word.

8. ____ homozygous
9. ____ dominant
10. ____ alleles
11. ____ recessive
12. ____ genotype
13. ____ phenotype
14. ____ heterozygous

a. B
b. b
c. Bb
d. BB
e. BB, Bb or bb
f. B or b
g.  (eye color)

Describe each of the genotypes below. The first two have been completed for you as examples.

15. DD *homozygous, dominant*
16. Dd *heterozygous*
17. dd _____
18. ss _____
19. Yy _____
20. WW _____

Determine the phenotype:
In humans, brown eye color (B), is dominant over blue eye color (b). What are the Phenotypes for each of the following genotypes? (In other words, what color eyes will they have?)

21. BB _____

22. bb _____

23. Bb _____

Part 2: Solving Genetics Problems with Punnett Squares

Punnett Squares are a tool that scientists use to predict the *genotype* and *phenotype* of offspring (kids) produced by a mom and dad. From a Punnett Square, you can determine the probability (aka, likelihood) that offspring will show a specific Phenotype (physical trait).

24. Review how to create Punnett Squares by watching the following video:

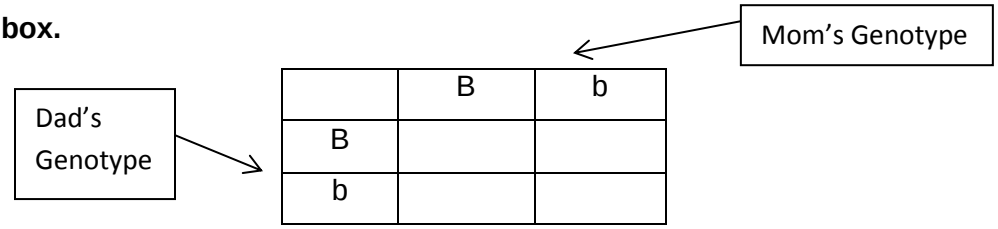
https://www.youtube.com/watch?v=prkHKjfUmMs

25. Read the following steps, then use them to answer questions 26-30. (You might want to take notes on these in your notebook).

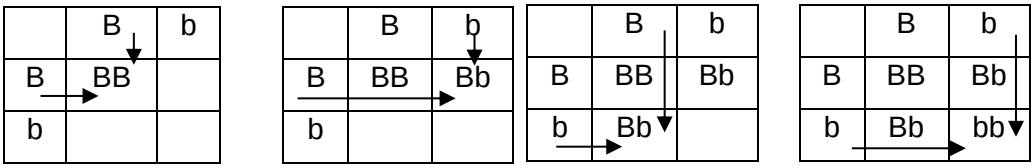
5 Steps for using Punnett Squares to predict the phenotype of offspring

I. Identify the Genotype of both parents.

II. Set-up the Punnett Square with the parents' genotypes on the top and side of the box.



III. Fill in each of the empty squares with the combination of mom and dad's alleles that could occur when the dad's sperm (with just one allele) fertilizes the mom's egg (with just one allele) during sexual reproduction.



IV. Determine the probability for each Genotype. Each square represents 25% of the offspring.

For example, for the trait represented in the Punnett Square above:

25% of offspring are BB (homozygous dominant)

50% of offspring are Bb (heterozygous)

25% of offspring are bb (homozygous recessive)

V. Use the probability of each Genotype to determine the probability of each Phenotype.

Any of the offspring with a dominant allele (B) will show that phenotype. For example, if B represents brown eyes and b represents blue eyes, then all offspring a B in their genotype (BB or Bb) will have brown eyes. Only offspring with homozygous recessive (bb) will have blue eyes.

BB = 25% offspring = Brown eyes
Bb = 50% offspring = Brown eyes
bb = 25% offspring = Blue eyes

So…. 75% of offspring will have Brown eyes
25% of offspring will have Blue eyes

Punnett Square Practice Problems:

26. A heterozygous male, black eyed mouse (Bb) is crossed with a red eyed, female mouse (bb). Black eyes are dominant.

a. What percentage of their offspring will have black eyes?

b. What percentage of their offspring will have red eyes?

27. A homozygous rabbit with straight ears (SS) is mated with a homozygous rabbit with floppy ears (ss). Straight ears are dominant.

a. What percentage of their offspring that will have floppy ears?

b. What kinds of rabbits would have to be mated in order to get offspring with floppy ears?

28. In humans, Dwarfism is dominant (D) over normal-height (d), however, homozygous dominant (DD) individuals die just after birth. If a heterozygous Dwarf (Dd) marries a normal-heighted woman (dd) and has kids.

a. What is the probability of having a normal child?

b. What is the probability of having a child that is a dwarf?

c. What is the probability of having a child that dies just after birth?

29. In humans, widow's peak (W) is dominant over straight hairline (w). A heterozygous man for this trait marries a woman who is also heterozygous.

a. What are the possible genotypes for their kids?

b. What percentage of their kids will have widow's peak?

c. What percentage of their kids will have straight hairline?

30. In humans, free earlobes (F) are dominant over attached earlobes (f). If one parent is homozygous dominant for free earlobes, while the other has attached earlobes, can they produce any children with attached earlobes?

Part 3: Connecting Pedigrees and Punnett Squares

During our genetic disorders project, we used Pedigrees to track Phenotypes in a family. We now know how to use Punnett Squares to predict Genotypes in families. We can use these tools together to better understand inheritance patterns of traits and diseases within families.

31. In mice, white hair (W) is dominant over brown hair (w). Two heterozygous mice are mated and have offspring.

a. Create a Punnett Square to show the probability of hair color for their offspring.

i. What percentage of offspring will have white hair?

ii. What percentage of offspring will have brown hair?

b. Create a Pedigree that shows the parents and their FOUR kids (you can decide if their kids are boys or girls). In the Pedigree, indicate the individuals with BROWN hair by coloring in his/her square or box.

Pedigree:

32. In dogs, black noses (B) are dominant over pink noses (b). A homozygous black-nosed dog has puppies with a heterozygous black-nosed dog.

a. Create a Punnett Square to show the probability nose color in their offspring.

i. What percentage of offspring will have black noses?

ii. What percentage of offspring will have pink noses?

b. The dogs have four puppies. Create a pedigree that indicates which dogs have PINK noses by coloring in those individuals.

Pedigree:

33. In humans, Sickle Cell Disease is a genetic disorder caused by a mutation in the hemoglobin gene. Normal individuals have Round Cells (R), which is a dominant trait. Individuals with the disease have sickle-shaped cells (r), which is a recessive trait. Individuals that are heterozygous for Sickle Cell disease have resistance to malaria, an infectious disease common to Africa.

a) Create a Punnett Square that shows the possible offspring produced by two individuals who are heterozygous for the trait.

i. What percentage of the offspring could have Sickle Cell disease?

ii. What percentage of the offspring could be healthy?

iii. What percentage of the offspring could be resistant to malaria?

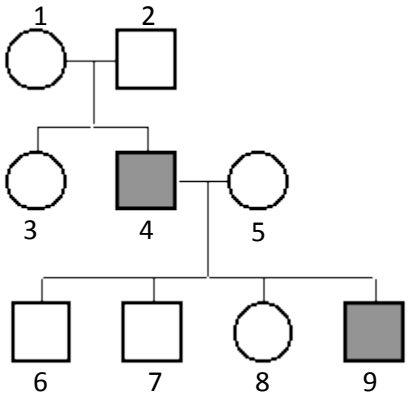
b) The heterozygous parents have 4 kids. Create a Pedigree that shows which individuals in the family have the disease by coloring in their box or circle. If a person is a "Carrier" of the disease (meaning they are homozygous and "carry" the recessive allele), fill in half of their box or circle.

Pedigree:

Part 5: Determining Genotypes from Pedigrees

In the previous section, we used the genotypes from Punnett Squares to determine the phenotypes for Pedigrees. Here, we will use a family's Pedigree to determine possible genotypes of family members.

34. The following pedigree shows the individuals in a family who exhibit curly hair, a recessive trait.

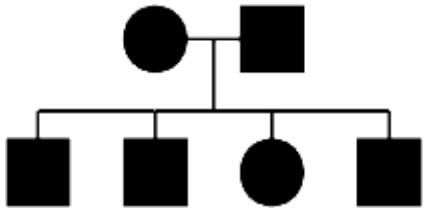


a. What is the genotype of individual 4?

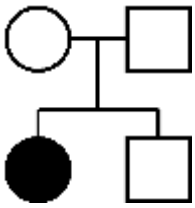
b. What genotype do individual 4's parents (individuals 1 & 2) have to have in order for this person to have curly hair? How do you know?

c. In order for individual 9 to have curly hair (homozygous recessive), what genotype does individual 4's wife (aka individual 5) have to have?

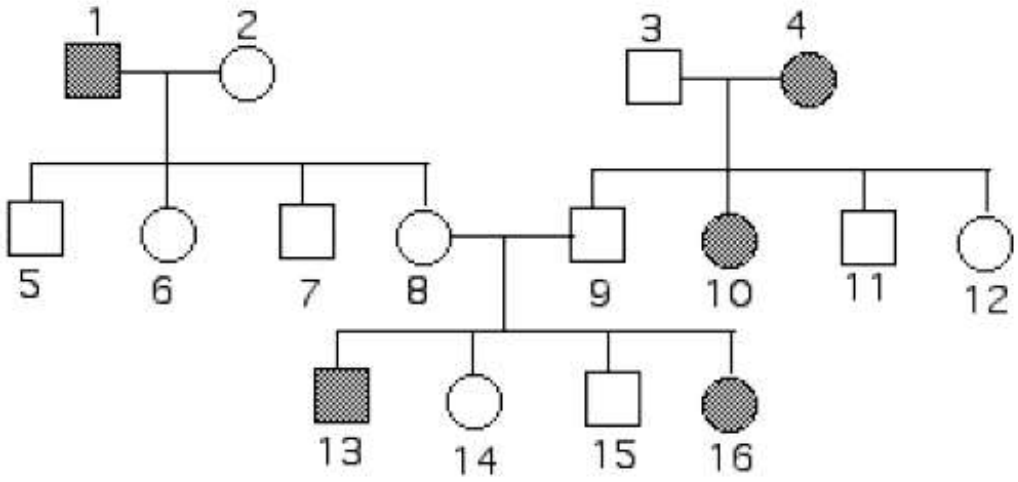
35. The pedigree below shows the individuals in a family who have rounded noses, a dominant trait. If the mom is heterozygous, what genotype does the dad have to have in order for all of their kids to have rounded noses? Explain your reasoning.



36. The pedigree below shows individuals (shaded in) with curly armpit hair. Is it possible for this trait to be dominant? Explain your reasoning.



37. The pedigree below shows the eye color of individuals within a family. Brown eyes are a dominant trait. Individuals with blue eyes are shaded in. Using the information in the pedigree, determine the possible genotypes of EVERY individual and write the genotype above or below each person's symbol.



EXTRA CREDIT:

38. Hemophilia is a genetic bleeding disorder caused by an X-linked recessive trait, which means the gene is located on the X-chromosome. In order for women to get the disease, they must be homozygous recessive. However, because men only have 1 X-chromosome, they will get the disease if the copy they get from their mom is recessive. Determine the genotypes of each individual on the Pedigree below and list it underneath each person's symbol.