Genetics Punnett Square Review Questions Work booklet Name: _____

There are several types of questions that involve the use of Punnett Squares in this unit. Here's the break down or summary of those problems.

1st Type – basic vocabulary and setting up Punnett Squares:

Describe the genotypes given (use your notes). The first two are already done.

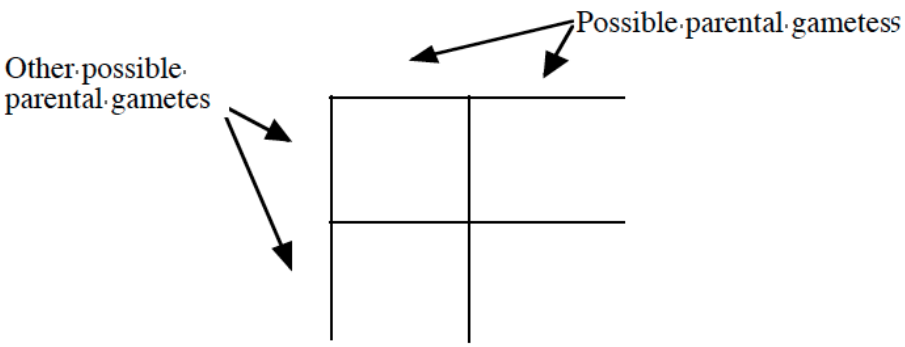
A. DD homozygous, dominant
B. Dd _heterozygous
C. dd _____
D. ss _____
E. Yy _____
F. WW _____

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

A. BB _____
B. bb _____
C. Bb _____

The Five (5) Steps Associated With Solving a Genetics Problem:
If you take the time to follow the directions below, you will be able to solve most genetics problems.

1. **Determine** the **genotypes** of the parents or whatever is given in problem.
2. Set up your **Punnett square** as follows: *# sq. based on possible gametes that can be formed.



3. **Fill in** the squares. This represents the possible combinations that could occur during fertilization.
4. **Write out** the possible **genotypic ratio** of the offspring.
5. **Using** the **genotypic** ratio determine the phenotypic ratio for the offspring.

Question 1: A heterozygous male, black eyed mouse is crossed with a red eyed, female mouse. Predict the possible offspring.

Question 2: A heterozygous, smooth pea pod, plant is crossed with a wrinkled pea pod plant. There are two alleles for pea pod, smooth and wrinkled. Predict the offspring from this cross.

a. What is the the genotype of the parents? _____

b. Set up a Punnett square with possible gametes.

c. What is the predicted genotypic ratio for the offspring ?_____

d. What is the predicted phenotypic ratio for the offspring ?_____

e. If this cross produced 50 seeds how many would you predict to have a wrinkled pod?

Question 3: In humans, *acondroplasia* "*dwarfism*" (D) is dominant over normal (d). A homozygous dominant (DD) person dies before the age of one. A heterozygous (Dd) person is dwarfed. A homozygous recessive individual is normal. A heterozygous dwarf man marries a dwarf heterozygous woman.

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

b. What is the probability that the next child will also be normal? _____

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

d. What is the probability of having a child that dies at one from this disorder? _____

Question 4: In humans, free earlobes (F) is 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?

Question 5: 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.

2nd Type – working backwards to figure out parents' genotypes:

Sometimes we only know about the offspring and we want to learn about the parents. If you have been paying attention, you should have started to notice a pattern. For example, when both parents are heterozygous the phenotypic ratio always comes out 3 to 1. If one parent is homozygous recessive and the other is heterozygous, the phenotypic ratio always comes out 1 to 1. Keeping this in mind see if you can solve the next two problems.

Question 1: In pea plants, yellow seeds (Y) are dominant and green seeds (y) are recessive. A pea plant with yellow seeds is crossed with a pea plant with green seeds. The resulting offspring have about equal numbers of yellow and green seeded plants. What are the genotypes of the parents?

Question 2: In another cross, a yellow seeded plant was crossed with another yellow seeded plant and it produced offspring of which about 25% were green seeded plants.
What are the genotypes of both parents?

3rd Type – test cross to figure out what genotype you have

When an organism has the dominant phenotype, then its genotype can be either heterozygous or homozygous dominant (you can't tell by looking at it). In order to find out we must do a test cross using an homozygous, recessive organism.

For example: In Dalmatian dogs, the gene for black spots is dominant to the gene for liver colored spots. If a breeder has a black spotted dog, how can she find out whether it is homozygous(BB) or heterozygous(Bb) spotted dog? *B = black spots and b = liver spots

If the breeder finds a black spotted dog, whose ancestry is not known, she cannot tell by looking at the dog if it is BB or Bb. She should find a liver spotted dog, whose genotype must be "bb" and mate it with the black spotted dog in question.

Setup the 2 different combinations of Punnett square of your test cross with the homozygous recessive (bb):

Test cross 1: BB with bb

Test cross 2: Bb with bb

If any of the breed offspring has liver spots, then she can say that she had a heterozygous black spotted dog. If all the offspring had black spots then she can say that the suspect dog was homozygous.

Why is this?

Question 1: You found a wild, black mouse. Explain how you would determine the genotype of this mouse. White fur is recessive:

1. Draw Punnett squares for your possible crosses.

2. You have 24 offspring, 23 with black fur and 1 with white fur. What was the genotype of mouse?

3. If you only had 3 black offspring, can you tell what the genotype was of the suspect mouse? Explain why or why not.

4th Type – With Blood types

In humans, there are four types of blood; type A, type B, type AB, and type O. The alleles A and B are codominant to each other and the O allele is recessive to both A and B alleles. So a person with the genotype AA or AO will have A type of blood.

a. What possible genotypes will produce B type of blood? _____

b. What is the only genotype that will produce O type of blood? _____

c. What is the only genotype that will produce AB type of blood? _____

Question 1: You are blood type O and you marry a person with blood type AB.

a. Complete the Punnett Square for this cross

b. List the possible blood types of your offspring:

Question 2: In the 1950's, a young woman sued film star/director Charlie Chaplin for parental support of her illegitimate child. Charlie Chaplin's blood type was already on record as type AB. The mother of the child had type A and her son had type O blood.

a. Complete a Punnett square for the possible cross of Charlie and the mother.

b. The judge ruled in favor of the mother and ordered Charlie Chaplin to pay child support costs of the child. Was the judge correct in his decision based on blood typing evidence? Explain why or why not. ***refer to any Punnett squares to support your answer**

Question 3: Suppose a newborn baby was accidentally mixed up in the hospital. In an effort to determine the parents of the baby, the blood types of the baby and two sets of parents were determined.

Baby 1 had type O
Mrs. Brown had type B
Mr. Brown had type AB
Mrs. Smith had type B
Mr. Smith had type B

a. Draw Punnett squares for each couple (you may need to do more than 1 square/ couple)

b. To which parents does baby #1 belong? Why? Hint you may want to refer to your Punnett squares.

5th Type – Sex linked traits

As many of you know boys are different than girls. In humans sex is determine by the twenty third pair of chromosomes known as "sex chromosomes". If you have two x-shaped (XX) chromosomes you are destined to be a female. If you have an x and a Y-shaped (XY) chromosomes you are destined to be a male. Since the X and Y chromosomes carry different information, any genes found on the X chromosomes are referred to as sex-linked genes. Therefore, women will have two alleles for these genes because they have two (XX) chromosomes. On the other hand, men have only one allele for each of these genes because they have only one X chromosome (XY). This is clearly a violation of Mendel's Principle of Unit Characteristics, which implies that you receive one set of alleles from each parent.

Example 1: In fruit flies, the gene for eye color is carried on the X chromosome which is a sex chromosome (sex-linked). The allele for red eyes is dominant over the allele for white eyes. If a white-eyed female fruit fly is mated with a red-eyed male, predict the possible offspring**.**

Step 1: Since the female has white eyes, she must be **"X^rX^r".** The male is red-eyed and because he has only one X chromosome, he has only one allele for eye color. His eyes are red so he must be X^{R}**Y.** means he only has one allele for eye color, so he must be **"X^RY".** Since the allele "R" is present on the X chromosome only, and there is no other allele for eye color because the male other sex chromosome is a Y chromosome.

Step 2: For sex-linked traits we need to list the genotype in a different fashion. We must identify the individual as being male or female according to their sex chromosomes. Females are XX, and males are XY. Sex-linked traits are only found on the X chromosome, therefore the letters are placed as superscripts (above) the X chromosome. Therefore the genotype for the female fly is X^rX^r and the male is X^RY. You can use shorthand notation rr x RY, but sometimes this can be confusing.

Step 3: The Punnett Square setup is:

	X^R	Y
X^r	X^RX^r	X^r Y
X^r	X^RX^r	X^r Y

Therefore, The genotypic ratio is 1 X^RX^r : 1 X^rY

The individual $\mathbf{X}_R\mathbf{X}_r$ will be a female because she has two **X** chromosomes. She will have red eyes because she has Rr. The individual with $\mathbf{X}^r$ Y will be a male because he has the **X** and **Y**chromosomes. He will have white eyes because he has only one allele and it is "r". So from this cross you would expect all of the females to have red eyes and all of the males to have white eyes.

Question 1:
Hemophilia is a sex-linked trait. A person with hemophilia is lacking certain proteins that are necessary for normal blood clotting. Hemophilia is caused by a recessive allele so use "N" for normal and "n" for hemophilia. Since hemophilia is sex-linked, remember a woman will have two alleles (NN or Nn or nn) but a man will have only one allele (N or n). A woman who is heterozygous (a carrier) for hemophilia marries a normal man:

a. What are the genotypes of the parents?

b. Setup the Punnett Square of the cross above:

c. What is the probability that a male offspring will have hemophilia? _____

d. What is the probability of having a hemophiliac female offspring? _____

Question 2: Can a color blind female have a son that has normal vision? Color blindness is caused by a sex linked recessive allele. *use N = normal vision and n = color blind

Question 3: Baldness is a sex-linked trait. What parental genotypes could produce a bald woman? ***use H = normal hair, and h = bald**

Question 4: In fruit flies, the gene for white eyes is sex-linked recessive. (R) is red and (r) is white. Cross a white-eyed female with a normal red-eyed male.

a. What percent of the males will have red eyes? White eyes?

b. What percent of the females will have red eyes? White eyes?

c. What **total percent** of the offspring will be white-eyed?

d. What **percent** of the offspring will be carriers of the white eye trait?

Question 5: In humans, hemophilia is a sex-linked recessive trait. If a female who is a carrier for hemophilia marries a male with normal blood clotting, answer the following questions.

a. What fraction of the female children will have hemophilia?

b. What fraction of the female children will be carriers?

c. What fraction of the male children will have normal blood clotting?

d. What fraction of the male children will be carriers?

e. What fraction of the male children will have hemophilia?

Question 6: A woman (whose father was red-green colour-blind) and a man with no history of colour-blindness in his family choose to have children. What is the chance that they will have children (of either gender) that are colour-blind?

Question 7: In cats, the allele (B) produces black color but (b) produces a yellow color. These alleles are incompletely dominant to each other. A heterozygote produces a tortoise shell color. The alleles (B) and (b) are sex-linked as well. Cross a tortoise shell female with a yellow male.

a. What percent of their offspring will be yellow?

b. What percent of their offspring will be black?

c. What percent of their offspring will be tortoise shell?

d. Why is it impossible to have a tortoise shell male offspring?

Question 8: A couple has four children, all of whom are boys. What is the chance that their next child will be another boy?

6th Type – Incomplete Dominance or Codominance

In Four o'clock flowers the alleles for flower color are both equal therefore *neither* dominates over the other. We call this condition **incomplete dominance** or **codominance** and it violates Mendel's principle of dominance. A red four o'clock flower (rr) is crossed with a white flower (ww). Since there is no dominant trait we use two different little letters for the genotype.

Question 1: In humans straight hair (ss) and curly hair (cc) are codominant traits, that result in hybrids who have wavy hair (sc). Cross a curly hair female with a wavy haired male.
What are the chances of having a curly haired child?

Question 2: Predict the offspring when two pink Four o'clock flowers are crossed. (Using the info from before)

a. Complete a Punnett square for this cross.

b. What is the predicted genotypic and phenotypic ratio for the offspring?

Other types : Dihybrid crosses and pedigree (separate sheet)