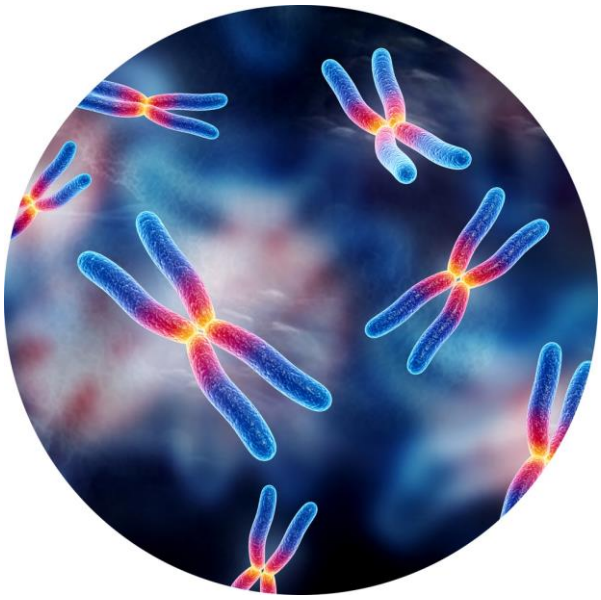
NAME:_____

Workbook

Unit 1 Genetics



Mendelian Principles Worksheet

1. For each of the diploid genotypes presented below, determine the genetic make up for all of the possible haploid gametes.
    a. Rr
    b. RrYy
    c. rrYy
    d. RrYY
    e. RrYyBb
    f. AABbCc

2. Use the Punnett square to determine all of the offspring genotypes (and their relative frequencies) from the following crosses:
    a. Rr x Rr
    b. Rr x rr
    c. RR x Rr

3. In the problem above, the "R" allele is a dominant allele specifying for round seeds (in peas), while the "r" allele is the recessive allele specifying for wrinkled seeds. Give the expected frequencies (as percentages or ratios) for the phenotypes of the offspring resulting from each of the crosses in #2 above.

4. In humans, brown eyes are dominant over blue eyes. A woman with blue eyes marries a man with brown eyes. This man's father had blue eyes.
    a. What would be the genotype of the man that married the blue-eyed woman?

    b. What would be the genotype of the blue-eyed woman?

    c. What are all the possible gametes related to eye color that could be produced from this man and woman?

    d. What will be the ratio of children with blue eyes from this marriage?

5. Would it make a difference to the question above, if the man had blue eyes and the woman had brown eyes, with the woman's father having blue eyes?

6. If a brown-eyed man marries a blue-eyed woman and they have ten children who all have brown eyes, what would the likely genotype of the father be? Can you be certain of the man's genotype?

7. If three of the children had blue eyes in the above question, what would be the genotype of the father? Can you be certain of the man's genotype?

8. Thalassemia is a type of human anemia controlled by a defective gene, t. The normal allele, T, produces hemoglobin normally. The disease occurs in two forms, minor and major. The major is more severe. Individuals with the major form are homozygous for the recessive allele and individuals with the minor form are heterozygous.
    a. Show the expected offspring between two parents, both of whom have thalassemia minor.

    b. Draw a Punnett square to support your answer.

Genotype/Phenotype Punnett Squares

For the following crosses, complete a Punnett square and determine (with a ratio) the possible phenotypes and genotypes of the resulting offspring.

Cross	Punnett Square	Resulting Genotype and Phenotype and Ratios
BB x bb		
Bb x Bb		
Blue eye (recessive) x Brown eye (dominant)		
Brown hair (homozygous) x Brown hair (heterozygous)		
Purple flower (dominant) x White flower (recessive)		
Wrinkled peas (recessive) x Smooth peas (heterozygous)		

Curly hair (dominant) x Straight hair (recessive)		
Curly hair (heterozygous) x Curly hair (heterozygous)		
Brown eyes (homozygous) x Blue eyes (homozygous)		
detached earlobes (heterozygous) x detached earlobes (heterozygous)		

Monohybrid Problems

In fruit flies, red eyes are dominant and white eyes are recessive (R-red eye allele, r-white eye allele). Use this information to answer the following questions.

1. Homozygous recessive fly crossed with a heterozygous fly.
    a. What fraction of the F1 flies will be homozygous dominant? _____
    b. What fraction of the F1 flies will be red eyed? _____
    c. What fraction of the F1 flies will be heterozygous? _____
    d. Determine the F1 genotypic ratio. _____

2. Two heterozygous flies are crossed.
    a. What fraction of the F1 flies will be white eyed? _____
    b. What fraction of the F1 flies will be heterozygous? _____
    c. What fraction of the F1 flies will be red eyed? _____
    d. Determine the F1 phenotypic ratio. _____

3. Homozygous dominant fly is crossed with a heterozygous fly.
    a. What fraction of the F1 flies will be white eyed? _____
    b. What fraction of the F1 flies will be heterozygous? _____
    c. What fraction of the F1 flies will be red eyed? _____
    d. Determine the F1 genotypic ratio. _____
    e. Determine the F1 phenotypic ratio. _____

4. The F1 generation consists of 50% hetero. Flies but all the F1 flies have the same eye colour. Determine the most likely monohybrid or parental cross that would produce this F1 generation. _____

In pea plants, yellow pods are dominant to green pods (Y-yellow pods, y-green pods). Use this information to answer the following questions.

5. The F1 generation consists of 25% green pod pea plants. Also, 25% of the F1 plants are homozygous dominant. Determine the most likely monohybrid or parental cross that would produce this F1 generation. _____

6. 50% of the F1 generation consists of plants with green pods. Determine the most likely monohybrid or parental cross that would produce this F1 generation. _____

7. In pea plants, yellow pods are dominant to green pods. Two yellow pod plants are crossed, and the result is an F1 generation in which the genotypic ratio is 2:2:0. What is the most likely parental cross?_____

8. In another experiment, a heterozygous plant is crossed with a green pod plant.

    a. Determine the F1 genotypic ratio. _____
    b. Determine the F1 phenotypic ratio. _____
    c. If there are 30 F1 pea plants, how many should be:
        i. Yellow pod _____
        ii. Homozygous dominant _____
        iii. Heterozygous _____
        iv. Green pod _____

9. In fruit flies, grey body colour is dominant to black body colour. Answer each of the following:
    a. If the parental cross is *Gg x Gg*, the F1 phenotypic ratio = _____
    b. If the parental cross is *GG x gg*, the F1 genotypic ratio = _____
    c. If the parental cross is *Gg x Gg*, and there are 24 F1 flies, _____ of these flies would likely be grey bodied and _____ would be heterozygous.
    d. If the parental cross is *Gg x gg*, and there are 35 F1 flies, _____ would likely be black bodied.

10. In fruit flies, red eyes are dominant to white eyes. Which parental cross(es) would most likely produce each of the following F1 generations?
    a. 25 red eyed, 21 white eyed _____
    b. 17 white eyed _____
    c. 32 red eyed, of which 17 are heterozygous _____
    d. 22 red eyed, 8 white eyed _____
    e. All red eyed (both parents are red eyed) _____

Genetics Problems 1

1. For each of the diploid genotypes presented below, determine the genetic make up for all of the possible haploid gametes.

    a. AA

    b. Aa

    c. AaBBCC

    d. AABbCCdd

2. In humans, long eyelashes are dominant; short eyelashes are recessive. A woman with long eyelashes and a man with long eyelashes have four children. One child has short eyelashes; the others have long eyelashes.
    a. List the probable genotypes of the parents.

    b. List the probable genotypes of the children.

3. Peas may have yellow or green seeds. A cross between a green seed plant and a yellow seed plant (P generation) produced all yellow seeds in the F1 generation.
    a. Identify the genotypes of the P generation.

    b. What would the phenotype ratio of yellow seeds to green seeds be if one plant from the F1 was crossed with the yellow seed plant from the P generation?

4. In cattle, polled (hornless) is dominant to horned. If a breeder of purebred cattle, all of which are polled, suspects that her recently purchased prize bull is heterozygous for the horned allele, how might she determine whether her suspicion is correct?

5. Cystic fibrosis is a recessive genetic disorder affecting 1 in every 2500 children born in Canada. A child with the disorder is born to a couple who show no symptoms of the disease.
    a. List the genotypes of the parents and the child.

    b. What is the chance that the next child the couple has will be a carrier of the disease?

6. In rabbits, black color is due to a dominant gene (B), and brown color to a recessive gene (b). Short hair is due to the dominant gene (S), and long hair to its recessive allele (s). A homozygous black, long-haired rabbit and a homozygous brown, short-haired rabbit are crossed.
    a. What would be the genotype of the F1 generation?

    b. What would be the phenotype of the F1 generation?

    c. If one of the F1 rabbits was mated with a brown, long-haired rabbit, predict the phenotype and genotype ratios of the offspring.

Test Cross Worksheet

Determine the unknown genotype of an organism given the F1 generations phenotypes by performing a test cross with a homozygous recessive individual.
Black = dominant (B), brown = recessive (b)

1. All F1 generation offspring are black.

2. Half F1 generation offspring are black and half F1 generation offspring are brown.

3. All F1 offspring are brown.

Dihybrid Crosses

Complete the following Punnett squares and answer the corresponding questions for humans. USE BOTH METHODS IN YOUR CALCULATIONS.

1. For humans, freckles and broad noses are dominant to no freckles and narrow noses. Use the Punnett square below to determine the possible offspring from a cross between two heterozygous freckled broad nose people.

   METHOD 1: Large Punnett Square

   METHOD 2: Two Punnett Squares/Multiply Fractions

Genotypes: _____

Phenotypes:_____

Phenotypic Ratios: _____

2. For humans, large eyes and nearsightedness are dominant to small eyes and normal vision. Use the Punnett square below to determine the possible offspring from a cross between a person who is homozygous dominant for both traits and homozygous recessive for both traits. Mate one offspring from the F1 generation with a person who is homozygous recessive for both traits.

   METHOD 1: Large Punnett Square

F1

F2

F2 Phenotypic Ratios:_____

METHOD 2: Two Punnett Squares/
Multiply Fractions

3. Explain how the two-trait Punnett square demonstrates the law of independent assortment.

_____

_____

Dihybrid Worksheet

In fruit flies, red eyes (R) are dominant to white eyes (r). Also, grey body (G) is dominant to black body (g). And long wings (L) are dominant to short (l).

1. A male fly which is homozygous dominant for body colour and is short winged is crossed with a female which is heterozygous for both traits.
    a. Determine the F1 phenotypic ratio.

    b. If this cross results in an F1 generation with 28 offspring, how many should be grey bodied/short winged?

2. A male fly which is homozygous dominant for both traits is crossed with a female fly which is homozygous recessive for both traits.
    a. Determine the F1 phenotypic ratio.

    b. Determine the F2 phenotypic ratio.

    c. If the F2 generation consists of 36 flies, how many should be:
        i. Grey/long

        ii. Black/long

    d. Suppose an F1 male fly is backcrossed with the female parent. Determine the phenotypic ratio of the backcross generation.

    e. If the backcross generation consists of 40 offspring, how many should be black/short?

3. A male fly which is heterozygous for both eye colour and body colour is crossed with a female which is homozygous recessive for eye colour and heterozygous for body colour.
    a. Determine the F1 phenotypic ratio.

    b. If there are 25 F1 offspring, how many should be white/grey?

    c. If a white-eyed/black bodied male is back crossed with the female parent, determine the phenotypic ratio of the back cross generation.

4. Two flies are crossed and the F1 generation consists of 14 red/long, 13 red/short, 4 white/long, 5 white/short. Determine the most likely parent cross(es).

5. Two flies are crossed and the F1 generation consists of 23 red/long and 8 white/long. Determine the most likely parental cross(es).

Co-Dominance and Incomplete Dominance Worksheet

1. Practice setting up keys for the phenotypes listed in each set. Remember that the "medium" trait must always be heterozygous.
   a. Birds can be blue, white, or white with blue-tipped feathers.

   b. Flowers can be white, pink, or red.

   c. A Hoo can gave curly hair, spiked hair, or a mix of both curly and spiked.

   d. A Sneech can be tall, medium, or short.

   e. A Bleexo can be spotted, black, or white.

2. Now, can you figure out in the above list, which of the letters represent codominant traits and which are incomplete.
   Codominant _____ Incomplete _____

SpongeBob loves growing flowers for his pal Sandy! Her favorite flowers, Poofkins, are found in red, blue, and purple. Use the information provided and your knowledge of incomplete dominance to complete each section below.

3. Write the correct genotype for each color if R represents a red gene and B represents a blue gene.
   Red - _____ Blue - _____ Purple - _____

4. What would happen if SpongeBob crossed a Poofkin with red flowers with a Poofkin with blue flowers? Complete the Punnett square to determine the chances of each flower color.

   a. Give the genotypes and phenotypes for the offspring.
   b. How many of the plants would have red flowers? _____%
   c. How many of the plants would gave purple flowers? _____%
   d. How many of the plants would have blue flowers? _____%

5. What would happen if SpongeBob crossed two Poofkins with purple flowers? Complete the punnett square to show the probability for each flower color.

   a. Give the genotypes and phenotypes for the offspring.
   b. How many of the plants would have red flowers? _____%
   c. How many of the plants would have purple flowers? _____%
   d. How many of the plants would have blue flowers? _____%

6. What would happen if SpongeBob crossed a Poofkin with purple flowers with a Poofkin with blue flowers? Complete the Punnett square to show the probability for plants with each flower colour.

   a. Give the genotypes and phenotypes for the offspring.

   b. If SpongeBob planted 100 seeds from this cross, how many should he expect to have of each color?
      Purple flowers - _____ Blue flowers - _____
      Red flowers - _____

7. A cross between a black cat and a tan cat produces a tabby pattern (black and tan fur together).

   a. What pattern of inheritance does this illustrate?

   b. What percent of kittens would have black fur if a tabby cat is crossed with a black cat?

8. There are three genotypes and three phenotypes possible for the color of wings for a butterfly species.
   RR = red RY =orange YY = yellow

   Use a Punnett square to answer the following questions:

   a) What is the inheritance pattern?

   b) What are the genotypes and phenotypes of parents if one crosses a red butterfly and an orange butterfly?

   c) What percentage of offspring have red wings? Orange? Yellow?

   d) Suppose that parents produce 1200 descendants. How many will have orange wings?

   e) Suppose the 1200 descendants, 950 have orange wings. Is it possible? Why?

9. In a fictional species of mice, a gene determines the color of fur.
   B = black W= white. A black mouse was bred with a white mouse. Use a Punnett square to answer questions.
   a) True or False. The descendants will have a variety of phenotypes.

   b) Suppose the alleles show incomplete dominance. What would you expect that the offspring look like?

   c) Suppose the alleles demonstrate co-dominance. What would you expect that the offspring look like? Explain your answer.

Genetics Problems 2

1. In radish plants, the shape of the radish produced may be long, round, or oval. Crosses among plants that produced oval radishes yielded 121 plants that produced long radishes, 243 plants that produced oval radishes, and 119 plants that produced round radishes.
    a. What type of inheritance appears to be involved? Explain your logic.
    b. What results would you expect from a cross between two long radishes?
    c. What results would you expect from a cross between two round radishes?

2. In crosses between two crested ducks, only about three-quarters of the eggs hatch. The embryos in the remaining one-quarter of the eggs develop nearly to hatching, and then die. Of the ducks that do hatch, about two-thirds are crested and one-third have no crest.
    a. What type of inheritance pattern appears to be involved? Explain.
    b. If a crested and non-crested duck were crossed, what phenotypic ratio would you expect in the ducklings? What genotypic ratio would you expect?

3. In certain cattle, the hair color can be red (homozygous RR), white (homozygous WW), or roan, a mix of red and white hair (heterozygous RW).
    a. When a red bull is mated with a white cow, what genotypes and phenotypes of offspring could result?
    b. If one of these offspring is mated to a white cow, what genotypes and phenotypes of offspring could be produced? In what proportion?

Multiple Alleles Worksheet

In humans, there are 4 types of blood; A, B, AB, and O. The alleles A and B are co-dominant to each other and the O allele is recessive to both A and B alleles. So, a person with genotype AA or AO will have type A blood.

1. What possible genotypes will produce type B blood?

2. What is the only genotype that will produce type O blood?

3. What is the only genotype that will produce type AB blood?

4. You are blood type O and you marry a person with blood type AB.
    a. Complete a Punnett square for this cross.
    b. List the possible blood types (phenotypes) of your offspring.

5. 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.*

6. 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. The baby had type O, Mrs. Brown had type B, and 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?
    **refer to your Punnett squares to support your answer.*

Epistasis Worksheet

1. In mice, the allele A, causes agouti colored hair, and is dominant to the allele a, so that aa mice are solid black. The allele C causes color and is dominant to c, and cc mice are albinos. When a mouse is albino, its color cannot be shown. Heterozygous CcAa mice are crossed to ccaa mice. What will the phenotypic ratios be in the progeny?
    a. 2 agouti: 1 black: 1 albino
    b. 1 agouti: 2 black: 1 albino
    c. 1 agouti: 1 black: 2 albino
    d. 1 agouti: 1 albino

2. In the summer squash a dominant allele, W, and colored fruit control white fruit by its recessive, w. In ww plants the color alleles (Y for yellow fruit, are dominant to y for green fruit) are expressed.

    In this problem, plants must be recessive at the W locus (ww) to show color. wwY_ = yellow fruit and wwyy = green fruit.
    a. What is the phenotype of the F1 of a white plant of genotype WWyy crossed with a homozygous yellow plant?

b. What ratio is expected in the F2? What type of interaction is involved?

c. A cross between a plant with yellow fruit and a plant with white fruit produced 58 white: 39 yellow: 16 green. What are the genotypes of the parents?

Genetics Problems 3

1. A couple has four children, all of whom are boys. What is the chance that their next child will be a girl?

2. Duchenne muscular dystrophy (DMD) is a recessive sex-linked disorder. A man and a woman who are both free of the disorder have two children. Their elder son develops DMD, while their younger son is free of the disorder.
    a. Determine the genotypes of the parents.
    b. Determine the genotypes of the children.

3. A woman (whose father was red-green colour-blind) and a man with no history of colour-blindness in his family plan to start a family. What is the chance that they will have children who are colour-blind?

4. Given the following data, determine the inheritance pattern of black, orange, and calico coat colour in cats.
   Hints: Male cats are XY and female cats are XX. Calico is a mix of orange and black fur.

Cross Parents	***Offspring***
#1 black male x orange female	1 orange male : 1 calico female
#2 orange male x black female	1 black male : 1 calico female
#3 orange male x calico female	1 black male : 1 orange male : 1 orange female : 1 calico female

5. A hemophiliac woman marries a normal man. None of their children is a hemophiliac. A daughter marries a normal man whose father had hemophilia. What are the odds that this couple had normal children?

6. In Drosophila, eye color is related to sex. White eyes are recessive, red eyes are dominant.

   a) If a female with white eyes is crossed with a male with red eyes what are the phenotypic and genotypic ratio?

   b) If a female homozygous for red eyes is crossed with a male with white eyes what are the phenotypic and genotypic ratio?

   c) If a female heterozygous for red eyes is crossed with a male with white eyes what are the phenotypic and genotypic ratio?