Genetics: The Science of Heredity

Part A

Mendel's Work
Probability and Heredity

Name _____ Date _____ Class _____

Mendel's Work (pp. 76–81)

This section describes how Gregor Mendel identified the method by which characteristics are passed from parents to their offspring.

Use Target Reading Skills

As you read, complete the outline about Mendel's work. Use the red headings for the main idea and the blue headings for the supporting ideas.

I. **Mendel's experiments**
   A. crossing pea plants
   B.
   C.
   D.
II.
   A.
   B.
   C.
   D.

Introduction (p. 76)

1. Gregor Mendel experimented with hundreds of pea plants to understand the process of _____.

Match the term with its definition.

Term	Definition
____ 2. heredity	a. The scientific study of heredity
____ 3. genetics	b. Physical characteristics
____ 4. traits	c. The passing of traits from parents to offspring

Mendel's Experiments (pp. 77–78)

5. In a flower, the female sex cells, or eggs, are produced by the _____. Pollen, which contains the male sex cells, is produced by the _____.

6. What are purebred organisms?

_____

_____

_____

Mendel's Work *(continued)*

7. Complete the flowchart below, which summarizes Mendel's first experiment with pea plants.

Mendel's Experiment

Purebred tall plants are crossed with purebred _____ plants.

↓

F_1 offspring are all _____.

↓

F_1 offspring are allowed to self-pollinate.

↓

F_2 offspring are _____ and _____.

8. Circle the letter of other traits in garden peas that Mendel studied.
   a. seed size, seed shape, seed color
   b. seed color, pod color, flower shape
   c. flower size, pod shape, seed coat color
   d. pod color, seed shape, flower position

9. Two forms of the trait of seed shape in pea plants are _____ and _____.

Dominant and Recessive Alleles (pp. 79–81)

10. Circle the letter of each sentence that is true about alleles.
    a. Recessive alleles are never present when dominant alleles are present.
    b. Alleles are different forms of a gene.
    c. A trait controlled by dominant alleles always shows up in the organism when the allele is present.
    d. Recessive alleles hide dominant alleles.

11. Is the following sentence true or false? Only pea plants that have two recessive alleles for short stems will be short. _____

Name _____ Date _____ Class _____

Match the pea plant with its combination of alleles.

Pea Plant	Combination of Alleles
____ 12. purebred short	a. Two alleles for tall stems
____ 13. purebred tall	b. One allele for tall stems and one allele for short stems
____ 14. hybrid tall	c. Two alleles for short stems

15. A dominant allele is represented by a(n) _____ letter.

16. A recessive allele is represented by a(n) _____ letter.

17. How would a geneticist write the alleles to show that a tall pea plant has one allele for tall stems and one allele for short stems?

_____

18. Is the following sentence true or false? Some scientists during Mendel's time thought Mendel should be called the Father of Genetics.

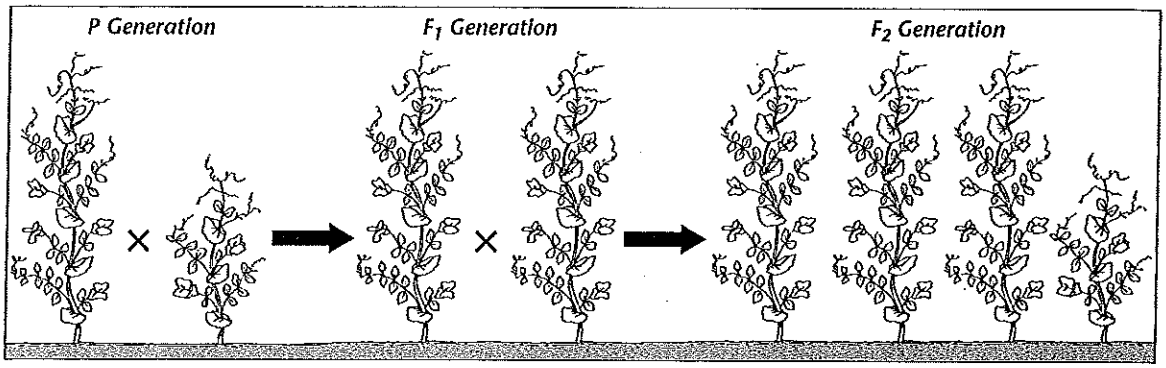
_____

Name _____ Date _____ Class _____

Mendel's Work

Understanding Main Ideas

Study the diagram. Then answer the following questions on a separate sheet of paper.



1. What trait in pea plants is being studied in the cross above?
2. What are the two alleles of this trait?
3. Which allele is the dominant allele? Explain how you know.
4. Which allele is the recessive allele? Explain.
5. What alleles do the F_1 offspring have? Explain which allele was inherited from which parent.

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term.

____ 6. genetics
____ 7. alleles
____ 8. traits
____ 9. recessive allele
____ 10. genes
____ 11. hybrid
____ 12. heredity
____ 13. dominant allele

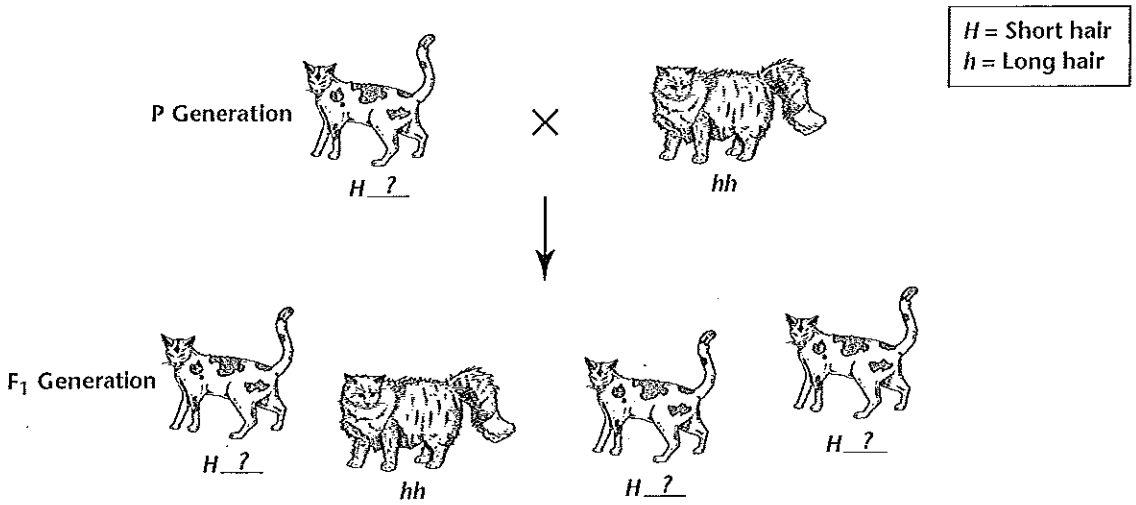
a. the passing of traits from parents to offspring
b. an organism with two different alleles for a trait
c. factors that control traits
d. physical characteristics of organisms
e. an allele whose trait always shows up in the organism
f. the different forms of a gene
g. the scientific study of heredity
h. an allele whose trait is masked in the presence of a dominant allele

Name _____ Date _____ Class _____

The Test Cross

When an organism has a trait controlled by a dominant allele, it can either be a hybrid or a purebred. To find out which, geneticists can use a test cross. In a test cross, the organism with the trait controlled by a dominant allele is crossed with an organism with a trait controlled by a recessive allele. If all offspring have the trait controlled by the dominant allele, then the parent is probably a purebred. If any offspring has the recessive trait, then the dominant parent is a hybrid. Study the test cross below and then answer the questions.

Test Cross



Answer the following questions on a separate sheet of paper.

1. Is the long-haired cat in the P generation a hybrid or a purebred? Explain your answer.
2. Is the short-haired cat in the P generation a hybrid or a purebred? Explain your answer.
3. If the short-haired cat in the P generation were purebred, what would you expect the offspring to look like?
4. In horses, the allele for a black coat (*B*) is dominant over the allele for a brown coat (*b*). A cross between a black horse and a brown horse produces a brown foal. Is the black horse a hybrid or a purebred? Explain.
5. In guinea pigs, the allele for a smooth coat (*S*) is dominant over the allele for a rough coat (*s*). Explain how you could find out whether a guinea pig with a smooth coat is a hybrid or a purebred.

Name _____ Date _____ Class _____

Genetics: The Science of Heredity ▪ *Skills Lab*

Take a Class Survey

Problem

Are traits controlled by dominant alleles more common than traits controlled by recessive alleles?

Skill Focus

developing hypotheses, interpreting data

Materials

mirror (optional)

Procedure

PART 1 Dominant and Recessive Alleles

1. Write a hypothesis reflecting your ideas about the problem question.

_____

_____

2. For each of the traits listed in the data table on the next page, work with a partner to determine which trait you have. Circle that trait in your data table.
3. Count the number of students in your class who have each trait. Record that number in your data table. Also record the total number of students.

PART 2 Are Your Traits Unique?

4. Look at the circle of traits in your text. All the traits in your data table appear in the circle. Place the eraser end of your pencil on the trait in the small central circle that applies to you—either free ear lobes or attached ear lobes.
5. Look at the two traits touching the space your eraser is on. Move your eraser onto the next description that applies to you. Continue using your eraser to trace your traits until you reach a number on the outside rim of the circle. Share that number with your classmates.

Name _____ Date _____ Class _____

Data Table				
Total Number or Students _____				
	Trait 1	*Number*	*Trait 2*	*Number*
A	*Free ear lobes*		*Attached ear lobes*	
B	*Hair on fingers*		*No hair on fingers*	
C	*Widow's peak*		*No widow's peak*	
D	*Curly hair*		*Straight hair*	
E	*Cleft chin*		*Smooth chin*	
F	*Smile dimples*		*No smile dimples*	

Analyze and Conclude

Write your answers in the spaces provided.

1. **Observing** The traits listed under Trait 1 in the data table are controlled by dominant alleles. The traits listed under Trait 2 are controlled by recessive alleles. Which traits controlled by dominant alleles were shown by a majority of students? Which traits controlled by recessive alleles were shown by a majority of students?

_____

_____

2. **Interpreting Data** How many students ended up on the same number on the circle of traits? How many students were the only ones to have their number? What do the results suggest about each person's combination of traits?

_____

_____

_____

3. **Developing Hypotheses** Do your data support the hypothesis you proposed in Step 1? Write an answer with examples.

_____

_____

_____

Name _____ Date _____ Class _____

Probability and Heredity (pp. 84–89)

This section explains what probability is and how the laws of probability can be used in the study of genetics.

Use Target Reading Skills

After you read the section, reread the paragraphs that contain definitions of Key Terms. Use all the information you have learned to write a definition of each Key Term in your own words. Write your definitions on a separate sheet of paper.

Principles of Probability (pp. 84–85)

1. A number that describes how likely it is that an event will occur is called _____.

2. Circle the letter of each answer that equals the probability that a tossed coin will land heads up.
   a. 1 in 2
   b. 1/2
   c. 50 percent
   d. 20 percent

3. Is the following sentence true or false? When you toss a coin 20 times, you will always get 10 heads and 10 tails. _____

4. If you toss a coin five times and it lands heads up each time, can you expect the coin to land heads up on the sixth toss? Explain.

_____

_____

Probability and Heredity *(continued)*

Probability and Genetics (pp. 86–87)

5. When Mendel crossed two hybrid plants for stem height (Tt), what results did he always get?

_____

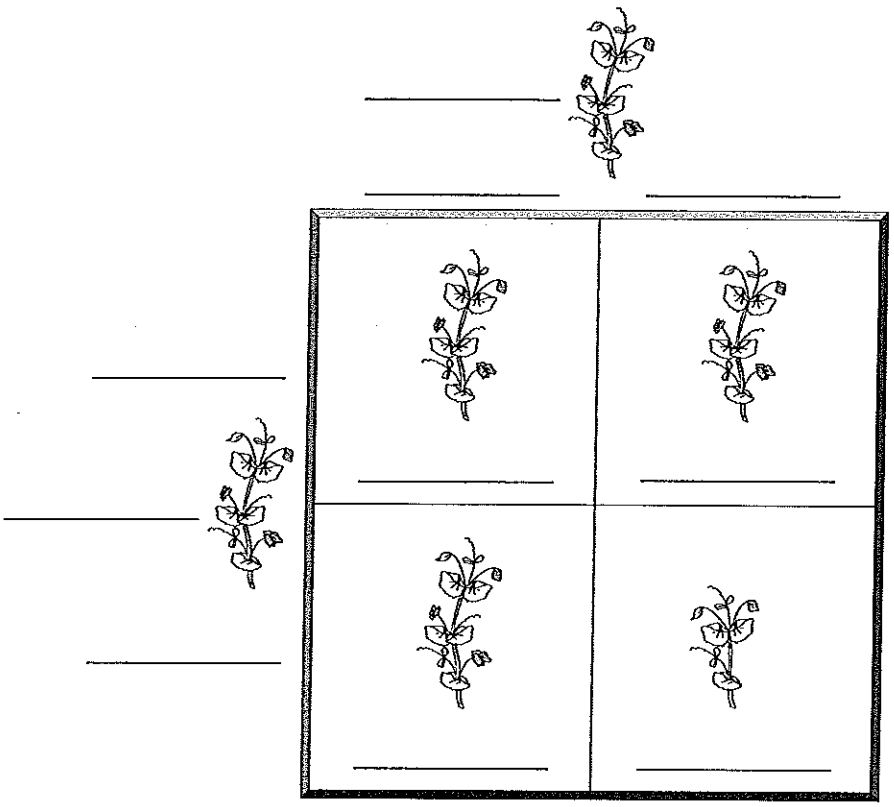
_____

_____

6. Mendel realized that the principles of probability could be used to _____ the results of genetic crosses.

7. A chart that shows all the possible combinations of alleles that can result from a genetic cross is called a(n) _____.

8. Write in the alleles of the parents and the possible allele combinations of the offspring in the Punnett square below. (Note that both parent plants are tall. Three of the offspring are tall and one is short.)



Name _____ Date _____ Class _____

Phenotypes and Genotypes (p. 88)

Match the term with its definition.

Term	Definition
____ 9. phenotype	a. Describes an organism with two identical alleles for a trait
____ 10. genotype	b. An organism's physical appearance, or visible traits
____ 11. homozygous	c. An organism's genetic makeup, or allele combinations
____ 12. heterozygous	d. Describes an organism that has two different alleles for a trait

13. Mendel used the term _____ to describe heterozygous pea plants.

Codominance (p. 89)

14. Is the following sentence true or false? In codominance, the alleles are neither dominant nor recessive. _____

15. In cattle, red hair and white hair are codominant. Cattle with both white hair and red hair are _____.

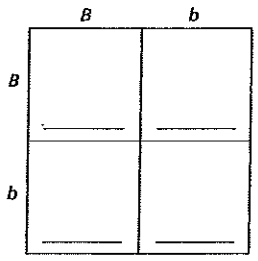
Name _____ Date _____ Class _____

Probability and Heredity

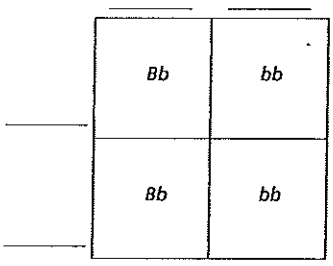
Understanding Main Ideas

Complete the two Punnett squares below, and then answer the questions on a separate sheet of paper.

1. Punnett Square A:



2. Punnett Square B:



3. In the cross between two black guinea pigs shown in Punnett Square A, what is the probability that an offspring will be black? White?
4. Is it possible that the cross between two black guinea pigs in Punnett Square A would not produce a white guinea pig? Explain.
5. What color are the guinea pig parents in the cross shown in Punnett Square B?
6. Which guinea pig parent(s) in Punnett Square B is homozygous? Which is heterozygous? Explain how you know.
7. Calculate the probability that an offspring will be black in the cross in Punnett Square B. What is the probability that an offspring will be white?

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition on the line beside the term.

____ 8. heterozygous
____ 9. Punnett square
____ 10. genotype
____ 11. codominance
____ 12. probability
____ 13. homozygous
____ 14. phenotype

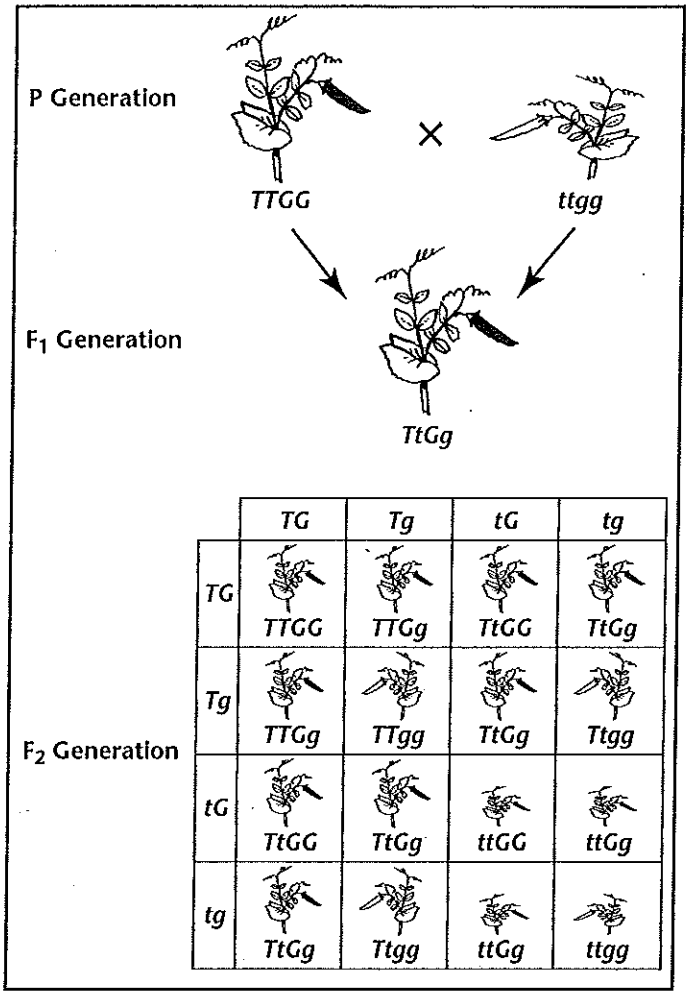
a. a chart that shows all the possible combinations of alleles that can result from a genetic cross
b. a number that describes how likely it is that an event will occur
c. an organism that has two identical alleles for a trait
d. an organism's physical appearance
e. an organism's genetic makeup, or allele combinations
f. an organism that has two different alleles for a trait
g. inheritance pattern in which the alleles are neither dominant nor recessive

Name _____ Date _____ Class _____

Genetic Crosses With Two Traits

In his work with garden peas, Mendel also set up crosses in which he studied the inheritance of two traits at one time. For example, he crossed tall plants having green pods *(TTGG)* with short plants having yellow pods *(ttgg)*. The F_1 offspring showed both traits controlled by dominant alleles, tall and green. Mendel allowed the F_1 offspring to self-pollinate. The F_2 offspring had four different phenotypes: tall plants with green pods, tall plants with yellow pods, short plants with green pods, and short plants with yellow pods. These results led Mendel to formulate the Law of Independent Assortment, which states that alleles of one gene separate or assort independently of alleles of another gene. In other words, the distribution of alleles of one gene does not affect the distribution of alleles for another gene.

Study the Punnett square of a genetic cross between two pea plants with two different traits. Then answer the questions that follow.



Answer the following questions on a separate sheet of paper.

1. What are all the possible combinations of alleles that each F_1 parent can pass on to the offspring?
2. What are the possible genotypes of the F_2 offspring? What are the possible phenotypes of the F_2 offspring?
3. What is the probability that an F_2 offspring will be tall with green pods? What is the probability that an F_2 offspring will be short with yellow pods?

Name _____ Date _____ Class _____

Make the Right Call!

Problem

How can you predict the possible results of genetic crosses?

Skills Focus

making models, interpreting data

Materials

2 small paper bags
3 blue marbles
marking pen
3 white marbles

Procedure

1. Label one bag "Bag 1, Female Parent." Label the other bag "Bag 2, Male Parent." Then read over Part 1, Part 2, and Part 3 of this lab. Write a prediction on another sheet of paper about the kinds of offspring you expect from each cross.

PART 1 Crossing Two Homozygous Parents

2. Place two blue marbles in Bag 1. This pair of marbles represents the female parent's alleles. Use the letter *B* to represent the dominant allele for blue color.
3. Place two white marbles in Bag 2. Use the letter *b* to represent the recessive allele for white color.
4. For Trial 1, remove one marble from Bag 1 without looking in the bag. Record the result in your data table. Return the marble to the bag. Again, without looking in the bag, remove one marble from Bag 2. Record the result in your data table. Return the marble to the bag.
5. In the column labeled Offspring's Alleles, write *BB* if you removed two blue marbles, *bb* if you removed two white marbles, or *Bb* if you removed one blue marble and one white marble.
6. Repeat Steps 4 and 5 nine more times.

PART 2 Crossing Homozygous and Heterozygous Parents

7. Place two blue marbles in Bag 1. Place one white marble and one blue marble in Bag 2.
8. Repeat Steps 4 and 5 ten times, and record your data in the data table for Part 2.

Name _____ Date _____ Class _____

Data Table: Part 1

Trial	*Allele From Bag 1 (Female Parent)*	*Allele From Bag 2 (Male Parent)*	*Offspring's Alleles*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Data Table: Part 2

Trial	*Allele From Bag 1 (Female Parent)*	*Allele From Bag 2 (Male Parent)*	*Offspring's Alleles*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Data Table: Part 3

Trial	*Allele From Bag 1 (Female Parent)*	*Allele From Bag 2 (Male Parent)*	*Offspring's Alleles*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Make the Right Call! *(continued)*

PART 3 Crossing Two Heterozygous Parents

9. Place one blue marble and one white marble in Bag 1. Place one blue marble and one white marble in Bag 2.
10. Repeat Steps 4 and 5 ten times, and record your data in the data table for Part 3.

Analyze and Conclude

Write your answers on a separate sheet of paper.

1. **Making Models** Make a Punnett square for each of the crosses you modeled in Part 1, Part 2, and Part 3.
2. **Interpreting Data** According to your results in Part 1, how many different kinds of offspring are possible when the homozygous parents (*BB* and *bb*) are crossed? Do the results you obtained using the marble model agree with the results shown by a Punnett square?
3. **Predicting** According to your results in Part 2, what percentage of offspring are likely to be homozygous when a homozygous parent (*BB*) and a heterozygous parent (*Bb*) are crossed? What percentage of offspring are likely to be heterozygous (*Bb*)? Does the model agree with the results shown by a Punnett square?
4. **Communicating** According to your results in Part 3, what different kinds of offspring are possible when two heterozygous parents (*Bb* × *Bb*) are crossed? What percentages of each type of offspring are likely to be produced? Does the model agree with the results of a Punnett square?
5. **Inferring** For Part 3, if you did 100 trials instead of 10 trials, would your results be closer to the results shown in a Punnett square? Explain.
6. **Communicating** In a paragraph, explain how the marble model compares with a Punnett square. How are the two methods alike? How are they different?

More to Explore

In peas, the allele for yellow seeds (*Y*) is dominant over the allele for green seeds (*y*). What possible crosses do you think could produce a heterozygous plant with yellow seeds (*Yy*)? Use the marble model and Punnett squares to test your predictions.

Name _____ Date _____ Class _____

Chapter Project All in the Family

Have you ever been surprised to see two people who looked alike but were not related? On the other hand, you're probably surprised when family members do not share the same physical characteristics. You may have wondered what causes people to look the way they do, or why offspring commonly look like their parents. These are questions that geneticists are trying to answer as they study the inheritance of traits.

In the Chapter Project, you will explore how traits are passed from parent to offspring by creating a family of "paper pets." First, you will create your own "paper pet" by choosing its characteristics. Then you will find a mate for your pet and determine the characteristics of six offspring. Finally, you will present your pet family to the class.

Project Rules

- Use Chapter Project Worksheet 1 to help you create your paper pet. Cut out your pet from either blue or yellow construction paper. Then choose the other traits for your pet: gender, eye shape, nose shape, and teeth shape. Use any materials you wish to decorate your pet.
- On the back of your pet, write the alleles it has for each trait. Use XX for females and XY for males. For the other traits, the dominant alleles are for blue body color, round eyes, triangular nose, and pointed teeth. The recessive alleles are those for yellow body color, square eyes, oval nose, and square teeth.
- Find a mate for your pet and determine the alleles that each of six offspring will inherit from each parent by tossing a coin. Construct a paper pet for each of the offspring, showing their phenotypes. Write the genotypes on the back of each offspring.
- Make a display of your pet family in which you label the P generation and the F_1 generation. Construct a Punnett square for each trait to show all the possible allele combinations in your pet family.
- Present your pet family to the class. Explain why some offspring look like one or both of the parents and why some offspring do not.

Name_____ Date_____ Class_____

Project Hints

- Remember, if your original pet has a trait controlled by a dominant allele, you can choose whether your pet is homozygous or heterozygous for the trait.
- Construct each of six offspring. Remember that each offspring must inherit its traits from the parents according to the laws of genetics. You will toss a coin to determine which allele each offspring inherits.
- Set up your display so that it is easy to turn over the pets and read their genotypes.

Project Timeline

Task	Date Due
1. Complete Chapter Project Worksheet 1.	_____
2. Identify your pet's genotype.	_____
3. Complete Chapter Project Worksheet 2.	_____
4. Construct Punnett squares for each trait.	_____
5. Make a display of your pet family.	_____
6. Present your display to the class.	_____

Name _____ Date _____ Class _____

Making a Paper Pet

Follow the instructions to create your own paper pet with five different traits.

Materials

blue or yellow construction paper
scissors
glue
markers
materials to decorate your pet, such as glitter, sequins, buttons, yarn, and beads

Possible Traits		
Color	blue	yellow
Gender	female (curl)	male (no curl)
Eyes	square	round
Nose	triangular	oval
Teeth	square	pointed

Procedure

1. Cut out the outline of the paper pet below. Trace the paper pet design onto either blue or yellow construction paper and cut it out.
2. On the front of your paper pet, draw the other four traits you have chosen for it. The table above lists the possible choices and shows how they should be drawn.
3. On the back of your paper pet, copy the chart shown on the right. Then write your pet's traits in the phenotype column. Give your pet a name, and write the name at the top of the chart.
4. Fill in your pet's genotypes. Use XX for a female and XY for a male. The dominant alleles for the other four traits are: *B* (blue skin), *R* (round eyes), *T* (triangular nose), and *P* (pointed teeth).
5. Decorate your paper pet with materials of your choice.

Pet's Name

_____

	Phenotype	*Genotype*
Color	_____	_____
Gender	_____	_____
Eyes	_____	_____
Nose	_____	_____
Teeth	_____	_____

Name _____ Date _____ Class _____

Making Paper Pet Offspring

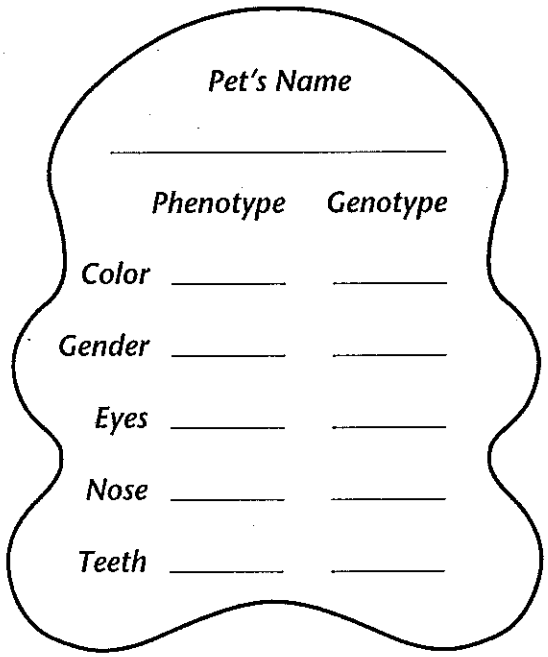
Follow the instructions to make the offspring of your paper pet.

Materials

scissors
blue and yellow construction paper
glue
markers
coin

Procedure

1. Cut out the outline below of the paper pet offspring. Toss the coin to determine which alleles the first offspring will inherit for color from each parent. For example, "heads" could represent *B*, the allele for blue skin, and "tails" could represent *b*, the allele for yellow skin. Remember, blue is controlled by a dominant allele. Trace the outline of the offspring onto the appropriate color construction paper and cut it out.
2. On the back of the offspring, copy the chart for the phenotype and genotype of each trait. Write in the genotype and phenotype for color.
3. Toss the coin and record the results to determine the genotypes for the other four traits. Record the genotypes and phenotypes in the appropriate column. Remember, the traits controlled by dominant alleles are round eyes, triangular nose, and pointed teeth. A male has an X and a Y. A female has two Xs. Name each paper pet offspring, and write its name on the back.
4. On the front of the offspring, draw its traits according to the genotypes determined by the coin toss.
5. Repeat this procedure five times so that all together you have six offspring.



Name _____ Class _____ Date _____

All in the Family Project Requirements (50 points)

1. Show your completed parent and offspring to your teacher (6 pts).
2. Write the phenotypes and genotypes of your pet (5 pts):
3. Write the phenotypes and genotypes of your pet's mate (5 pts):
4. Write the phenotypes and genotypes of your 6 offspring (6 pts):
5. Make a Punnett square for each of the 5 traits and write the probabilities for each trait (25 pts):
6. Did your actual results match the probabilities? Describe why or why not (3 pts):

Name _____ Class _____ Date _____

Genetics Quiz 1 review

Know all 4.1 and 4.2 Key terms

Know the name of the father of modern genetics:

Be able to describe why we use a Punnett square:

Be able to describe the phrase; "The coin has no memory":

Sample probability problems:
In a breed of dog, the allele for brown fur is dominant over the allele for yellow fur.

Write the possible genotypes for these dogs:

Use a Punnett square to find the probabilities of brown and yellow offspring when a heterozygous male dog is crossed with a yellow dog:

In goats, black and white colors for fur are codominant traits. What color would the offspring be if a black goat was crossed with a white goat?

Use a Punnett square to find the probabilities of each phenotype if the goat offspring were crossed: