Passing Traits to Offspring

Strand Heredity and Genetics

Topic Investigating how genes are passed from parent to offspring

Primary SOL LS.12 The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include
- c) genotypes and phenotypes;
- d) characteristics that can and cannot be inherited;
- e) genetic engineering and its applications; and
- f) historical contributions and significance of discoveries related to genetics.

Related SOL LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- d) models and simulations are constructed and used to illustrate and explain phenomena;
- i) patterns are identified in data and are interpreted and evaluated.

Background Information

Parents pass characteristics such as hair color, nose shape, and skin color to their offspring. Not all of the parents' characteristics will appear in the offspring, but the characteristics that are more likely to appear can be predicted. Such predictions are based on the work of Gregor Mendel. The transmission of characteristics from parents to offspring is called *heredity,* and the characteristics that are *inherited* can be predicted.

Reginald Punnett contributed much to the science of genetics when he designed a method of predicting traits as he was studying poultry genetics. The Punnett square, originally called the checkerboard or chessboard method, is a diagram that is used to predict the outcome of all possible offspring that could result from crossing the genes of two parents.

DNA technology allows researchers to produce offspring with specific characteristics or abilities. Students should understand that gene technology is a powerful tool and is controversial. The industry prefers the term *biotechnology* to *genetic engineering.* Genes are portions of DNA that code the instructions to build bodies in certain ways. Scientists know much about how genes work; they know how to "snip" genes out of one place and "stick" them into another. This is the hi-tech world of genetic engineering.

Materials

- Copies of "Facial Features" handout for each pair of students (attached)
- Copy of "Our Alien" handout for each student (attached)
- Class set of coins (pennies)

Vocabulary

alleles, dominant, gametes, genes, genetic cross, genetics, genotype, heredity, heterozygous, homozygous, hybrid, incomplete dominance, multiple alleles, offspring, phenotype, probability, Punnett squares, recessive, traits

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

This lesson should be preceded by a basic introduction to heredity and genetics.

1. Ask students about Gregor Mendel and his work studying pea plants and inheritance.
2. Remind students of the basic terminology associated with Mendel's genetic crosses of pea plants: P1 generation, F1 generation, F2 generation, allele, dominant, recessive, phenotype, genotype, homozygous, and heterozygous.

3. Model for students how to complete a Punnett square, showing the result of crossing a homozygous dominant (BB) black guinea pig with a homozygous recessive (bb) guinea pig: Determine the possible gametes from the test parents—i.e., BB = B and B; bb = b and b—and label the columns and rows of a Punnett square with these letters, as shown at right.

	B	B
b		
b		

4. Complete the square by determining the possible gamete combinations, as shown at right.

	B	B
b	Bb	Bb
b	Bb	Bb

5. Ask students to complete a Punnett square of a cross between two of the offspring in step 3—i.e., a cross between Bb with Bb—as shown at right:

	B	b
B	BB	Bb
b	Bb	bb

We Are Making an Alien Baby!

6. Explain to students how the Punnett square practice above relates to actual genetic inheritance.
7. Place students into pairs in order to create a full set of baby alien genes. Determine how the gender role will be chosen (e.g., flip a coin): One student will play the role of the mother, and the other will be the father.
8. Give each pair of students a coin to toss to determine the genotype for each trait. Heads represents the dominant allele, and tails will represent the recessive allele to be passed on to the alien offspring. Have students record the results of their tosses on the "Our Alien" response sheet.

Assessment

- **Questions**
  - How can you calculate the chance of having a particular trait when using Punnett squares?
  - Will a Punnett square tell you the exact results of genetic cross or possible results? Explain your answer.
  - Why is Gregor Mendel known as the Father of Genetics?
  - How much does each parent contribute to a child's DNA?

  - Why does tossing a coin accurately represent passing traits to offspring?
  - What is the difference between genotype and phenotype? Why do we need to know *both*?
  - If you had the ability to genetically engineer your alien baby (choose its traits), would your offspring have a different appearance? What would you have changed?
  - Examples of traits that *can* be inherited were reviewed in today's activity. What are some examples of traits that *cannot* be inherited?
- **Journal/Writing Prompts**
  - Think about what you know about physical traits of humans (e.g., eye color/shape, hair color/texture, skin color). Explain why there is so much variation in the different shapes and structures. (Hint: Review your coin tosses for hair color, skin color and hair texture.)
  - Describe how genetic engineering could be beneficial to our society, especially in agriculture and farming.
  - Explain why genetic engineering is so controversial. List as many examples of genetic engineering with which you are familiar.

Extensions and Connections (for all students)

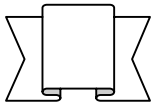
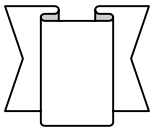
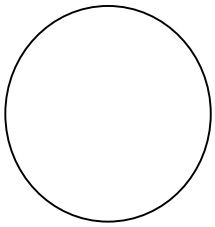
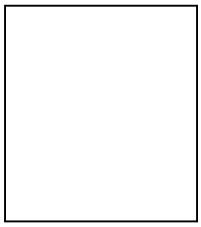
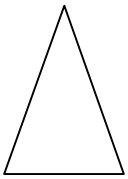
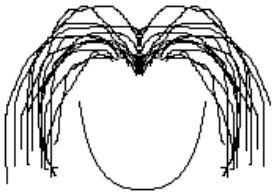
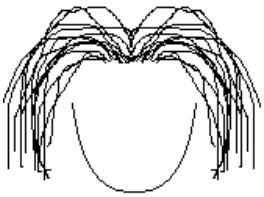
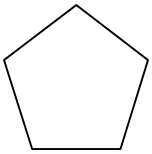
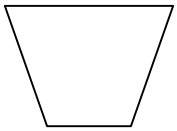
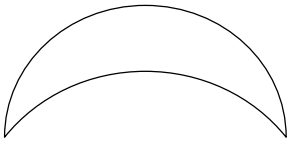
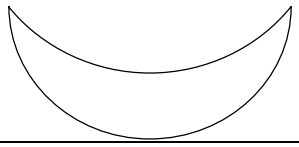
- In many dog breeds, inbreeding has resulted in certain genetic disorders being common to a particular breed, such as cataracts in Boston terriers. Have students research other disorders that are common to highly inbred animals, such as domestic dogs and horses.
- Have students find out the current status of allowing DNA evidence in the courtroom and investigate a recent trial that has involved use of DNA evidence.

Strategies for Differentiation

- Introduce the topic of *nature* versus *nurture* in relation to mannerisms and personality traits. This can be used as a full class discussion or as think-pair-share activity. All opinions should be respected.
- Have students use an online simulation of genetic inheritance to further reinforce the concept.

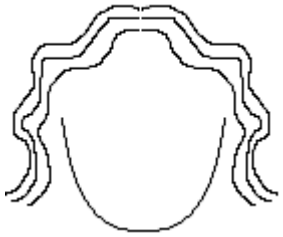
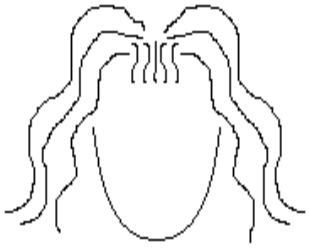
Facial Features

Name: _____ **Date:** _____

1. Gender The female will always contribute the X and therefore should not flip. Male determines sex: X (heads) = female or Y (tails) = male.	**Female (XX)**  Place bow on TOP of head.	**Male (XY)**  Place BOW TIE under chin.
2. Face Shape	**Round (RR , Rr)** 	**Triangle Square? (tt) (rr)?** 
3. Eye Shape	**Star (SS, Ss)** 	**Triangle (tt)(ss)?** 
4. Widow's Peak: Hair comes to a point at the forehead	**Present (WW, Ww)** 	**Absent (ww)** 
5. Nose Shape	**Pentagon (PP, Pp)** 	**Trapezoid (pp)** 
6. Mouth Shape	**Frown (FF, Ff)** 	**Smile (ff)** 

<table>
<tr><td>7. Skin Color</td><td colspan="3">Skin color involves three gene pairs. Each parent will flip the coin three times and record the A, B, and C alleles. For example, the result of the first pair of coin flips might be AA, Aa, or aa. Record the first coin flip, then do two more alleles, B and C.

Each capital letter will represent an active gene for skin color:
6 capitals – Green
5 capitals – Purple
4 capitals – Blue
3 capitals – Yellow
2 capitals – Orange
1 capitals – Red
0 capitals – Brown</td></tr>
<tr><td>8. Hair Color</td><td colspan="3">Like skin color, hair color is produced by several genes (polygenic or multiple alleles). For the purpose of this activity, we will assume that four pairs are involved (more are likely), so each parent will have to flip the coins four times for the A, B, C, and D alleles.

As before, the capital letters (dominant) represent color, while the lower case (recessive) represents little or no color.
8 capitals – Black
7 capitals – Brown
6 capitals – Pink
5 capitals – Yellow
4 capitals – Green
3 capitals – Light Blue
2 capitals – Orange
1 capitals – Dark Blue
0 capitals – Red</td></tr>
<tr><td>9. Hair Type: Incomplete dominance</td><td>Curly (CC)
  </td><td>Wavy (Cc)
  </td><td>Straight (cc)
  </td></tr>
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Our Alien

Name: _____ **Date:** _____

Features

Record the *genotypes* and *phenotypes* for your genetic crosses in the spaces below:

1. _____ _____ 2. _____ _____ 3. _____ _____

4. _____ _____ 5. _____ _____ 6. _____ _____

7. _____ _____ 8. _____ _____ 9. _____ _____

Complete an accurate sketch of your alien baby in this picture frame.