Variation in Traits

Lesson Overview

In this lesson, students will simulate the transfer of genetic information from parent to offspring by tossing a coin. Based on the genetic contributions of each parent, students will communicate data about the genotypes and phenotypes of different traits into a table. Student pairs will analyze the data to create a sketch of their genetic offspring and post a picture to be viewed through a gallery walk.

Alignment

Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

7. L.4A.2 <mark>*Construct explanations*</mark> for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.

Science and Engineering Practices (as appropriate)

7. S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

Students should also ask questions and define problems; analyze and interpret data; use mathematical and computational thinking; develop and use models; plan and carry out investigations; engage in scientific argument from evidence; and obtain, evaluate and communicate information.

Crosscutting Concepts: Patterns, Structure and Function

Standard/Indicator Addressed

SCCCR Math 7.RP.2   Identify and model proportional relationships given multiple representations, including tables, graphs, equations, diagrams, verbal descriptions, and real-world situations.

     a.   Determine when two quantities are in a proportional relationship.
     d.   Use equations to model proportional relationships.

SCCCR Math 7.RP.3   Solve real-world and mathematical problems involving ratios and percentages using proportional reasoning (e.g., multi-step dimensional analysis, percent increase/decrease/ tax).

SCCCR Math 7.DSP.1   Investigate concepts of random sampling.

a. Understand that a sample is a subset of a population and both possess the same characteristics.
b. Differentiate between random and non-random sampling.
c. Understand that generalizations from a sample are valid only if the sample is representative of the population.
d. Understand that random sampling is used to gather a representative sample and supports valid inferences about the population.

SCCCR Math 7.DSP.2 Draw inferences about a population by collecting multiple random samples of the same size to investigate the variability in estimates of the characteristic of interest.

Standards for Mathematical Practice (as appropriate)

Standard 1: Make sense of problems and persevere in solving them.
   a. Relate a problem to prior knowledge.
   b. Recognize there may be multiple entry points to a problem and more than one path to a solution.

Standard 2: Reason both contextually and abstractly.
   a. Make sense of quantities and their relationships in mathematical and real-world situations.

Standard 3: Use critical thinking skills to justify mathematical reasoning and critique the reasoning of others.
   a. Construct and justify a solution to a problem.
   b. Compare and discuss the validity of various reasoning strategies.
   c. Make conjectures and explore their validity.
   d. Reflect on and provide thoughtful responses to the reasoning of others.

Standard 6: Communicate mathematically and approach mathematical situations with precision.
   a. Express numerical answers with the degree of precision appropriate for the context of a situation.
   b. Represent numbers in an appropriate form according to the context of the situation.
   c. Use appropriate and precise mathematical language

Connections

Active Learning Strategies
   o Two Minute Paper
   o Elbow Partner
   o Gallery Walk

- o [Most Important Point](#)
- o [Exit Ticket](#)

Computational Thinking:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- The ability to communicate and work with others to achieve a common goal or solution

Content Connections

- Science
- English Language Arts
- Computational Thinking
- Mathematics

This lesson correlates well with mathematics standards on random sampling.   See corresponding mathematics lesson: Just Like Me!

Random sampling and probability are familiar topics from mathematics class. This science lesson supports and develops learner understanding of random sampling and probability.

Lesson Plan

Time Required –Two 60 minute class periods

Disciplinary Vocabulary –dominant trait, recessive trait, homozygous, heterozygous, allele, inherited trait, phenotype, genotype, environmental factors, polygenic trait

Materials Needed:

- o Video: "*How Mendel's pea plants helped us understand genetics*"(3:06) https://www.youtube.com/watch?v=Mehz7tCxjSE
- o Copies of Variation on a Human Face Activity (attached)
- o Colored pencils
- o Copies of paper for student drawings (attached)
- o For special needs students: Masking Tape (tape a small piece of tape on each side of the coin and write a D on one side and an r on the other side)
- o Coins or plastic discs to flip (for students who don't have coins)

Formative Assessment Strategies: Students will be assessed by completing a 2 minute paper, their dialogue, and the data tables and drawings of offspring created during the activity.

Computational Thinking: This lesson addresses computational thinking by allowing students to interact with authentic data to organize and analyze data about single genetic traits, represent the data visually, use evidence, apply logic, and construct arguments for their proposed explanations, and evaluate and communicate the information scientifically.

Misconceptions:

According to Benchmarks, when asked to explain how physical traits are passed from parents to offspring, elementary-, middle-, and some high-school students express various misconceptions. For example, some students believe that traits are inherited from only one of the parents (e.g., the traits are inherited from the mother, because she gives birth or has most contact as children grow up; or the same-sex parent will be the determiner). Other students believe that certain characteristics are always inherited from the mother and others come from the father. Additionally, some students believe in a "blending of characteristics."

Early middle-school students explain inheritance only in observable features, but upper middle-school and high-school students have some understanding that characteristics are determined by a particular genetic entity that carries information to be translated by the cell. (*Benchmarks for Science Literacy,* p. 341)

Some students may also think that because they look similar to an aunt or uncle that they received those traits from them.

Another misconception is that a dominant trait is the trait most likely found in the population However, a dominant trait does not mean "more potent," and recessive does not mean "weaker." The terms simply refer to the visible trait, the phenotype.

Students may believe that one set of alleles is responsible for determining each trait, and there are only 2 different alleles (dominant and recessive) for each gene.

Engage

- o Students begin class by writing a **2 Minute Paper** on the following topic: Explain why children who are biologically related to one another are sometimes said to favor or look like each other. Use the word allele in your answer.
- o Students share their responses with an **Elbow Partner**.
- o Show the video "How Mendel's pea plants helped us understand genetics"(3:06) **https://www.youtube.com/watch?v=Mehz7tCxjSE**
- o Ask the question: What trait was Mendel investigating in the video? What were his findings? How does what Mendel learned with pea plants relate to you and your siblings?
- o What are some predictions can you make about the possible genes that offspring can have based on the genotypes of their parents? Mendel modeled how this looks in pea plants. Today, we are going to continue this exploration with humans.

Explore
- o Provide students with the **Handout: Variation on a Human Face.**
- o Students will work in pairs to complete the activity. They will follow the directions on the handout.
- o Review the procedures with students; specifically Polygenic Traits.
- o Ask students what do you think a polygenic trait is? What are the three examples listed on your handout? How many times will each person need to flip his or her coin to collect the genetic information needed for hair color, eye color, and skin color?
- o Students will check the box of the phenotype represented by the genotype (coin toss). If both partners flip heads, the students will check the first box for the dominant trait. If both partners flip tails, the students will check the third box for the recessive trait. If one partner flips heads and the other flips tails, then the students will check the middle box for hybrid or heterozygous.
- o Students will record data in the data table provided (see attached) and draw pictures of the offspring created. Another option is to allow students to create drawings using technology. If time permits, students may wish to repeat the process to create a sibling.
- o Students will complete the analysis and conclusion sheet which teachers may choose to utilize as a formative or summative assessment.

Explain
- o Students will view sketches of others through a **Gallery Walk**.
- o When students return to their seats, they will use the **Most Important Point** Strategy.
- o Each student will write down his or her most important point of learning from the lesson on a notecard and turn the notecard in as an **Exit Ticket.**

Lesson adapted from
- • K-8 Science Lessons. (2010, August). Retrieved April 25, 2017, from http://www.s2temsc.org/k-8-science-lessons.html (Science S3 Seventh Grade 7-2.6 Lessons A)
- • (n.d.). Retrieved April 25, 2017, from https://www.biologycorner.com/worksheets/variations_on_a_human_face.html

Names: _____

Variations on a Human Face

Adapted from https://www.biologycorner.com/worksheets/variations_on_a_human_face.html

Materials: 2 pennies, chart on human traits, data table

Single Allele Traits

1. Determine which partner will toss for the male and which will toss for the female.

2. Have the parent who is representing the male flip the coin, if the coin lands heads up, the offspring is female, if tails, then the offspring is male. What sex is your offspring?

3. For all coin tosses from now on, heads will represent the dominant allele and tails will represent the recessive allele. **For each trait on the chart, you will flip a coin to determine the GENOTYPE of your offspring.** ==Put a check in the box that represents your offspring's appearance, or PHENOTYPE.==

Example: For the shape of the face, your partner tossed heads and you tossed tails. This means the offspring's genotype is Rr and the child will have a round face, so check that box. If you had both tossed tails, you would check the square-shaped face (rr) and if you had both tossed heads, you would have a round shaped face (RR)

4. When you have completed all of the coin tosses, transfer the information you have checked to the data table. This will help organize the information for drawing your picture.

5. Attach your data table to the back of your baby picture sketch.

Polygenic Traits - Hair, Eye, Skin

Some traits are controlled by more than two genes, such as hair color, eye color and skin color. For these traits you will need to perform a different procedure to determine your offspring's phenotype.

Hair color

Dark hair is dominant over light. To determine the color of the offspring's hair, assume there are two gene pairs involved (there are actually probably more than that, but for the purpose of this activity, let's not go crazy). Flip your coin first to determine the genotype of the first pair of alleles (AA, Aa, or aa). Now, flip the coins again to determine the genotype of the second pair of alleles (BB, Bb, or bb). Match the genotype you have to the hair color on the chart. **Circle your offspring's hair color.**

If the genotype is....	The hair color is....
AABB	black
AABb	black
AAbb	red
AaBB	brown
Aabb	regular blonde
AaBb	brown
aaBB	dark blonde
aaBb	regular blonde
aabb	pale yellow blond

Eye Color

To determine the color of the offspring's eyes, assume there are two gene pairs involved, one which codes for pigment in the front of the iris, and one which codes for pigment n the back of the iris. Determine the genotype of the first pair (AA, Aa, or aa) Then flip again to determine the genotype of the second pair (BB, Bb, or bb). Use the chart below to find out what eye color your offspring has and circle it.

If the genotype is....	The hair color is....
AABB	dark brown
AABb	dark brown
AAbb	brown
AaBB	brown with green flecks
Aabb	brown
AaBb	gray
aaBB	green
aaBb	dark blue
aabb	light blue

Skin Color

Skin color is controlled by a lot of different genes that basically add together to determine how dark the skin is and variations in tone. To simulate how skin color might be determined. Flip a single coin 10 times. Each time the coin turns up heads, give your offspring a point. Add your points together. 10 pts would be a very dark child and 1 pt would be a very pale child. How many points does your child have? _____
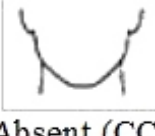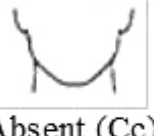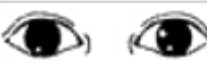
NAMES

Now that you have determined all the traits of your child. You will **draw a picture. Use colors and try to make the sketch as accurate as possible given the traits your child inherited. <mark>Make sure you name your child too</mark>! **

Analysis and Conclusions

1. Was your child exactly like any other child in the room? Give examples to show your evidence.

2. What do you think the odds are that two children in the room would turn out **exactly** alike?

3. How might it be possible for you to show a trait that neither of your parents have?

4. Why did you have to flip the coin twice to determine hair and eye color?

5. How do human traits differ from the pea plants that Mendel worked with?

6. Show the cross of a wavy haired person with a wavy haired person. Use a Punnett square.

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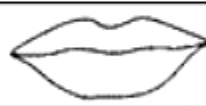
Human Variations

Trait	Dominant (both heads)	Hybrid (one head, one tail)	Recessive (both tails)
Shape of Face	Round (RR)	Round (Rr)	Square (rr)
Cleft in Chin	Absent (CC)	Absent (Cc)	Present (cc)
Hair	Curly (HH)	Wavy (Hh)	Straight (hh)
Widow's Peak	Present (WW)	Present (Ww)	Absent (ww)
Spacing of Eyes	Close (EE)	Normal (Ee)	Far (ee)
Shape of Eyes	Almond (AA)	Almond (AA)	Round (aa)
Position of Eyes	Straight (SS)	Straight (Ss)	Slant (ss)
Size of eyes	Large (LL)	Medium (Ll)	Small (ll)

NAMES:

Trait	Dominant (both heads)	Hybrid (one head, one tail)	Recessive (both tails)
Length of Eyelashes	Long (LL)	Long (Ll)	Short (ll)
Shape of Eyebrows	Bushy (BB)	Bushy (Bb)	Thin (bb)
Position of Eyebrows	Not connected (NN)	Not connected (Nn)	Connected (nn)
Size of Nose	Large (NN)	Medium (Nn)	Small (nn)
Shape of Lips	Thick (TT)	Medium (Tt)	Thin (tt)
Size of Mouth	Large (LL)	Medium (Ll)	Small (ll)
Size of Ears	Large (LL)	Medium (Ll)	Small (ll)
Freckles	Present (FF)	Present (Ff)	Absent (ff)
Dimples	Present (DD)	Present (Dd)	Absent (dd)

https://www.biologycorner.com/worksheets/variations_on_a_human_face.html
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TRAIT	GENOTYPE	PHENOTYPE
Gender		
Eye Color		
Hair Color		
Skin Color		
Shape of Face		
Cleft in Chin		
Hair		
Widow's Peak		
Spacing of Eyes		
Shape of Eyes		
Position of Eyes		
Size of Eyes		
Length of Eyelashes		
Shape of Eyebrows		
Position of Eyebrows		
Size of Nose		
Shape of Lips		
Size of Mouth		
Size of Ears		
Freckles		
Dimples		

Parents: _____

Child's Name: _____