It's in the Genes

Lesson Title

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NGSS Core Idea: Locate this information in your NGSS document.	
NGSS Grade Level End-point:	
Next Generation Science Standards: **Strand:**	

Arkansas Frameworks:
http://arkansased.org/educators/pdf/science_k-8_011006.pdf
LS.3.7.9
Identify the number and source of chromosomes in human cells.
LS.3.8.4
Predict patterns that emerge from simple genetic crosses.
LS.3.8.7
Conduct investigations demonstrating that the phenotype of a *genetic* trait is the result of a genotype.

Essential Questions:
How is gender determined and how are physical characteristics inherited?
How can the inheritance of characteristics be predicted mathematically?

Objectives: Students will know how dominant and recessive genes are inherited and the role of probability in inheritance.

Class Time: 1-2 class sessions

Key Vocabulary Terms: inheritance, chromosome, gene, allele, trait, phenotype, genotype, probability, dominant, recessive.

Materials: Coins, colored markers, deck of cards (optional)

Teacher Preparation:
Determining whether activities will be done in groups or individually. Write brief instructions on the board. Makes copies of the table of traits and elaboration questions.

BACKGROUND INFORMATION

Genes that govern inheritance of physical characteristics are located on chromosomes. Chromosomes exist in "homologous pairs" which control inheritance of the same traits, but they may have different forms of the trait called alleles. In humans there are 23 pairs of chromosomes with one pair designated as the "sex chromosomes". These chromosomes are termed X and Y, a female has the XX combination, and XY is a male. Any off-spring inherits

one chromosome of each pair from each of the two parents. An off-spring inherits alleles (on chromosomes) randomly, but in a large sample the inheritance can be predicted using the laws of probability.

LESSON PROCEDURE

Pre-Assessment Plan: Determine if students understand simple probability, the difference between genes and chromosomes, and that genes control inherited characteristics.

Introduction (Elicit) None for this lesson

Engage:

Draw a stick figure boy and girl on the board and ask the students if they know how the gender of someone is determined. Listen to answers, and reinforce that two chromosomes, X and Y, determine the gender of a child. Write the genotypes (XX, XY) on the stick figures. Students will be questioned to determine if they know the probability of having a male or female child, and why there is an equal chance of having a boy or girl (this is discussed in relationship to X and Y chromosomes).

Activity: Tell students to flip a coin to determine the gender of 4 children born to two parents. Explain and model that the sex of the each child is determined by flipping the coin once because one X is <u>always</u> given from the mother so it has already been determined.

- heads=X, tails=Y
- females- (X, X)
- males- (X, Y)

Ask students to report how many children were boys and how many were girls. Discussion continues about why the ratio of boy and girl children was not always 2:2.

Explore:

Reinforce that chromosome determines gender. In addition individuals inherit other characteristics that are the result of inheritance of genetic traits (genes) on chromosomes. Explain that some **gene traits** have <u>two forms</u>, called **alleles,** and that you inherit one allele from each parent to determine the trait you have.

Tell students they will examine "hypothetical" genetic traits that a S*miley Face* might inherit. Tell them that any smiley that inherits **ONE or TWO** dominant alleles will have the dominant appearance, and that to be recessive in appearance the smiley must have **TWO** recessive alleles. Write brief instructions on the board if necessary and model how to do one trait.

Students will complete a **"Smiley Face Traits"** lab during which they will draw a face and add characteristics determined by tossing a coin. As the coin is flipped, they will create a data table that shows the alleles for each genetic trait and phenotype of the off-spring.

<u>Both parents are heterozygous for each trait.</u> Each coin toss will represent the allele the off-spring inherited from one parent; mother or father. The first flip will represent the allele from the mother, the second the one from the father. If student's flip a **"head"** the dominant trait is selected and a **"tail"** selects the recessive trait. After filling in a table of the traits, they will add them to the drawing. Model the results of flipping the coin and beginning the smiley face.

1. The student will flip the coin twice for 9 traits and write down the **genotype** (combination of alleles) for each trait in a **data table**.
2. The **phenotype** (appearance) should also be listed in the data table.
3. The student will determine the *Smiley Face* eye color and shape, length of eye lashes, face shape, skin type, kind and color of hair, type of ears, and shape of mouth.
4. From all the data recorded, each student will draw a Smiley Face by using the phenotypes they listed.

Trait	Heads = Dominant Allele	Tails = Recessive Allele
Eye Color	Brown: B	Blue: b
Eye Shape	Round: R	Oval: r
Length of Eye Lashes	Long: L	Short: s
Face Shape	Heart: H	Oval: h
Skin Type	Plain: P	Freckles: f
Kind of Hair	Curly: C	Straight: c
Hair Color	Yellow: Y	Red: y
Type of Ears	Floppy: F	Tiny: f
Shape of mouth	Smiley: S	Frown: s

The chart and instructions can be printed for students or written on the board, it can be modified if desired. The student created data table will show the allele inherited from the mother, the one from the father, and the appearance (phenotype) in the offspring. They will complete the Smiley from the data.

Modification: Students may do the activity in pairs. One student will flip the coin to provide the mother's allele and add it to the table. The other student will flip the coin while acting as the father. This can allow pairing of students who may have difficulty understanding the ideas with those who will grasp them more quickly.

Explain:
There will be a class discussion on the inheritance of traits in the Smiley. **Throughout the lesson reinforce the vocabulary that applies to the lab: Vocabulary: phenotype, genotype, homozygous, heterozygous, recessive, dominant, alleles, trait, and probability.**
Question Examples:

1. If homozygous means "the same alleles", which Smiley Face traits resulted from the homozygous dominant combination of alleles in the genotype? (BB for example; Brown Eye Color. All Column 1 traits in the chart will result from homozygous dominant combinations.)
2. How would you describe the genotype of any homozygous dominant trait? (Two of the same capital letters.)
3. If heterozygous means "different alleles" Which facial traits resulted from the heterozygous dominant genotype? (All in the first column of traits.)

4. Describe a heterozygous allele combination? (A combination of one capital and one lower case letter of the same allele; Bb is heterozygous. Results in brown hair.)
5. Does your smiley face have any characteristics that are recessive? (answers vary)
6. How would you describe a recessive allele? (Alleles expressed only when two are present, bb is recessive.)
7. Is it always possible to determine the combination of the alleles for the traits by looking at the appearance of the *Smiley Face*? Explain why or why not? (No, the Smiley might have a dominant allele and a recessive allele which is not expressed. You could determine the alleles for all recessive traits.)
8. According to laws of probability should the face have more dominant or more recessive traits? Why? (More dominant traits- when flipping the coin there is a great probability of getting at least 1 dominant allele than there is of getting two recessive alleles.)
9. Compare your smiley face to others in your group. Is it exactly like others in the group, explain why or why not. (Answers vary, but it is doubtful if any two will be exactly alike due to the low probability of tossing the same combinations as other students.)

If necessary other activities can be used to reinforce probability concepts. Small groups can be assigned and each group will flip a coin 10 times, recording the actual results of the number of heads and tails. The groups' tallies will be combined into a classroom data pool on the board. Then the actual probability of flipping heads or tails can be compared to the data. Decks of cards or dice can also be used to explain probability. For example; 1/4 chance of drawing a heart, 1/13 chance of drawing a King, 1/4 x 1/13 = 1/52 chance of drawing King of Hearts.

Elaborate:

Post examples of questions the students can answer to determine if they understand probability, phenotype and genotype.

<u>Examples: In these questions long eyelashes are dominant to short; and heart-shaped faces are dominant to round. (L=Long, H=heart shape)</u>

1. Betsy has a phenotype of short eyelashes, and her son Bob has a phenotype for short eyelashes. What kind of eyelashes can Bob's father have? Explain. (Bob's father could have long (Ll) or short eye lashes (ll) and Bob could still inherit two recessive alleles.)
2. Joe has a genotype of Hh for face shape, and Julie has a genotype of hh. What are the possible phenotypes of their first born child? (Both (Hh) heart and (hh) round.)
3. (Refer back to question 2) Joe and Julie's first child has a heart-shaped face, what is the probability of the second child having a heart-shaped face? (It is 1 out of 2. The first child having a heart-shaped faces doesn't affect the probability of subsequent children inheriting face shape.)

Evaluate:

- As an exit slip, the students write down in their own words the difference between genotype and phenotype and give an example.
- Students create a foldable with 6 terms related to the lesson and describe their understanding of each term.

- Ask students to look at a sample smiley you created (no table of results should be provided). They should list any characteristics for which they are **certain of the alleles and those that are in question.** Any dominant trait could be heterozygous or homozygous since it has to have one dominant allele. The recessive traits all have two recessive alleles.
- Evaluate student performance on the activity and the answers to the questions posed during class.

Extensions:
Give students a sample Punnett square and examples of two parents with a single trait (from the smiley exploration). Show students how to distribute the alleles from the parents into the boxes and count a ratio of off-spring.
Ask students to write a problem they could solve with their smiley chart and a Punnett square. In groups, have them exchange problems, work them, and share the solutions.

ADDITIONAL RESOURCES and CROSS-CURRICULAR CONNECTIONS
Math: 6SP.5 Probability, 6th grade Common Core State Standards for Math
Language Arts:
Social Studies:
Parental Involvement:
Technology Connections:
Bibliography and Resources: 1. Mendelian genetics coin toss lab. http://www.sciencegeek.net/Biology/biopdfs/Lab_Coin_Toss.pdf 2. The genetics of parenthood. http://science.holeintheground.net/events/DesGene/genetics_human_concepts.pdf 3. Genetics with a Smile. http://sciencespot.net/Media/gen_smilewkst1.pdf 4. Genetics worksheet demonstrating Punnett squares: http://www.sutherlinffa.org/planbook/Ag%20Biology/Mar202012/BIO%2011.2%20-%20Pedigrees%20Part%2010.pdf
Notes: Mendelian Genetics is an important concept in biology, but is sometimes hard to grasp. By having the students perform this activity, they will more likely understand the information. The students will be more engaged in the idea of probability, genotypes and phenotypes by creating their own smiley instead of just being given the definitions and told examples.