

Lesson Plan: GENOTYPE AND PHENOTYPE

Pacing

Two 45- minute class periods

RATIONALE:

According to the National Science Education Standards, (NSES, pg. 155-156), “ In the middle-school years, students should progress from studying life science from the point of view of individual organisms, to recognizing patterns in ecosystems and developing understandings about the cellular dimensions of living systems.”

Some aspects of middle-school student understanding should be noted. This period of development in youth lends itself to human biology. Now is the time to begin the study of genetic traits (i.e. what offspring get from parents).

The topic of the lesson is: Genotype and Phenotype. This topic can be addressed as a natural part of the study of human reproduction. Concerning **heredity**, younger middle-school students tend to focus on observable traits, and older students have some understanding that genetic material carries information. “By the end of the eighth grade, students should know that ... in organisms that have sexes, typically half of the genes come from each parent.” (Benchmarks for Science Literacy- Project 2061 pg. 108)

PURPOSE

The purpose of this activity is to further student understanding of how genotype translates into phenotype as they build and then examine the traits of a new population of offspring. This will be achieved by simulating genetic inheritance through modeling. Research has shown that meaningful hands on inquiry-based lessons are a more effective method of achieving scientific literacy. Students often hold onto misconceptions about inheritance, even after instruction. Some of the misconceptions addressed by this activity include:

- Many students believe that traits are inherited from only one parent.
- Many students believe that recessive traits are rare and dominant traits are more common.

AUDIENCE

This lesson is designed for middle school students in grades 6-8. It should be used with groups of 3-4 students. The specific lesson described will be done as a whole group, interactive lesson. In small group activities that will be part of this unit, special strategies will be used to address the needs of English language learners, learning disabled, attention deficit disorder, developmentally delayed, as well as students at the advance level.

CONTEXT

In the course of this unit, the following topics will be addressed:

1. **We have two alleles for each gene that codes for a trait.** An allele is one version of a gene that determines a specific trait. Traits are inherited characteristics of an organism.
2. The relationship between traits and heredity- Heredity is the passing of traits from one generation to another.
3. The process of meiosis - Genetics is the study of how traits are passed from parent to offspring.
4. How genes and alleles are related to genotypes in offspring –
 - Genotype is the genetic makeup of an organism.
 - Phenotype is the result of genotype and environment
 - Phenotype is the physical appearance of an organism.
5. Constructing and interpreting a Punnett square.
6. How probability can be used to predict possible genotypes in offspring.
7. How chromosomes determine sex.
8. Why sex-linked disorders occur in one sex more often than in the other.
9. Interpret a pedigree

Extension lesson – The experimentation of Gregor Mendel

ENDURING UNDERSTANDING:

- Students understand that every organism has a set of genetic instruction that determines its inherited traits.
- We can understand biological phenomena by analyzing them at multiple levels from the molecular to the population level.

Standards Addressed

NATIONAL STANDARDS

Unifying Concepts and Processes (UCP)

UCP 1. Systems, order, and organization.

UCP 2. Evidence, models, and explanation

Science As Inquiry (SAI)

SAI 1. Abilities necessary to do scientific inquiry

SAI 2. Understandings about scientific inquiry

Life Science Content Standards (LS)

LS 2c. Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.

LS 2e. The characteristics of an organism can be described in terms of a combination of traits.

STATE STANDARDS

Biological Science

3.3.7 C Know that every organism has a set of genetic instructions that determines its inherited traits.

OBJECTIVES of This Lesson:

1. Explain how a combination of alleles for a gene can code for a specific trait.
2. Distinguish between dominant and recessive alleles.
3. Explain how genes and alleles are related to genotypes and phenotypes.

Teacher Preparation

Prepare 14 small paper bags to represent paired parent alleles for each of seven characteristics as follows:

Characteristics: antennae color, body segments, tail shape, legs, nose color, foot color, and number of eyes.

1. Label each pair of bags with one of the seven characteristics. For each characteristic, label one bag “Mom” and the other bag “Dad” (e.g. tail shape-Mom, tail shape-Dad).
2. Use the table labeled Genotype and Phenotype, located on the Bug Builders Data Sheet, to decide the genotype of each parent. For example, the dad has green antennae, which is a recessive trait (rr). Therefore his antennae bag should only contain alleles with “r”.
3. Cut 1 inch squares of paper to represent alleles. Use seven colors of paper – a different color for each characteristic. Cut enough squares so that each student will receive two alleles for each trait.
4. Label half of the paper squares for each characteristic with capital letters to indicate dominant alleles. Label the other half with lower case letters to indicate recessive alleles.
5. Place an equal number of alleles into each bag according to parent genotype.

Safety Caution: Students should review all safety cautions before beginning this activity. Students should use caution with toothpicks, push pins, map pins, and should not eat any of the materials used.

LESSON

Day 1

Some people have brown eyes, some have blue, and some have green. Some people have earlobes attached directly to their head, while others have earlobes that hang loose.

- Where do people get their different traits?
- How are traits passed from one generation to the next?

Students will record their initial thoughts in their Science Journals with the expectation that they will revisit these questions at the conclusion of the lesson.

Engage 15 minutes

Ask students to notice the differences in tongue curling. Have them count the number of students with each trait and record the results in their science journals using a data table. The tables have two columns (curl and no curl). Have students calculate the ratios of students who can curl/total students in the class and students who cannot curl/total students in the class. Have the class discuss the results. (Note: A class of students is not a scientific sample and may not yield statistically significant results.)

Instruction

For a simple trait like tongue rolling (curling) you have to have 2 allele. We will label the allele that allows rolling "R".

- What happens if you have RR? (Wait for student response. Reinforce correct response.)
- Imagine you have rr. What does this mean? (Wait again. Reinforce correct response.)
- What do you think will happen if you have Rr?
 - Possible responses - "You can almost roll your tongue."
 - "It means you cannot roll your tongue."
 - "You can roll your tongue."
- Act out "dominance" For example stand over a student in a domineering (but harmless) manner. Ask "What does it mean to be dominant?"
- "Think of recessive as laid back. If R is dominant and r is laid back, what does this mean for a person who has Rr?" Wait for responses then state (or restate) that the person will have the ability to roll their tongue.

Note: Some students may ask if the order matters. "Order does not matter. If you have Rr or rR, you have the ability to roll your tongue."

- Introduce the bug parents.
 - “We are going to practice our understanding of dominant and recessive alleles by looking at some bugs.”
 - Distribute the chart of the genotypes and phenotypes (See attached), and display a large copy.
 - Have genotypes for the mom and dad displayed. The students will tell you what phenotypes are expressed. You will build the parents according to their instructions.
 - Follow-up questions:
 - “What were the alleles that the mom had for antennae?” “How did she end up with red antennae?” Pose the same question for body segments, curl of tail and number of eyes.
 - “If we had a bug with (insert genotype) what would it look like?”
 - Albinism is the result of a recessive gene “a”. Write the phenotype for the following genotypes:
 - AA, Aa, aA, aa
- Tomorrow you will use your knowledge of genotypes and phenotypes to make bug babies.

**POSSIBLE GENOTYPES AND PHENOTYPE OF
CANDY BUGS**

DOMINANT Genotypes and Phenotype	<i>recessive</i> Genotype and Phenotype
RR or Rr – red antennae	rr – green antennae
SS or Ss – three body segments	ss – two body segments
CC or Cc – curly tail	cc- straight tale
LL or Ll – three pairs of legs	ll – two pairs of legs
BB or Bb – blue nose	bb – green nose
GG or Gg – green feet	gg – black feet
EE or Ee – two eyes	ee - three eyes

Mom's genotype: Rr, Ss, Cc, ll, bb, gg, ee

Dad's genotype: rr, ss, cc, Ll, Bb, Gg, Ee

Which parent has more dominant genes? _____

Describe how each parent will look. (Write the phenotypes.)

Mom

Dad

Model-making lab –please refer to lab activity sheets
Students will complete steps 1-5 (refer to lab activity sheet)

Day 2

Model-making lab – (refer to lab activity sheets)
Students will continue at step 6 to construct offspring and complete analyze section of the activity sheet.

EXTENSION LESSON

(Several days so students have time to complete their surveys).

Design Your Own, "Tracing Traits," Students trace an inherited trait through their own family or another family and determine how the trait passed from generation to generation. Students gather data from family members and construct a pedigree to show that data.

- Both inquiry labs and their corresponding data sheets can be used as an assessment tools for grading.

Resources:

National Science Education Standards
Benchmarks For Science Literacy Project 2061
Cells, Heredity and Classification- Holt Science and Technology
Teaching Science in Elementary and Middle School Classrooms, A Project-Based Approach Krajcik, Joseph S. , Czerniak, Charlene, and Berger, Carl