Teacher Guide: A Tree of Genetic Traits

ACTIVITY OVERVIEW

Abstract:
Students mark their traits for tongue rolling, PTC tasting (a bitter tasting chemical) and earlobe attachment on tree leaf cut-outs. They then place their leaves on a large tree whose branches each represent a different combination of traits. When completed, the tree forms a visual representation of the frequency of certain trait combinations within the class. The leaves are clustered around the branch representing the most common combination of traits in the class while other branches of the tree remain sparse.

Module:
Introduction to Heredity (Grades 5-7)

Key Concepts:
Certain combinations of traits are more common than others in a given population; some people can taste PTC while others can not

Prior Knowledge Needed:
Traits are inherited physical characteristics.

Materials:
PTC paper, hard candies, leaf cut-outs, large butcher paper, tape, scissors

Appropriate For:
Ages: 10 - 12
USA grades: 5 - 7

Prep Time:
20 minutes

Class Time:
30 minutes

Activity Overview Web Address:
http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=traittree
# Teacher Guide: A Tree of Genetic Traits

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I. PEDAGOGY

A. Learning Objectives
   • Students will determine whether or not they have the PTC-tasting trait.
   • Students will determine their tongue rolling and earlobe attachment traits.
   • Students will compare their combination of traits with other students in the class.
   • Students will organize data visually.
   • Students will determine the most and least common combination of traits in a population.

B. Background Information

Basic information students need to understand:
Physical traits are observable characteristics. While each of us shares some of our traits with many other people, our own individual combination of traits is what makes each of us look unique. Some combinations of traits are more common than others.

More advanced information:
Physical traits are determined by specific segments of DNA called genes. Multiple genes are grouped together to form chromosomes, which reside in the nucleus of the cell. Every cell (except eggs and sperm) in an individual’s body contains two copies of each gene. This is due to the fact that both mother and father contribute a copy at the time of conception. This original genetic material is copied each time a cell divides so that all cells contain the same DNA. Genes store the information needed for the cell to assemble proteins, which eventually yield specific physical traits.

Most genes have two or more variations, called alleles. For example, the gene for hairline shape has two alleles – widow’s peak or straight. An individual may inherit two identical or two different alleles from their parents. When two different alleles are present they interact in specific ways. For the traits included in this activity, the alleles interact in what is called a dominant or a recessive manner. The traits due to dominant alleles are always observed, even when a recessive allele is present. Traits due to recessive alleles are only observed when two recessive alleles are present. For example, the allele for widow’s peak is dominant and the allele for straight hairline is recessive (See Figure 1). If an individual inherits:
   • Two widow’s peak alleles (both dominant), their hairline will have a peak
   • One widow’s peak allele (dominant) and one straight hairline allele (recessive), they will have a widow’s peak
   • Two straight hairline alleles (recessive), their hairline will be straight.
A widespread misconception is that traits due to dominant alleles are the most common in the population. While this is sometimes true, it is not always the case. For example, the allele for Huntington’s Disease is dominant, while the allele for not developing this disorder is recessive. At most, only 1 in 20,000 people will get Huntington’s; most people have two recessive, normal alleles.

Most human genetic traits are the product of interactions between several genes. The traits included in this activity, however, are part of the small number that may be due to only one or two genes (and its alleles). More information about these traits is listed below. Note that scientists usually use the shorthand of a “dominant trait” rather than saying that a trait is due to a dominant allele. A pictorial reference and a description of some of the traits is available (see Additional Resources).

- **PTC tasting** – PTC (phenylthiocarbamide) is a harmless, bitter tasting chemical. The ability to taste PTC is controlled by a single gene. The PTC-tasting allele is dominant while the non-tasting allele is recessive. In the United States, approximately 70% of the population can taste PTC while the remaining 30% cannot. Ideas about the ability to taste PTC range from evolutionary explanations to a possible link between the ability to taste PTC and choices in diet and smoking behaviors. (see Additional Resources).

- **Tongue rolling** – Tongue rolling ability may be due to a single gene with the ability to roll the tongue a dominant trait and the lack of tongue rolling ability a recessive trait. However, many twins do not share the trait, so it may not be inherited. About 70% of people can roll their tongues while 30% can not.

- **Earlobe attachment** – Some scientists have reported that this trait is due to a single gene for which detached earlobes are dominant and attached earlobes are recessive. Other scientists have reported that this trait is probably due to several genes.
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For the purpose of this activity, students do not need to know about DNA, genes, alleles, or dominant and recessive interactions. However, this information may be helpful to you to answer some of the more advanced questions that students may have during the course of the activity. Additional information can be found in the Basics and Beyond section of the Genetic Science Learning Center website, in particular, Tour of the Basics (see Additional Resources).

C. Teaching Strategies

1. Timeline

   • Three weeks before activity:
     - Order PTC paper (see Material Preparation Guide for sources)
   • One day before activity:
     - Create a large trait tree out of butcher or other paper
     - Make copies of leaf cut outs
     - Gather hard candies, PTC paper, tape and scissors
   • Day of activity:
     - Post the Genetic Traits Tree in an easily accessible and visible area of the room
     - Optional: Place small waste containers for PTC paper and candy wrappers around the room
     - Hand out leaf cut-outs, PTC paper, hard candies, scissors and tape and proceed with the activity as outlined below

2. Classroom Implementation

   • Give each student a leaf and a pair of scissors and instruct them to cut their leaf out.
   • Have students mark “yes” or “no” on their leaf for the tongue rolling and earlobe attachment traits.
   • Give each student a piece of PTC paper and instruct them to place the paper on the tip of their tongue to see if they can taste the chemical. The chemical tastes bitter to those who can taste it. For those who can not taste it, the paper has no taste.
   • Hand out hard candies to each student to neutralize the taste of the PTC. Instruct students to check “yes” or “no” on their leaves for PTC tasting.
   • Demonstrate how to determine where to place the leaves on the Trait Tree starting at the base of the branches and working your way out toward the tips.
   • Call students up in groups to place their leaves on the appropriate branches.
   • Once the tree is completed, ask students the following questions:
     ◦ What is the most common combination of traits in the class?
     ◦ What is the least common combination of traits in the class?
     ◦ Does this correspond to the most and least common individual traits in
the class? Use this question as a springboard for discussing with students the fact that, while individual traits may be common in a population, the various ways those traits combine is not as common. The traits we share as humans make us alike, but our individual combinations of traits make us each unique.

3. Extensions:

• Have students use the completed Trait Tree to calculate the percentage of the class population with certain trait combinations.

Example: To calculate the percentage of people who have attached earlobes, can taste PTC paper and can roll their tongue.

\[
\frac{\text{Number of leaves on that particular branch}}{\text{Total number of leaves}} \times 100 = \text{______}\%
\]

*Teaching Tip:* You may want to make a key depicting the different combinations. For example:

- AE, P, T = attached earlobes, can taste PTC, can roll tongue
- FE, P = free earlobes, can taste PTC, can not roll tongue

• Once the percentages have been calculated, have the students construct a bar or pie graph from the data using PowerPoint, Microsoft Excel, or pen and paper.

• You may also use the completed Trait Tree to calculate the frequency of *individual* traits among your population if you have not already done so in the *An Inventory of My Traits* activity (see Additional Resources). Follow the method above, but count one single trait instead of a combination. Be sure that students count items checked “yes” on all branches of the tree.

Example: \[
\frac{\text{Number of tongue rollers}}{\text{Total number of leaves}} \times 100 = \text{______}\%
\]

• Follow this activity with *Traits Bingo* (see Additional Resources)

3. Adaptations:

• Make leaf cut-outs in two different colors, one for boys and one for girls, to track traits or combinations of traits within the different genders.

• Increase your data pool by including other classes in the exercise, taping all leaves to one tree.
3. Assessment Suggestions:
   • Have students answer the following questions in writing or orally:
     ◦ What is the most common combination of traits in the class, and how do you know?
     ◦ What is the least common combination of traits in the class? How can you tell?

II. ADDITIONAL RESOURCES
A. Activity Resources - linked from the online Activity Overview:
   http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=traittree
   • Teacher Guide: Comparing Inherited Human Traits - A pictorial reference to traits inventoried in this activity.
   • Website: Tour of the Basics - An animated introduction to DNA, genes, chromosomes and inheritance.
   • Website: PTC Gene May Explain Dietary Choices, Other Habits - News article on the discovery of the PTC gene.
   • Teacher Guide: An Inventory of My Traits
   • Teacher Guide: Traits Bingo

III. MATERIALS
A. Detailed Materials List
   • PTC paper – one piece per student
   • Hard candies – one per student
   • Photocopies of leaf cut-outs (page 8) – one leaf per student
   • Large paper – one piece
   • Scissors – one per 2-4 students
   • Tape – one roll

B. Material Preparation Guide
   PTC paper can be ordered from:
   • Sargent Welch - $1.50 per vial of 100 (www.sargentwelch.com)
   • Carolina Math and Science - $3.45 per packet of 100 (www.carolina.com)
   • Ward’s Natural Science - $1.05 per vial of 100 (http://www.wardsci.com)

Trait Tree:
   Draw a tree (several feet tall) on large paper. See page 9 for a suggested tree shape and labels.
IV. STANDARDS

A. U.S. National Science Education Standards
Grades 5-8:
• Content Standard A: Science As Inquiry - Abilities Necessary To Do Scientific Inquiry; use appropriate tools and techniques to gather, analyze and interpret data.
• Content Standard C: Life Science - Reproduction and Heredity; every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to the other.
• Content Standard C: Life Science - Reproduction and Heredity; the characteristics of an organism can be described in terms of a combination of traits.

B. AAAS Benchmarks for Science Literacy
Grades 3-5:
• The Living Environment: Heredity - some likenesses between children and parents, such as eye color in human beings, or fruit or flower color in plants, are inherited.
Grades 6-8:
• The Human Organism: Human Identity - human beings have many similarities and differences.

C. Utah Elementary Science Core Curriculum Grade 5
Intended Learning Outcomes
Students will be able to:
1. Use Science Process and Thinking Skills
   a. Observe simple objects, patterns, and events and report their observations.
   b. Sort and sequence data according to criteria given.
   d. Compare things, processes, and events.
   e. Use classification systems.
   i. Use data to construct a reasonable conclusion.

4. Communicate Effectively Using Science Language and Reasoning
   a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
b. Describe or explain observations carefully and report with pictures, sentences, and models.

Standard V: Students will understand that traits are passed from the parent organisms to their offspring, and that sometimes the offspring may possess variations of these traits that may help or hinder survival in a given environment.

Objective 1: Using supporting evidence, show that traits are transferred from a parent organism to its offspring.
   a. Make a chart and collect data identifying various traits among a given population.

V. CREDITS

Activity created by:
Molly Malone, Genetic Science Learning Center
Harmony Starr, Genetic Science Learning Center (illustrations)

This activity was adapted from “State Your Traits - Genetic Traits Tree”, The GENETICS Project, University of Washington (2001).

Funding:
A Howard Hughes Medical Institute Precollege Science Education Initiative for Biomedical Research Institutions Award (Grant 51000125).
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B. Example Trait Tree

- Tongue Roller
- Non-Tongue Roller
- Non-Tongue Roller
- Tongue Roller
- Tongue Roller
- Non-PTC Taster
- PTC Taster
- Attached Earlobes
- Free Earlobes
- Non-PTC Taster
- Non-PTC Taster
- Non-Tongue Roller
- Non-Tongue Roller
- Non-Tongue Roller
- Tongue Roller
- Tongue Roller

Adapted from “State Your Traits - Genetic Traits Tree”, the GENETICS Project, University of Washington (2001).