Teacher Guide: Comparing Inherited Human Traits

ACTIVITY OVERVIEW

Abstract:
This activity and reference includes photographs of several inherited human traits that are due to one or more genes. Both variations (dominant and recessive) of each trait are shown, accompanied by brief descriptions, frequencies (if available) and other interesting information.

Module:
Introduction to Heredity (Grades 5-7)

Key Concepts:
Inheritance; traits; trait variations

Prior Knowledge Needed:
None

Materials:
Student pages; PTC paper; hard candies and mirrors (optional)

Appropriate For:
Ages: 10 - 18
USA grades: 5 - 12

Prep Time:
15 minutes to read materials

Class Time:
30 minutes

Activity Overview Web Address:
http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=traitcompare

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I. PEDAGOGY

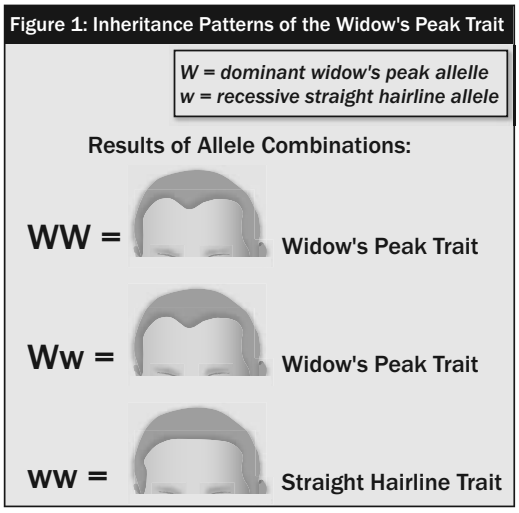
A. Learning Objectives

- Students will determine which variation they have for several traits.
- Students will understand that scientific research is continually evolving and that more recent research may not support the conclusions of earlier research.
- Students will understand that not all scientific studies reach the same conclusions.

B. Background Information

Physical traits are observable characteristics 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. 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.

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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.

While a few traits are due to only one gene (and its alleles), most human genetic traits are the product of interactions between several genes.

The traits in this activity have commonly been presented as being determined by single genes. However, several have been shown to involve more than one gene, and research studies do not agree on the inheritance patterns of others. The text accompanying the photographs on the student pages (S-1 to S-7) details information about each trait. Note that scientists usually use the shorthand of a "dominant trait" rather than saying that a trait is due to a dominant allele. The information on the student pages was summarized from the following sources (see links in Additional Resources):

- Unless otherwise noted, all information is from Online Mendelian Inheritance in Man.
- PTC Tasting: - "Hating Broccoli May be in the Genes"
  - "Scientist Finds the Gene that Determines Major Sensitivity to Bitter Taste"

C. Teaching Strategies

1. Timeline

- Three weeks before activity:
  - Order PTC paper (see Material Sources)
- Day before activity:
  - Gather hard candies and PTC paper
- Day of activity:
  - Have students compare their traits to those in the photographs and determine which variation they have
  - Provide PTC paper to test for this trait

2. Classroom Implementation

This pictorial reference of traits was designed to be used in conjunction with two activities (see Additional Resources):

- *An Inventory of My Traits* – In this activity, students take an inventory of their own easily observable genetic traits and compare those inventories with other students in groups. Once the inventories are complete, students make data tables and bar graphs showing the most and least common traits in their group.

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- *A Tree of Genetic Traits* – In this activity, students mark their traits for tongue rolling, PTC tasting (a bitter tasting chemical) and earlobe attachment on tree leaf cutouts. They then place their leaves on a large tree whose branches 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.

You may also have students determine their traits without carrying out either of these activities.

To test for PTC-tasting ability:

- 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.
- Hand out a hard candy to each student, as the taste of PTC is bitter and slightly unpleasant.
  Teaching Tip: You may want to place small waste containers for PTC paper and candy wrappers around the room.

3. Extensions

- Carry out the *An Inventory of My Traits* activity and/or the *Tree of Genetic Traits* activity (see Additional Resources).
- Provide mirrors so students can observe their own facial traits.

4. Assessment Suggestions:

- Use *Traits Bingo* (see Additional Resources) as an assessment of students' understanding of inherited traits.

5. Common Misconceptions:

- Some students think that dominant alleles or traits are "stronger", "better" or always the most common. However, the frequency with which a trait is observed depends on the frequency of the alleles for that trait in the population. A dominant trait maybe quite rare, while a recessive trait may be the most common one observed.

II. ADDITIONAL RESOURCES

A. Activity Resources - linked from the online Activity Overview:
http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=traitcompare

- Website: Online Mendelian Inheritance in Man
- Websites: Three articles on the discovery of the PTC gene

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- Teacher Guide: An Inventory of My Traits
- Teacher Guide: A Tree of Genetic Traits
- Teacher Guide: Traits Bingo

III. MATERIALS

A. Detailed Materials List

- Photocopies of student pages (S-1 to S-7) – one per group
- PTC paper – one piece per student
- Hard candies – one piece per student
- Mirrors - optional

B. Materials Sources

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)

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.

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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.
   d. Compare things, processes, and events.

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:
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Harmony Starr, Genetic Science Learning Center (illustrations)

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

Name_____ Date_____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ▪▪▪▪▪▸ Dimples

Check your smile. If small indentations form on the surface of one or both cheeks you have dimples.

Dimples are reportedly due to a single gene with dimples the dominant trait and a lack of dimples the recessive one.

Dimples

Name _____ Date _____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ·····→ Earlobe Attachment

Examine the lower part of your earlobes. If they hang free, you have detached earlobes. If they attach directly to the side of your head, you have attached earlobes.

Some scientists have reported that this trait is due to a single gene for which unattached earlobes is dominant and attached earlobes is recessive. Other scientists have reported that this trait is probably due to several genes.

The size and appearance of the lobes are also inherited traits.

Attached Earlobes

Detached Earlobes

Name_____ Date_____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ·····→ Hairline Shape

Examine the shape of your hairline across your forehead. If it forms a V-shaped point, you have a widow's peak. If not, you have a straight hairline.

Hairline shape is reportedly due to a single gene with a widow's peak dominant and a straight hairline recessive.

Widow's Peak Hairline

Straight Hairline

Name _____ Date _____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ·····→ Hand Clasping

Without thinking about it, fold your hands together by interlocking your fingers. Which thumb is on top – your left or your right?

One study found that 55% of people place their left thumb on top, 45% place their right thumb on top and 1% have no preference.

A study of identical twins concluded that hand clasping has at least some genetic component. However, other scientists have not found evidence that genetics plays a significant role in determining this trait.

Cross Left Thumb Over Right

Cross Right Thumb Over Left

Name _____ Date _____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ▪▪▪▪▪▸ Thumb Extension

Try to bend your thumbs backwards at the joints. Some people can form at least a 45 degree angle, which is called a hitchhiker's thumb. Other people have straight thumbs which do not bend in this way.

The thumb extension trait is reportedly due to a single gene. Straight thumb is dominant, with 75% of the U.S. Caucasian population displaying this trait. Only 25% of the population has the recessive hitchhiker's thumb.

No Hitchhiker's Thumb

Hitchhiker's Thumb

Name_____ Date_____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ▪▪▪▪▪→ Tongue Rolling

Can you roll your tongue into a U shape? Try it.

In 1940, the famous geneticist Alfred Sturtevant noted that about 70% of people of European ancestry are able to roll up the lateral edges of the tongue, while the remaining 30% were unable to do so.

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, there is some question about the inheritance of tongue rolling. Recent studies have shown that around 30% of identical twins do not share the trait.

Can Roll Tongue

Can't Roll Tongue

Name _____ Date _____

COMPARING INHERITED HUMAN TRAITS

Trait Profile ▪▪▪▪▪→ PTC Tasting

For some people the chemical phenylthiocarbamide (PTC) tastes very bitter. For others, it is tasteless.

Does Not Taste PTC

The ability to taste PTC shows dominant inheritance and is controlled by a gene on chromosomes 7. This gene codes for part of the bitter taste receptor in tongue cells. One of its five alleles (forms) causes a lack of ability to sense bitter tastes; the other four alleles produce intermediate to fully sensitive taste abilities. Approximately 75% of people can taste PTC while the remaining 25% cannot.

Tastes PTC

PTC-like chemicals are found in the Brassica family of vegetables, such as cabbage, brussels sprouts, and broccoli. People who can taste PTC often do not enjoy eating these vegetables, since they taste bitter to them. Non-tasters tend not to notice bitter tastes and therefore may be more likely to become addicted to nicotine (which is bitter).

PTC-tasting ability has also provided information related to human evolution. Populations in Sub-Sahara Africa, and people who are descended from this area, contain at least five forms of the gene. Some of these forms confer a PTC-tasting ability that is intermediate between taster and non-taster. However, with only a few exceptions, only two forms – taster and non-taster – are found in populations outside of Africa and their descendents. This is consistent with the out-of-Africa hypothesis of modern human origins.

Some scientists think that tasters have fewer cavities, suggesting that there might be a substance in the saliva of tasters that inhibits the bacteria that cause cavities to form. Others think that PTC tasting may be in some way connected with thyroid function.

PTC tasting was a chance discovery in 1931.