Gene Schemes

Overview

Students will be exploring a variety of observable inherited traits in order to develop a foundation on which to build an understanding of genetics and heredity. They will tally their own and classmates' observable, inherited traits such as whether or not their earlobes are attached or free. In addition, they will discover that some traits are learned or the result of environmental factors, while others are inherited.

Suggested Use

Use this activity as a motivating way to introduce some of the basic concepts of heredity and to provide a brief introduction to the concept of dominance and recessiveness. Rather than using this activity as a stand-alone, it should be integrated into a unit of study. (Stacops, an investigative activity available on this Web site, gives students an opportunity to further study heredity at the genetic level using fictitious marshmallow creatures as models.)

Approximate Time

This activity will take one forty-five to sixty-minute period to collect and analyze data. You may wish to devote another period to analyzing data collected from a larger sample of students as a homework assignment. Additionally, students can use secondary resources including the Internet to deepen their understanding. Keep in mind that timing may vary with student needs and interests.

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Content Background

Every human is different and unique. The characteristics that make up these differences may be acquired through environmental factors or inherited as **traits**. Traits are passed down from parents to children. The passing of traits from parent to offspring is called **heredity**. A child will be a unique combination of traits from both mother and father and will resemble each parent in some way.

The **gene** is the unit of inheritance. In sexual reproduction, sperm and egg each carry one-half of the genes for the new individual. The resulting fertilized egg contains genetic information from each parent.

One pair or many pairs of genes can determine a single inherited trait of an individual. Some genes are **dominant** and some are **recessive**. If one kind of gene of a pair hides the other, the trait that is expressed is dominant. The trait that is hidden is called recessive.

Dominance has nothing to do with how common a trait is in the population. Some dominant traits are actually rare.

Vocabulary

traits	**heredity**	**gene**	**dominant**
recessive			

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New York State Core Curriculum Major Understandings

This activity supports the following **New York State Core Curriculum Major Understandings for Grades 5 to 8:**

2.2a In all organisms, genetic traits are passed on from generation to generation.

2.2b Some genes are dominant and some are recessive. Some traits are inherited by mechanisms other than dominance and recessiveness.

(The understandings that this activity presents are correlated with The State Education ILSE Test Sampler #3 and 4.)

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New York City edition of the *New Standards*™ *Performance Standards* for Middle School Science

This activity supports the following **New York City Performance Standards for Middle School Science:**

The student demonstrates conceptual understanding of (S2b) reproduction and heredity, such as sexual and asexual reproduction; and the role of genes and environment on trait expression by using these concepts accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate.)

This activity can be adapted to address standards listed in the new of the **New York City edition of the *New Standards*™ *Performance Standards* for High School Science** and the **New York State Core Curriculum for The Living Environment.**

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Materials

For each student:

- One copy Handout 2.

For each set of partners or small group:

- One copy of Handout 1.
- Several strips of PTC (phenylthiocarbamide*) paper or other taste papers available from biological supply companies
- Several strips of control taste papers available from biological supply companies (These papers look like taste papers – but they have no chemical additive.)
- One small plastic mirror (optional)

*(These papers are impregnated with chemicals that will taste differently depending upon an individual's genotype. For example, seven out of ten people will detect a definite taste of PTC. For three out of ten there will be no taste.)

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Getting Ready

1. Cut PTC paper, or other taste papers, into small strips, one per student.
2. Cut control paper into small strips, one per student.
3. Divide materials for appropriate number of groups and place in trays for distribution.
4. Make one photocopy of Handout 1 for each set of partners or small group and one copy of Handout 2 for each student.
5. Make a class tally chart on large poster paper or on an overhead transparency similar to the following.

Tally for Class:

TRAIT ↓	Table 1		Table 2		Table 3		Table 4		Table 5		Table 6	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Tongue Roller												
Widow's Peak												
Free Earlobe												
Taste PTC												
Hitchhiker's Thumb												
Bent Little Finger												
Mid-Digital Hair												
Dimples												
Short Hallux												
Short Index Finger												

Handouts are provided to give students directions as well as a place to record responses, questions and results. In order to encourage students to write more in-depth responses, you may wish to provide journals.

Tally for Class:

TRAIT ↓	Table 1		Table 2		Table 3		Table 4		Table 5		Table 6	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Tongue Roller												
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Lesson Procedure

First 45-to-60 minute period

Setting up the Problem

With the whole class, brainstorm and develop a list of characteristics or traits that make one person different from another. (Possible responses include: hair color, hairstyles, eye color, skin color, height, weight, and language spoken.) Then have students help you identify those traits that are inherited from parents, which are learned or acquired and which might be a combination of both. Ask them to defend their choices with evidence. (Possible response: You inherit your ability to speak, but the language or languages that you speak is dependent upon which you are taught. You inherit your skin color; but exposure to sun can darken it.) List any questions that come out of the discussion for later research.

Mini-Lesson

Display the following data table.

The Length of 30 Eighth Graders' Big Toes

Trait	Number of Students
Short big toe relative to 2nd toe	~~////~~ ~~////~~ ~~////~~ ~~////~~
Long big toe relative to 2nd toe	~~////~~ ///

Can students find the error in the data table? (Answer: The number of tally marks does not equal the total number of students.) If necessary, quickly review how tallies are kept. Then explain to students that they will be creating data tables to keep a tally of different inherited traits in a group of students. Why do they think it is important to make sure that the tally marks add up to the total number of students? (Possible answer: In order to draw conclusions about the results, it is important to keep accurate data.) Ask them to double-check their data as they work to be sure that they are recording accurately.

Independent Work Time

Divide the class into groups of three to four students. Distribute Handout 1 to students. Discuss the inherited traits described. Distribute Handout 2 and ask students to create data tables for themselves and their groups to show the number of people with each trait.

As they work, ask students to describe how they are working to ensure that they record and tally their data accurately.

In addition, you might want to encourage students to begin to speculate about questions such as the following: "Are there any two students in their groups that share all of the traits listed? Why do they think this is so? Are there any traits that seem to occur more frequently than others? Why do they think this is so? Do they notice any relationship between any two traits—for example index finger length and hallux (big toe) length?"

When each group of students has completed its tally chart, have one student enter its data onto the class tally chart.

NOTE: Do not allow any individual student's personal or family genetic information to be displayed or discussed – discuss only the number of people with various traits.

Share

Have students work to total the results of each trait. Did the class do a good job of recording the results? Do the totals in the *yes* and *no* columns for each group add up to the total number of students?

Ask students to write in their journals about some of the things they notice about the results. Suggest they answer questions such as: "Do some traits occur more frequently than others? How do the class results compare with their individual group's results? Are there any surprises? What might explain why some traits are more common than others? Do they think they would get the same results if they surveyed other students?"

As students write, walk around to determine which students' conclusions might be interesting to share with the class. As a class, discuss their conclusions and reasoning.

When students are finished sharing, summarize with students that traits are passed down from parents to children. Mention that this passing of traits from parent to offspring is called *heredity* and that genes are the unit of heredity. Explain that we get half of our genes from our fathers and half from our mothers. Which version of some traits that we inherit – such as a long or short big toe – is dependent upon **dominance** and **recessiveness**. Do students know what these terms mean? If not, you might want to provide this or a similar explanation: "Polydactyly (more than five digits) and syndactyly (webbed fingers or toes) are dominant traits. People with five, unwebbed fingers and toes form the large majority of the population. These people must have two genes – one from each parent – for each of the recessive traits (five fingers, no webbing). To inherit a dominant trait, only one gene of the pair of genes for that trait is necessary." Emphasize that dominance refers only to the appearance (phenotype) of individuals – it has nothing to do with how common a trait is in the population.

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Extension/Homework

Have students research information about the role of dominant and recessive genes in heredity. An excellent Web site for them to visit is: http://vector.cshl.org/dnaftb/. This site explains concepts in simple language with animated graphics. It also gives students an opportunity to test their understanding of concepts through problem-solving activities.

Optional Lesson Procedure

Second 45-to-60 minute period

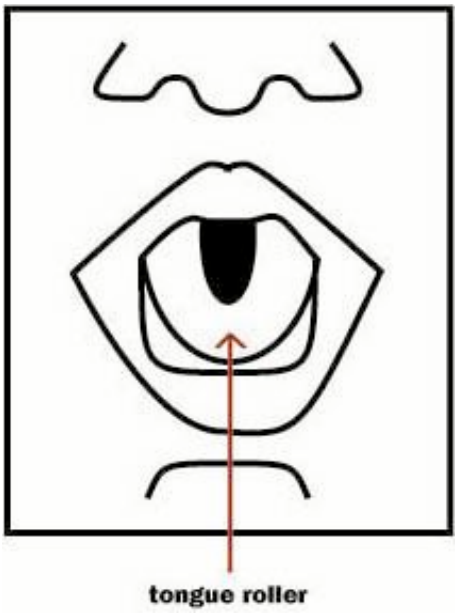
Assign students the task of conducting a random sampling of their schoolmates or out how prevalent a given trait – such as widow's peak – is. First compute the percent of students with the trait from the class survey. Then gather data and compute the percent from the random sample. Why might they be the same or different? Can they make any conclusions about the wider population from their sample? Why or why not?

Gene Schemes: Handout 1

Name: _____ Date: _____

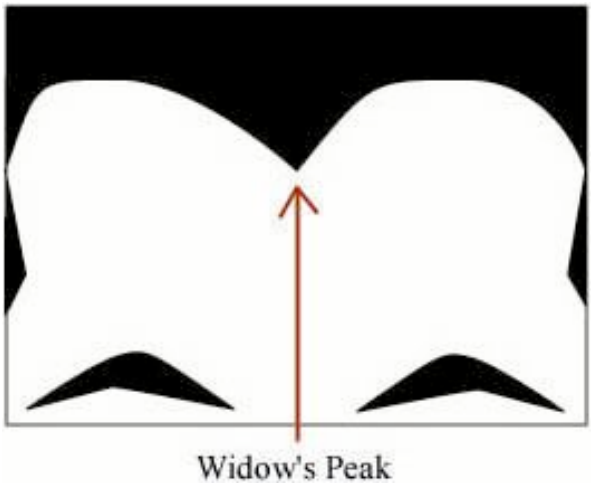
Human beings are different in many ways. They have different characteristics and traits. In this activity, you are going to determine how your traits differ from other people's traits.

Determine which of the following traits that you have. Use the drawings and the descriptions to help you. Record the appropriate response for each item on the data sheet.



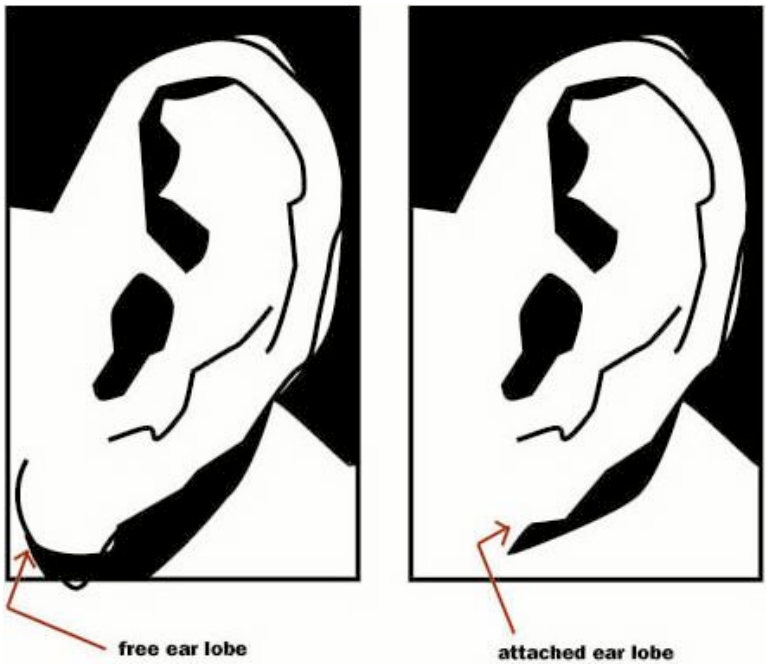
Tongue Rolling

Try to roll your tongue into a u-shape. The sides of your tongue should be curled upwards.



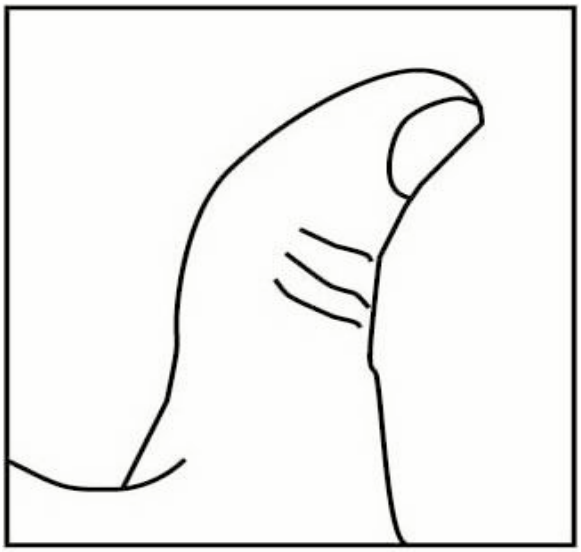
Widow's Peak

In some people the hairline forms a distinct downward point in the center of the forehead. Baldness will mask the expression of this gene. With the aid of a mirror or classmate, determine whether or not you have inherited a Widow's Peak.



Earlobe Attachment

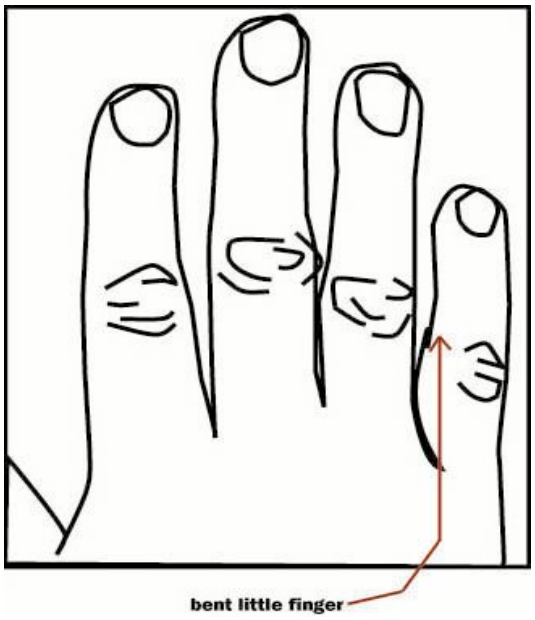
Some people have a free or unattached earlobe (on the left); others have an earlobe attached directly to the head (on the right). Determine if you have attached or free earlobes.



Hitchhiker's Thumb

Hitchhiker's Thumb

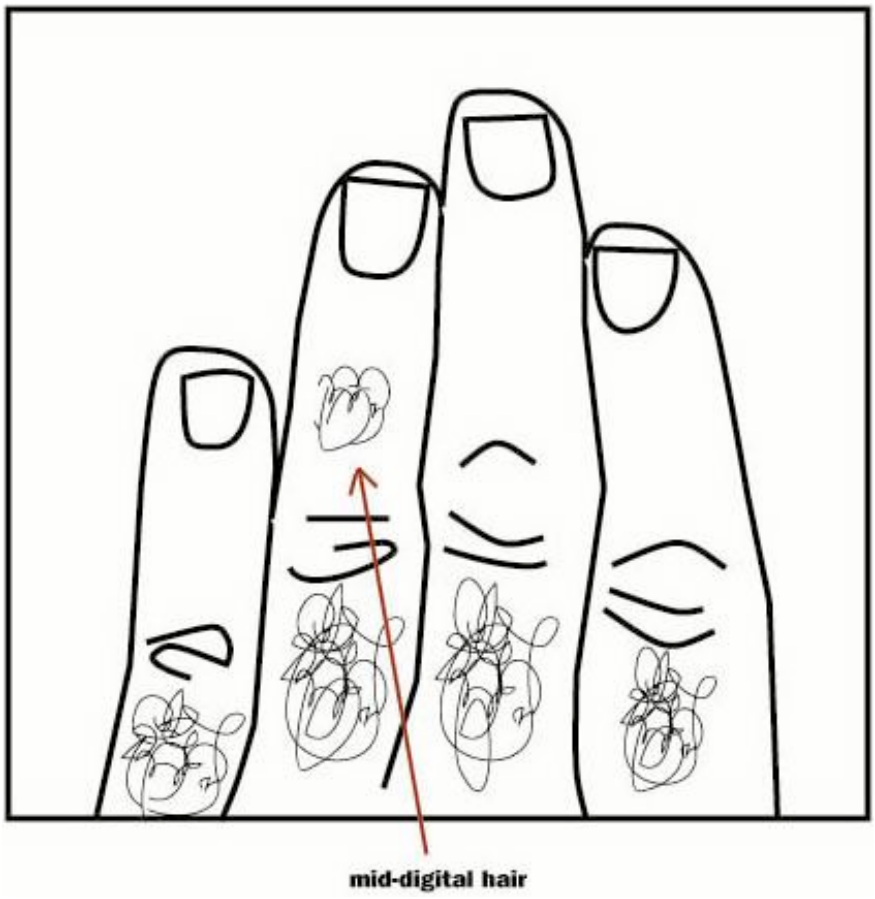
Some people can bend the last joint of the thumb backwards at about a 45° angle. Bend each of your thumbs back as far as possible. If you can bend both thumbs back 45° or more, you have a hitchhiker's thumb.



Bent Little Finger

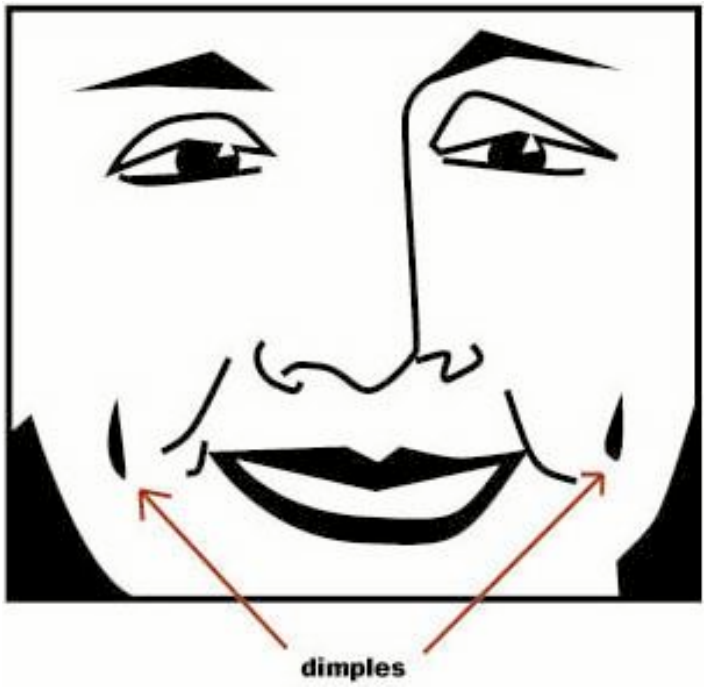
In some individuals the last bone of the little finger angles towards the fourth (ring) finger. Check this characteristic by laying your hands flat on the desk and relaxing them.

GENE SCHEMES: HANDOUT 1, CONTINUED



Mid-digital Hair

Some individuals have hair on the middle segment of the fingers. Examine your hands closely to see if you have hair on the middle or second joint of any of your fingers.



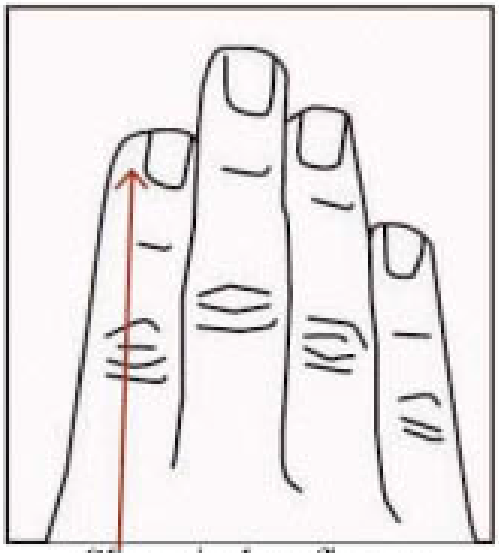
Facial Dimples

Smile to determine if you have facial dimples.

Hallux Length

Some individuals have a hallux (big toe) that is shorter than their second toe. If necessary, take one shoe off and feel through your sock.

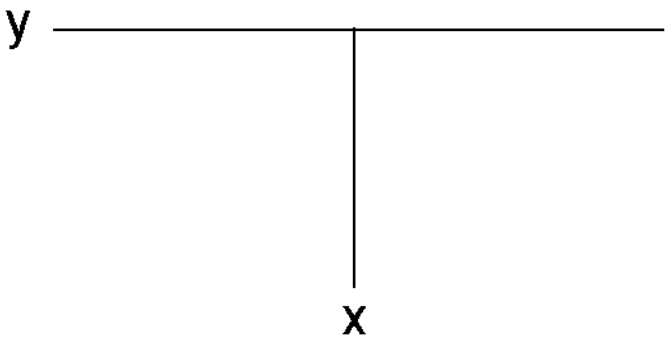
GENE SCHEMES: HANDOUT 1, CONTINUED



Short index finger

Index Finger Length

Relax your right hand on this sheet of paper so your middle finger lies on top of line *x* (below) and the end of your fourth finger (ring finger) is in line with line *y*. If your second finger (index finger) does not reach to the top of line *y* or beyond, you have a short second finger.



PTC Tasting

Phenylthiocarbamide (PTC) is a harmless chemical in small quantities. Some individuals can taste it and others cannot.

Tear off a small piece (about 5mm square) of the *Control Taste Paper* (white). Place the paper on your tongue and move it around to be sure it becomes saturated with saliva. Notice the taste of the paper so you will not confuse it with the taste of PTC. Discard the bit of *Control Taste Paper* and repeat the test with *PTC Taste Paper* (blue). If you notice a bitter taste, then you are a taster of PTC. Discard the bit of *PTC Taste Paper* and have some water.

GENE SCHEMES: HANDOUT 1, CONTINUED

HUMAN TRAITS DATA SHEET

Name: _____ Class: _____Group:_____Date:_____

Chart of Individual Traits:

TRAIT ↓	Yes	No
Tongue Roller		
Widow's Peak		
Free Earlobe		
Taste PTC		
Hitchhiker's Thumb		
Bent Little Finger		
Mid-Digital Hair		
Dimples		
Short Hallux (big toe) relative to 2nd toe		
Short Index Finger		

Tally for Group:

TRAIT ↓	Number Yes	Number No
Tongue Roller		
Widow's Peak		
Free Earlobe		
Taste PTC		
Hitchhiker's Thumb		
Bent Little Finger		
Mid-Digital Hair		
Dimples		
Short Hallux (big toe) relative to 2nd toe		
Short Index Finger		

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