State Your Traits

Basic Principles of Inheritance for Grades 4 – 8

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Contents:

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Classroom Version & Teacher Instructions
Sample teacher dialog is given for guidance only. Commentary, extra teacher background, and sample student responses are given in italics.

Audience
Grades 4-8. This activity is very suitable for grades 4-6. Extensions are possible for grades 7-8. For example, the concepts of recessive and dominant can be incorporated into this activity for middle school students.

Classroom Set-Up
This activity works well with small groups of students (~4) clustered around tables.

Materials
- Genetic Traits Tree (see pp. 14, 19)
- Large wall graph for PTC tasting data (draw on butcher paper or blackboard)
- PTC paper, 100 strips/vial (order #AP7989 from Flinn Scientific, 800-452-1261)
- Waste containers (for used PTC papers, candy wrappers)
- Hard candies
- Genetic traits biophoto sheets (order #AA-17-4831 & #AA-17-4832 from Carolina Biological, 800-334-5551)
- Hand mirrors (1–2 per four students)
- Scissors (1–2 per four students)
- Post-its, $1^1/_2$" X 2" green and yellow (or any two different colors)
- Leaf pictures, green and yellow (included in this document)
- Genetic traits data forms (see pp. 16–18)

Preparation
Onto each table, place these materials for each group: vials of PTC paper, waste containers, hard candies, hand mirrors, post-its, scissors. Attach Genetic Traits Tree and large PTC wall graph to wall.

Activity 1: PTC Tasting
Activity 2: My Traits
Activity 3: Genetic Traits Tree
Activity 4: The Traits Game

Activities 1, 2, 3, and 4 should be done in sequence with no pause between activities. If a lack of class time necessitates, break the sequence between activities.

Activity 1: PTC Tasting ----------

Teacher: You will find a vial of paper strips on your table. These paper strips have small amounts of the chemical PTC spotted onto them. Small amounts of PTC are harmless to humans.

T: Remove one strip from the vial and place it on your tongue. Hold it there for a few seconds. Allow it to get wet, but do not chew it or swallow it. Discard the paper into the waste container on your table. After tasting the paper, you can help yourself to a candy if you'd like.

T: What did the paper taste like?

Bitter, nasty, like dandelion stems, like brussels sprouts, like old vegetables, like when you throw up, like nothing, like paper. If they wish, students who report the paper tasted like nothing/paper should be allowed to taste a second paper to confirm their "result."

T: Raise your hand if you tasted something when you put the paper into your mouths.

It is expected about 70% of people in the North American population are tasters of PTC, and this figure may be higher in children. The frequency of tasters also varies depending on race. People of African descent, for example, taste PTC at higher frequencies than people of Northern European descent.

T: Now raise your hand if you didn't taste anything or all you tasted was a paper taste.

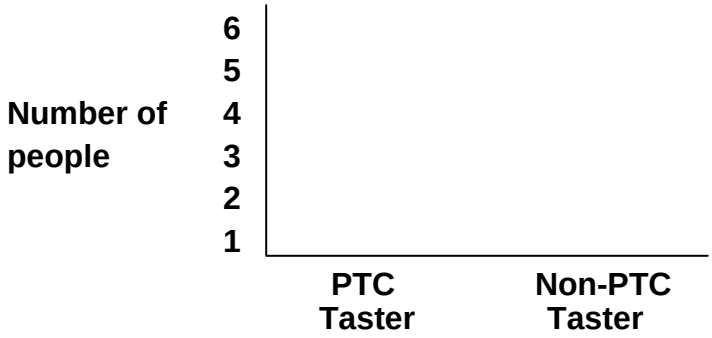
About 30% of people will be non-tasters of PTC.

T: Let's collect our taste information or **data** and make a graph on the wall. Scientists use graphs to help them organize and understand the data they collect during experiments.

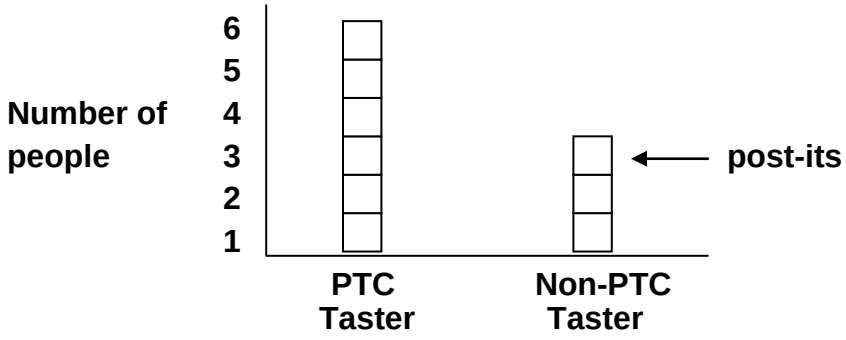
T: Look at the empty graph on the wall. Add your own PTC tasting data to the empty graph on the wall. Take a post-it note and place it on the graph in either the "PTC taster" or "Non-PTC taster" column. Place your post-its one on top of the other, so that a vertical bar is formed in each column. Use a green post-it if you're a boy and a yellow post-it if you're a girl.

See diagram of graph on next page. Note: other colors of post-its can be substituted for green and yellow.

EMPTY GRAPH
PTC Tasters vs. Non-PTC Tasters



COMPLETED GRAPH
PTC Tasters vs. Non-PTC Tasters



T: What does the graph tell us?

Some people can taste PTC, some can't. More people can taste it than can't. Some boys and girls can taste it. some boys and girls can't (no difference between the sexes in ability to taste).

T: Yes. We **vary** in our ability to taste PTC.

T: What do you think accounts for this **variation**? Why can some people taste PTC and other people can't?

An inherited difference, they got it from their parents, people who can't taste PTC have dulled their tastebuds with spicy foods.

At this point you may or may not choose to confirm for students that we do get the ability to taste PTC from our parents.

Students often wonder why we even have the PTC tasting trait. This can be discussed now or after more genetic traits have been introduced. Scientists don't know for sure why humans have a PTC tasting trait, but they do have some ideas. Although evolution and natural selection have probably not yet been covered in upper elementary school classrooms, students can understand that this trait may have been helpful long ago when humans were hunter-gatherers. What if a person put a poisonous leaf or root in his mouth? Would it help him survive if it tasted bitter to him and prompted him to spit it out?

Activity 2: My Traits ----------

T: There are other differences between us too. Look at these two people...

Ask for two volunteers to come stand at the front of the room.

T: How are they alike and how are they different?

One is girl and one is a boy (or they're both boys/girls), their hair color, hair texture (curly, straight, wavy), eye color, skin color, clothes, height, weight, eye glasses, hair length and style, ears pierced or not, both have one nose (or two ears, two hands, etc.)

Note: teacher or another volunteer can keep running list of traits on blackboard as students give responses.

T: Your **traits** are the way you look. And also sometimes what you can do, such as taste PTC. There are other traits that we can't see, such as your bloodtype.

T: Which of the traits on our list can be changed?

hair style and length, pierced ears, weight, hair color

T: Which traits can't?

sex, hair color, hair texture, eye color, skin color, height, vision, one nose, etc.

Students may give a variety of responses, and some traits may be placed in both categories, for example, hair color. Some traits such as height and weight may not fit clearly into either category because they are influenced by both genetic and environmental factors.

T: Why can't some traits be changed?

You were born with them... (see extended response below)

T: Where do these traits come from?

Your parents... (see extended response below)

T: (It may be helpful to use the following response verbatim. Notice the word "gene" has not been used.) Most traits that can't be changed are inherited from our parents. These are called **"genetic traits."** Some traits, like pierced ears, can be changed. These traits are not inherited from our parents. They are determined by what we do and how we live, in other words, by our **environment**. A few traits, like hair color, can be changed, but the hair color we are born with is a genetic trait. Our hair can change color if it is dyed with chemicals or exposed to lots of

sun. Some traits are affected by both our genetics and the environment, such as height and weight.

<u>Optional Assessment.</u> Ask students which traits on the list on the blackboard are inherited and which are environmentally determined.

Activity 3: Genetic Traits Tree ----------

T: Now we're going to look at a few more traits that make each of us similar and each of us unique.

Pass out biophoto sheets, data forms, and leaves. People will score traits and record on forms. Biophoto sheets are not passed out with the other materials prior to Activity 1 because they can be very distracting.

T: Fill in the data form with your traits. Work with a partner. Some traits are hard to score on your own, so ask your partner and use your mirror.

Give students 5-10 minutes to complete their forms. Circulate among the groups to monitor progress. There should be lots of informal discussion. Help students resolve scoring ambiguities for traits such as attached vs. free earlobes and mid-digital finger hair (see Appendix I for scoring tips).

Students are often intensely interested in genetic traits and may ask what other traits are inherited. Additional examples are hair, eye, and skin color, although these are determined by multiple genes instead of single genes like the other traits. Other single gene traits are freckles, color blindness, and hitchhiker's thumb. We have also heard but haven't seen this verified in the scientific literaturethat some simple behaviors are determined by single genes, such as sneezing in bright sunlight or which thumb a person places on top when clasping hands. Some classes may wish to investigate some of these other traits. Some inherited disorders such as sickle cell disease and hemophilia are also determined by single genes. Two blank rows have been left in the data form for classes that want to score additional traits.

T: Raise your hand if you can roll your tongue. How many people have dimples? Widow's peak? How many people can roll their tongues, have dimples, AND have widow's peak?

Very few students will have all three traits.

T: I've only asked you about 3 genetic traits, and already there are very few people in the class with that particular combination. The many possible combinations of all of our genes is our species' **genetic variation** or **genetic diversity.**

T: Now you'll compare your combination of traits to the combinations of others in the class.

- Cut out a leaf from the yellow and green papers found on your table. If you are a boy, cut out a yellow leaf. If you are a girl, cut out a green leaf.
- On your leaf, mark your traits for tongue rolling, earlobes, and PTC tasting. *Note: other trait combinations can also be used.*
- If you wish, write your name on your leaf.

  Note: optional only. Allows students to easily find their leaf later and compare their trait combination to others in the class.
- Each branch of the tree *(point to large tree taped to wall)* represents a different combination of traits. Tape your leaf to the end of the correct branch for you.

  This will take several minutes. There will be a logjam as students gather around the tree to tape their leaves up. It may work more smoothly to ask tables one at a time to tape their leaves to the tree.

T: The tree is like the graph—a way to organize and display data. What do you observe when you look at the tree?

There are leaves on every branch, the leaves are spread out all over the tree, some branches don't have leaves, one side of the tree has most of the leaves, some branches have mostly yellow or green leaves, there are no branches with only one color of leaf.

Note: If the first trait you choose for the first branching point on the tree is a trait that most people in the class have, then the leaves will appear mostly on one side of the tree. We recommend you choose a trait for the first branching point that is not found predominantly in one form only, e.g. PTC tasting is probably not a good choice for the first branch.

If responses are slow in coming, teacher can ask questions to guide discussion, such as:

•Are the leaves all or mostly on the same branch of the tree? All or mostly on the same side of the tree?

•Are there any branches with mostly yellow or green leaves? If so, what does that mean? *(it means some combinations of traits are more often found in one sex than the other)*

•Is there anyone in the class that has the same three traits as you *(leaf at the end of the same branch)*? If yes, are there any other traits that distinguish you from him or her?

Activity 4: The Traits Game ----------

The game is modified from an activity contained in Human Genetic Variation (1999).

T: Let's look at just how unique each of us is. How many genetic traits do you think you would have to look at to identify yourself as unique—different from all the others in the class?

Allow students to volunteer their predictions: e.g. 5, 6, 7, 10, or 50 genes, etc. Now test the prediction by playing the game.

Have all students stand up. Ask for a volunteer. Volunteer reads off his first genetic trait from the list, e.g. "I am a PTC taster." Students who cannot taste PTC sit down. Volunteer reads off next trait: e.g. "I have attached earlobes." Students with free earlobes sit down. Volunteer continues reading off traits, one at a time, until he is the only student left standing. Ask students to count how many traits it took before the volunteer was unique. How well did this number match their prediction? The number is usually around 5-7.

T: It only took _____ traits (fill in number) before _____ (fill in name of volunteer) was unique. Let's try it again.

Repeat game one or two more times. You may find your students want to play this game until each student has had a chance to be the volunteer. This isn't necessary but can be done if there is extra time. Students can be fascinated by who is the last person left standing with the volunteer and may christen this student the volunteer's "twin." Students will be surprised to see that their "twins" often don't look very similar to themselves at all.

T: We've only looked at a few traits today, ones we can easily see. And we've seen that it takes about 6 (or whatever number your class has observed) traits to set one person apart from the rest of us. And there are so many more traits we haven't scored today, such as bloodtype and other traits inside of us that control how our bodies work. If you could look at all of our traits, there would many, many differences between us.

Extensions

Have students survey their parents and siblings for some common genetic traits and construct family trees for specific traits. A data collection form for relatives

of students is included in this document. Do children always have the same traits as their parents? As their brothers and sisters?

Saving Time

One way to compress the time these activities take is to eliminate having students score all the traits on the data form during Activity 3. Don't pass out the data forms. Instead pass out just the biophoto sheets and have students score only the traits on the leaves, e.g. PTC Tasting, Tongue Rolling, and Earlobe Attachment, or whichever three traits you have chosen.

References ----------

Human Genetic Variation (1999). NIH Curriculum Supplement Series. National Institutes of Health. http://science-education.nih.gov/supplements.

National Science Education Standards (1996). National Research Council. National Academy Press, Washington DC. http://search.nap.edu/html/nses/html.

Traits Information & Tips on Scoring the Traits----------

These traits are determined by single genes and have a dominant and recessive form: Tongue Rolling, Widow's Peak, Dimples, Cleft Chin, Earlobe Attachment, Finger Hair, and PTC Tasting. Scoring these traits is fairly unambiguous and information to help you is given below. The biophoto sheets contain color photographs of a number of common genetic traits. Some traits on the sheets are more difficult to score.

Tongue Rolling. The ability to roll your tongue upwards to form a closed tube. The sides of your tongue will meet at the top of the tube if you can roll your tongue.

When students first learn tongue rolling is an inherited trait, they may be surprised and comment that if only people who can't roll their tongues would practice, they could learn to roll their tongues too. Tongue rolling, then, is an example of a "motor skill" that is inherited. Is a good golf swing or a good free throw shot any different?

Widow's Peak. If you have Widow's Peak, your forehead hairline will have a downward dip in it, as in a heart. Lift up the hair of your forehead to score this trait. People without widow's peak have a smooth hairline with no dip. Men starting to go bald (or already bald) may be unable to score this trait.

Dimples. Indentations in the cheeks, especially noticeable when smiling. Score as "yes" only if a dimple on each side is present. Score those with a dimple on only one side as "no."

Cleft Chin. A dimple or cleft in the center of the chin.

Earlobe attachment. Earlobes are attached if the bottom lobe is attached directly to the head. Earlobes are free if the lobe hangs free.

Finger Hair. Officially known as *Mid-digital Finger Hair.* Consider your fingers to have 3 segments, top, middle, and bottom. If hair is present on the middle segment of any finger, even just one hair, you have mid-digital hair. Do not score the bottom segment of your fingers for hair, just the middle segment. Look closely, as is can be difficult to score. Hair may be present on only one finger or very fair, especially in children..

PTC Tasting. The ability to taste the chemical PTC, which is harmless when ingested in small amounts. To a non-taster, the paper strips have no taste.

Directions for Making and Using the Tree ----------

Making the Tree

You will need to make a Genetic Traits Tree to use with Activity 3. A diagram showing the outline of a tree can be found later in this document. Your finished tree need not be identical, but the branch structure should be similar. The completed tree should be about 3 to 4 feet tall and about 3 feet wide. How do you make the tree? One solution is to use a drawing program to create a computer document of a large tree for printing out on a large color printer/plotter. For increased durability, the tree poster can be laminated at a photocopy store. A perfectly adequate tree can also be created by cutting the trunk and branches out of brown butcher paper and taping them together. It is best to use light brown paper so that labels on the branches can be easily read.

Labeling the Tree

Label the two branches on each side of each fork in the tree with a particular trait. The traits are your choice. Use pencil or tape on labels so that you can try different traits on your tree if you use it again. The activity works best if the first trait (nearest to the trunk) is one where both forms are common in the population (e.g. attached and free earlobes). A good combination of traits is Earlobe Attachment, PTC Tasting, and Tongue Rolling. If you use this combination, you would label the tree as follows. Start at the bottom of the tree and move up the trunk to the first fork. Label the left branch "Attached Earlobes" and the right branch "Free Earlobes." Continue up the Attached Earlobes branch. When the branch forks, label the left branch "PTC Taster" and the right branch "Non-PTC Taster." Do the same on the "Free Earlobes" branch. Continue up the branch and at the final fork, label the new branches "Tongue Roller" and "Non-tongue Roller." Repeat for the remaining branches.

Labeling the Leaves

It is best to label the leaves with the traits in the order students will encounter them as they work up the tree from bottom to top. Included in this document are a leaf template with the trait combination Earlobe Attachment/PTC Taster/Tongue Roller and a template with blank leaves, so that you can fill in your own.

Science Standards ----------

The State Your Traits activities support the following national and Washington state science education standards.

National Science Education Content Standards for Life Science:

- Grades K-4. Plants and animals closely resemble their parents.
- Grades K-4. Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interaction with the environment. Features learned through interactions with the environment cannot be passed on to the next generation.
- Grades 5-8. Some organisms reproduce sexually.
- Grades 5-8. The new individual produced by sexual reproduction receives genetic information from its mother and its father. Sexually produced offspring never are identical to either of their parents.
- Grades 5-8. Hereditary information is contained in genes. Each gene carries a single unit of information.
- Grades 5-8. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.
- Grades 5-8. The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interactions with the environment.

Washington Essential Academic Learning Requirements in Science (scientific concepts and principles requirement)

- Grades K-5. Plants and animals closely resemble their parents.
- Grades K-5. There must be a reliable way to transfer information between generations.
- Grades K-5. Some likenesses between parents and offspring are inherited. Other likenesses are learned or . . . . influenced by environmental factors.
- Grades 6-8. Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another. The new individual receives genetic information from its mother and its father. Sexually produced offspring are never identical to either of their parents.
- Grades 6-8. The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others are acquired through interactions with the environment.

Individual Data Collection Form

Please provide the following information:

Date: _____ **School:** _____

Sex (circle one): Male Female **Age:** _____

Fill in your traits in the table below. If you are uncertain, mark neither option.

Trait	**Yes**	**No**
Tongue Rolling		
Widow's Peak		
Dimples		
Earlobe Attachment	(attached)	(free)
Mid-digital finger hair		
PTC Taster	(taster)	(non-taster)
Cleft Chin		

Individual Data Collection Form

Please provide the following information:

Date: _____ **School:** _____

Sex (circle one): Male Female **Age:** _____

Fill in your traits in the table below. If you are uncertain, mark neither option.

Trait	**Yes**	**No**
Tongue Rolling		
Widow's Peak		
Dimples		
Earlobe Attachment	(attached)	(free)
Mid-digital finger hair		
PTC Taster	(taster)	(non-taster)
Cleft Chin		

Individual Data Collection Form for Relatives of Students

Please provide the following information: **Date:** _____ **Age:** _____

Your relation to student: _____

School: _____ **Sex** (circle one): Male Female

Fill in your traits in the table below. If you are uncertain, mark neither option.

Trait	**Yes**	**No**
Tongue Rolling		
Widow's Peak		
Dimples		
Earlobe Attachment	(attached)	(free)
Mid-digital finger hair		
PTC Taster	(taster)	(non-taster)
Cleft Chin		

Please staple this form to student form

Individual Data Collection Form for Relatives of Students

Please provide the following information: **Date:** _____ **Age:** _____

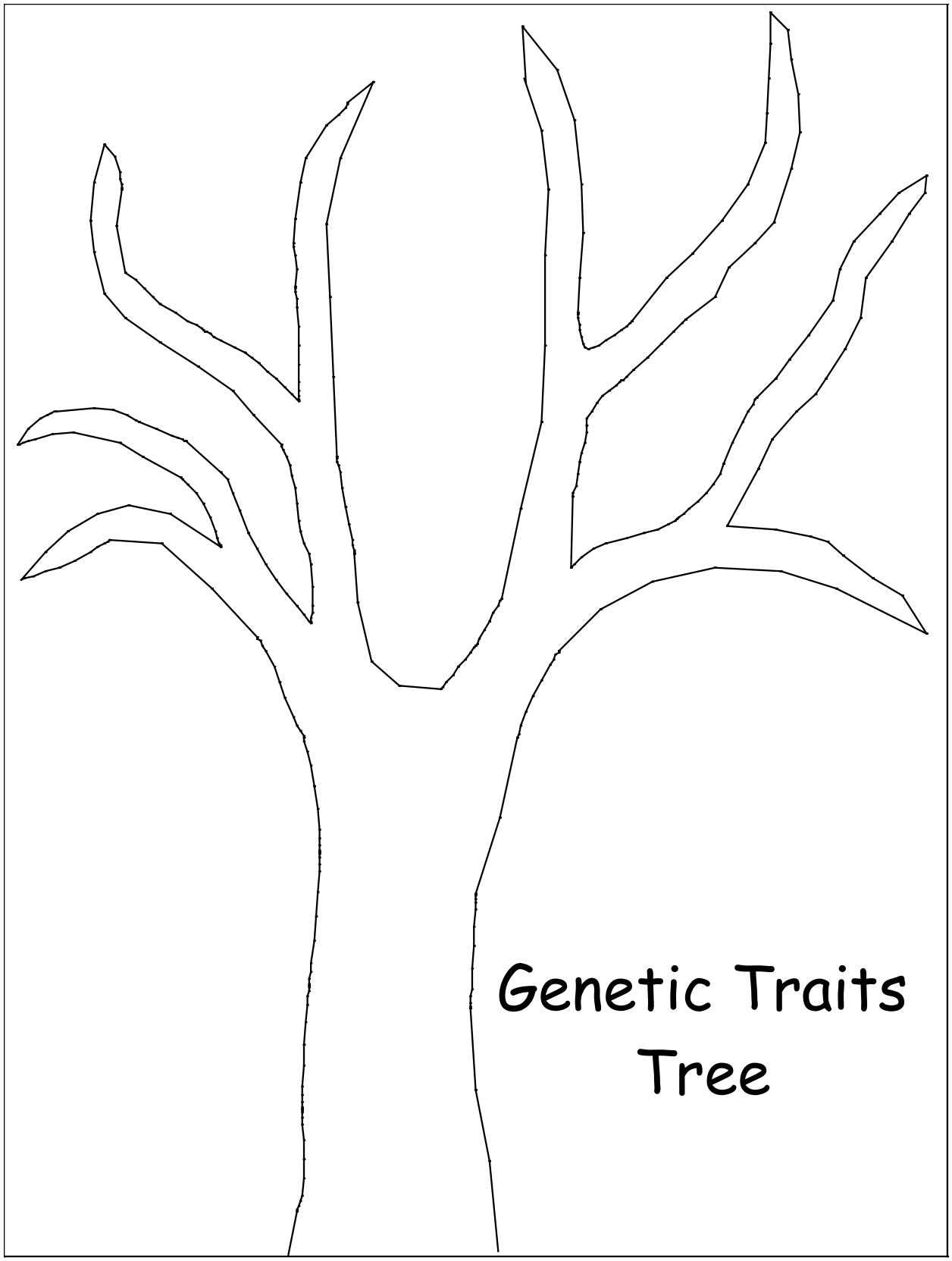
Your relation to student: _____

School: _____ **Sex** (circle one): Male Female

Fill in your traits in the table below. If you are uncertain, mark neither option.

Trait	**Yes**	**No**
Tongue Rolling		
Widow's Peak		
Dimples		
Earlobe Attachment	(attached)	(free)
Mid-digital finger hair		
PTC Taster	(taster)	(non-taster)
Cleft Chin		

Please staple this form to student form


Genetic Traits
Tree