54 Investigating Human Traits

Some children look very similar to one of their biological parents. Some appear to be more of a blend of both parents, while others don't look very much like either parent. What are the reasons for this variation in family resemblance? What causes variation among people in general? You will look at six different human **characteristics**, such as eye color, to study human variation. Each of these characteristics can occur in different versions, or **traits** (TRATES).

CHALLENGE **How much variation is shown by the students in your class?**

MATERIALS

For each pair of students

- **1 meter stick, tape measure, or height chart**

For each student

- **1 Student Sheet 54.1, "Human Traits: Group Results"**
- **1 Student Sheet 54.2, "Human Traits: Class Results"**
- **1 piece of PTC paper**
- **1 piece of control paper**
- **1 sheet of graph paper**

PROCEDURE

1. Working with your group, decide whether each person's eyes are blue, gray, green, brown, or hazel (hazel eyes are a very light brown with yellow or green tones). If a person's eyes are difficult to classify, choose the color that is closest. Record your results on Student Sheet 54.1, "Human Traits: Group Results."

TONGUE ROLLING

2. Try to roll your own tongue into a U-shape similar to that shown at left. On the student sheet, record who can and who cannot roll his or her tongue.
3. Try to cross all the fingers of the hand you normally write with as shown below. You may use your other hand to help position the fingers. You should begin by crossing your pointer finger over your thumb, then try to cross your middle finger over your pointer finger. Continue trying to cross each finger, one by one, on top of the next finger. On the student sheet, record who can and who cannot cross his or her fingers like this.
4. Working with a partner, use a meter stick or height chart to measure each other's height in centimeters (cm). Round to the nearest 5 cm and record the results on the student sheet.

FINGER CROSSING

5. Working with a partner, use a meter stick or measuring tape to measure each other's arm span in centimeters (cm). Obtain the arm span by spreading your arms out sideways as far as possible, and having your partner measure from the tips of the fingers on one hand to the tips of the fingers on the other hand, as shown below. You may have to ask another student to help you hold the meter stick or measuring tape. Round to the nearest 5 cm and record the results on the student sheet.

MEASURING ARM SPAN

6. Obtain one piece of plain paper and one piece of PTC paper from your teacher.
   a. Place the piece of plain paper on your tongue and move it around to be sure it mixes with your saliva. Then remove and discard the piece of paper as directed by your teacher.
   b. Do the same thing with the PTC paper. Record whether the PTC paper tastes different from the plain paper. If it tastes different, also record whether the taste is mild or strong.
7. Complete Table 1, "Group Results Summary," on Student Sheet 54.1. Note that you do not have to record totals for the height and armspan.
8. Have one person report your group's results to your teacher.
9. Record the class totals on Student Sheet 54.2, "Human Traits: Class Results."
10. Prepare a bar graph of the class data of one of the traits, as assigned by your teacher. Be sure to label your axes and title your graph.

ANALYSIS

1. For each of the six characteristics you studied, how many versions, or traits, are observed in your class? Copy a table like the one below into your science notebook. (For example, if your class has people with brown and blue eyes only, then you would fill in the first column with "eye color," the second column with "brown and blue," and the third column with the number "2" to represent the two colors observed.)

Characteristic	Traits	Number of Traits
Eye color		
Tongue rolling		
Finger crossing		
PTC tasting		
Height		
Arm span		

2. Which of the traits you investigated—for eye color, tongue rolling, PTC tasting, crossing all your fingers, height, and arm span—do you think people inherit from their biological parents? Explain.

3. If a trait is not inherited, what else might cause it? Explain or give some examples.

4. If you studied more people in your community, would you expect to find more traits for each characteristic? Explain your answer.

5. **Reflection:** Who do you most look like in your family? Explain.

EXTENSION

Gather data on ten more people who are not in your class and bring the results to class to add to the totals.

Investigating Human Traits 54

1-2
40- to 50-minute sessions

ACTIVITY OVERVIEW

Students investigate traits for six human characteristics to begin a discussion of human variation and heredity. They learn that traits can be inherited, environmentally acquired, or created by a combination of hereditary and environmental factors. When students graph their data they see human variation patterns.

KEY CONCEPTS AND PROCESS SKILLS

(with correlation to NSE 5–8 Content Standards)

1. Students use appropriate tools and techniques to gather, analyze, and interpret data. (INQUIRY: 1)
2. Students construct graphs to reveal patterns that are not immediately apparent in data tables. (INQUIRY: 1)
2. Every organism has a set of instructions for specifying its traits. (LIFE SCIENCE: 2)
3. Genes contain hereditary information. (LIFE SCIENCE: 2)
4. The characteristics of an organism can be described in terms of a combination of traits. (LIFE SCIENCE: 2)

KEY VOCABULARY

characteristic

gene, genetics

heredity

inherited

trait

MATERIALS AND ADVANCE PREPARATION

For the teacher

- 1 Transparency 54.1, "Human Traits: Class Results"
- 1 Transparency 54.2, "Bar Graph Grid"
- * 1 overhead projector
- 1 Scoring Guide: ORGANIZING DATA (OD)

For the class

- * 6 sheets of chart paper (or transparencies with graph grids)
- * several colors of markers (or transparency pens)

For each pair of students

- * meter stick, tape measure, or height chart

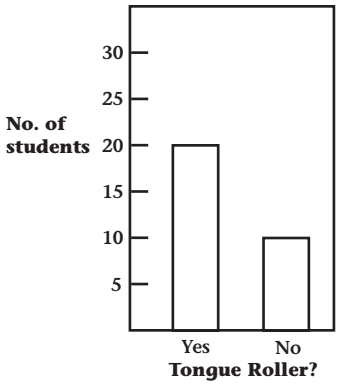
For each student

- 1 Student Sheet 54.1, "Human Traits: Group Results"
- 1 Student Sheet 54.2, "Human Traits: Class Results"
- 1 piece of PTC paper
- 1 piece of control paper
- * 1 graph paper
- 1 Literacy Student Sheet 1a, "Keeping a Science Notebook" (optional)
- 1 Literacy Student Sheet 3, "Procedural Reading Guidelines" (optional)
- 1 Science Skills Student Sheets 4a and 4b, "Scatterplot and Line Graphing Checklist" (optional)
- 1 Scoring Guide: ORGANIZING DATA (OD) (optional)

**Not supplied in kit*

Masters for Scoring Guides are in Teacher Resources III: Assessment. Literacy Student Sheets and Science Skills Student Sheets are in Teacher Resources II: Diverse Learners.

Prepare six charts (or six copies of Transparency 54.2, "Bar Graph Grid") for displaying sample graphs. While each pair of students will be asked to graph one of the six characteristics, only five of the student pairs need to copy their graphs to display in front of the entire class. (The graph for the PTC-tasting characteristic will serve as a demonstration.) In this way, the entire class can view all the graphs.



On each chart, label the y-axis of each graph as "Number of Students." Label the x-axis with the specific characteristic and its possible alternatives. For example, in the case of the PTC-tasting trait, the x-axis would be labeled as "PTC Taster?" and the alternatives listed as "Yes" or "No." A sample bar graph is shown to the left.

In Activity 64 students plant *Nicotiana* seeds, which have a usable shelf life of about 2 years. If your seeds are more than 1-1/2 years old, or if you do not know their age, it is recommended that you order fresh ones. The shelf life of the seeds can be extended if they are refrigerated.

TEACHING SUMMARY

Getting Started

1. Elicit students' ideas about genetics, and introduce the unit and activity.

Doing the Activity

2. Students collect data about six characteristics.
3. (OD ASSESSMENT) Each student prepares a graph of the class's traits for one of the characteristics.

Follow-Up

4. The class discusses their observations and the causes of variation among people.

Extension

Students gather data on ten more people who are not in the class and add the results to the totals.

BACKGROUND INFORMATION

The Genetic Basis of Selected Human Traits

The hereditary basis of some of the traits students investigate in this activity is fairly straightforward, while other traits are more complex.

■ **Teacher's Note:** Many fairly recent books and videos present incorrect information about some human traits. Almost no obvious physical characteristics of humans follow simple Mendelian inheritance patterns. (For background on Mendel and the Mendelian pattern of inheritance, see Activity 60, "Mendel, First Geneticist." However, do not introduce Mendel to students until Activity 60.) You will find materials that incorrectly indicate that eye color, tongue rolling, earlobe attachment, hitchhiker's thumb, dimples, widow's peak, and other traits can be explained by simple one-gene inheritance of dominant vs. recessive alleles. Twin studies have shown that earlier investigations into these traits came to incorrect conclusions.

Eye Color

Eye and hair color are the product of the action of several genes, interacting in a way that is not completely understood. Although brown eye color usually behaves as if dominant to blue eye color, it is possible for two blue-eyed parents to have brown-eyed children.

Tongue Rolling

For many years, textbooks have suggested that the ability to roll the tongue easily into a tube was a simple dominant Mendelian trait. However, studies of identical twins have provided convincing evidence against this type of inheritance pattern. Identical twins are no more likely than other siblings to display the same tongue-rolling behavior. The geneticist who originally published the report that this was a dominant trait has since published material indicating his concern that his incorrect results of many

years ago still persist in textbooks. (Similarly, free earlobes were once considered to be a simple dominant trait, but analysis of identical twins indicates that the determination of free vs. attached earlobes is more complex than originally thought.)

Double-Jointed Fingers

This is also not a simple trait. However, as students will learn later in the course, it can be associated with a dominant trait, called the Marfan syndrome.

PTC Tasting

The only known human trait that is relatively easy to determine and based on simple, one-gene Mendelian inheritance patterns is the ability to taste PTC. PTC is a chemical called phenylthiocarbamide. The PTC papers have a very small amount of this chemical. Tasting is dominant over non-tasting. However, this dominance may be incomplete; individuals with two alleles for PTC tasting may tend to have a stronger tasting reaction than individuals with only one allele for PTC tasting. This difference is more easily detected with another chemical, called PROP, which is not available for classroom use. Recent investigations of the genetics and physiological basis of PTC and PROP tasting suggest that food preferences are correlated to the ability to taste these chemicals. Non-tasters tend to like spicy, flavorful foods, while strong tasters (especially when young) are less likely to like strong flavors. Even this trait, which has a strong genetic basis, can vary with age or environmental factors (such as what a person has recently eaten).

■ **Teacher's Note:** Check your school district's policies on using PTC paper to test for a person's ability to taste PTC, a hereditary trait. PTC is a toxic substance, but the amount of PTC in one piece of PTC paper is small, relative to the toxic dose.

Height and Arm Span

Height and arm span are continuously variable characteristics determined by more than one gene and by environmental factors. For example, genetic factors determine the upper height an individual may reach, but environmental factors such as diet affect whether this potential height is actually reached.

REFERENCES

Blakeslee, S. "Chocolate Lover or Broccoli Hater: Answer's on the Tip of Your Tongue." *The New York Times.* C2 (February 18, 1997).

Jones, S.L. *The Language of Genes. Biology, History, and the Evolutionary Future.* London: Harper Collins Publishers, 1993.

McKusick, V.A. *Mendelian Inheritance In Man: Catalogs of Autosomal Dominant, Autosomal Recessive, and X-linked Phenotypes.* Baltimore: The Johns Hopkins University Press, 1992.

TEACHING SUGGESTIONS

GETTING STARTED

1. Elicit students' ideas about genetics, and introduce the unit and activity.

Begin by asking students if they know of any families where some or all of the family members look a lot alike. Bring out the idea that biologically related members of a family often resemble each other more than members who are related by marriage or adoption. Students are likely to offer some examples, and also to mention examples of families with members who don't look alike. After a few examples, ask ***What causes family members to look alike?*** Students may bring up terms like genes or the idea of heredity, but if not, listen to their ideas and explain that they will be studying this question and related questions in this unit on genetics and heredity.

This symbol represents an opportunity to elicit students' ideas so the subsequent instruction can take into account students' current understandings and experiences. Sometimes students' ideas will reflect partial understandings and relevant everyday experiences that you can build on. Some of their ideas are inconsistent with scientific explanations, but consistent with everyday observations. When this icon appears look to the Teacher's Edition for additional information.

For more information on identifying and addressing students' ideas see "Eliciting and Addressing Students' Ideas" in Teacher Resources II: Diverse Learners.

Explain that if a parent passes a trait, such as red hair, on to a child, we say that the child has **inherited** the trait from the parent. **Heredity** refers to the study of these traits that are passed on from parents to their children.

Then have students read the Introduction to the unit on page D-3 in the Student Book. Explain that **genetics** is the study of variation and heredity. Tell students that they will begin their study of genetics by gathering and discussing some information about people in the class. Emphasize that that there is nothing "right" or "wrong" about a particular trait.

The terms **characteristic** and **trait** are first used in the Introduction to the activity on page D-4 in the Student Book. Be sure to review the Introduction and to reinforce the use of these terms during the activity. A trait, such as round, describes a specific appearance of a *characteristic*, such as face shape. Explain to students that they will investigate human uniqueness and variability by collecting data about six different human characteristics. Distribute Student Sheet 54.1, "Human Traits: Group Results," to each student.

DOING THE ACTIVITY

2. Students collect data about six characteristics.

If students have not completed other *Issues and Life Science* units, introduce the science notebook. Throughout the unit, students keep a science notebook where they record questions, data, observations, hypotheses, and conclusions. Keeping a science notebook helps students process ideas and build scientific writing skills. Literacy Student Sheet 1a, "Keeping a Science Notebook," lists suggested guidelines. For more information about science notebooks, see the Literacy section of Teacher Resources II: Diverse Learners. These notebooks also help students learn to write lab reports. Formal laboratory reports generally include a title, purpose, introduction, hypothesis, procedure, data, analysis, and conclusions.

Some students may need assistance in following the procedure. You may wish to use Literacy Student Sheet 3, "Procedural Reading Guidelines," with some or all of your students. As students progress through the unit and/or the course, they should become more independent in reading and following activity procedures. For more information about literacy strategies to help differentiate instruction for students, see the literacy section of Teacher Resources II: Diverse Learners.

Have students follow the Procedure for the Investigation. You may wish to have a student read each step aloud to the class and then provide some clarification. For tongue rolling, refer to the picture and tell students to classify as positive only those students who can easily and fairly completely roll the tongue into a tube-like shape. If necessary, review how to use the meter sticks. Note: If you have any students who are extremely short or tall and you think this may lead to discomfort for these students, you can skip the collection of height and arm span data. In this case, you will not have data for any traits that show continuous variation within a range.

Tell students how you will distribute the PTC and control paper. It is best to distribute the paper yourself—have one student from each group first get a piece of control paper for everyone, and then return for PTC paper when everyone in the group is ready. Emphasize sanitary procedures for discarding the papers.

Allow the students about 15 minutes to collect their data and provide you with their results. Use the data they provide to complete Transparency 54.1, "Human Traits: Class Results."

3. (OD Assessment) Each student prepares a graph of the class's traits for one of the characteristics.

You may need to review for students how to construct a bar graph. If so, you may provide Science Skills Student Sheets 4a and 4b, "Scatterplot and Line Graphing Checklist," to help them with their graphs. Typical data are shown in the next column.

Students' graphs may be used to assess the "Organizing Data" element of the Designing and Conducting Investigations (DCI) variable. Ask students, ***Why should we prepare a bar graph to show the data you collected? and What should the bar graph look like?***

Because the data collected provide a frequency distribution for the various traits within the classroom population, bar graphs (histograms) are the most appropriate method for representing the data. The y-axis should always represent the number of students, while the x-axis should represent the traits.

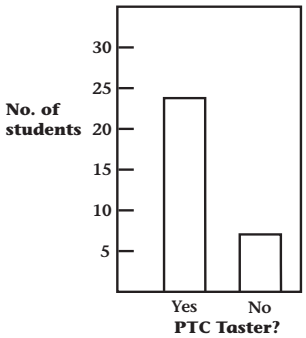
To best apply the SEPUP scoring system, it helps to firmly establish the criteria for a Level-3 response in your mind. Below are sample criteria for a graph.

Criteria: For a Level–3 response, students' graphs must have the following elements:

1. bar graph (histogram)
2. title
3. axes labeled
4. key
5. correct data
6. neatness

Level–3 Response

Demonstrate how to prepare a bar graph for the PTC tasting trait. There are likely to be two alternatives for this trait (tasting and not tasting), although you may have a third alternative if students decide to distinguish between strong tasting and mild tasting. Use chart paper or a copy of Transparency 54.2, "Bar Graph Grid," and the PTC data to show students how to prepare a bar graph of the results, as shown here.



Assign a trait (other than PTC tasting) for each student to graph for Step 10. For the height and arm span graphs, students should round their results to the nearest 5 cm. Each range can be used as a category on the horizontal axis of the bar graph, as shown on the right.

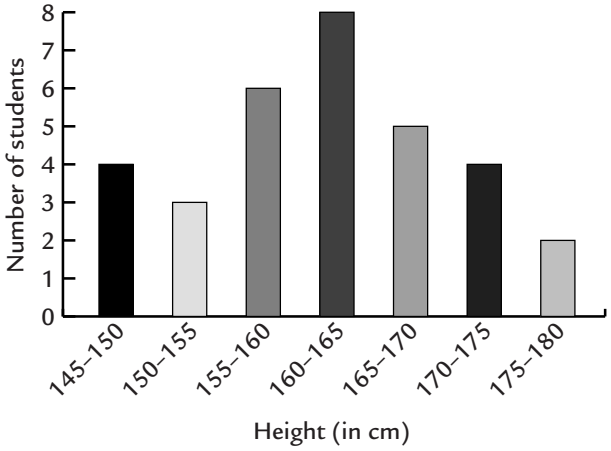
Selected students can transfer their graphs to a transparency or chart paper. Select a student to present each graph. These graphs can be saved for further discussion throughout the unit.

Discuss the results and student comments. Then have students proceed to the Analysis Questions. These questions are open-ended and are appropriate for group discussion.

FOLLOW-UP

4. The class discusses their observations and the causes of variation among people.

Ask students, ***What causes some of the variation among humans that you observed in this activity?*** Some of their suggestions are likely to refer to the idea that we get traits from our parents or grandparents. Others will refer to differences in the environment or during development and growth. You may wish to categorize their responses according to whether they are related to nature vs. nurture (that is, heredity vs. environment). Explain that the term *nature vs. nurture* is used to distinguish between traits that an individual is born with, either due to heredity or other factors, and traits that an individual acquires as a result of experiences, such as family experience or education. One of the most controversial and interesting questions related to inheritance is the role of genes vs. the environment in determining intelligence. This is a complicated question, as it is very difficult to control all the relevant variables in human studies and intelligence is not a simple, easily categorized or quantified characteristic. This provides an opportunity to reflect back to some of the concepts presented in Unit A, "Experimental Design: Studying People Scientifically," in *Issues and Life Issues*.



Encourage students to think of examples of traits that are influenced by both environment and genetics. Skin coloring or height can be used as examples. Both have a basis in heredity, but skin coloring can be affected by the amount of sunlight to which a person is exposed, and height can be affected by dietary factors. Use these discussions as a springboard to find out what students think and know about heredity. Have students think about the role of heredity and the environment in some of the characteristics they have looked at in this activity. You might ask if they can think of any environmental factors that might affect whether a person can taste PTC, for example. Age and what a person has eaten recently are two factors that might affect this trait, which does have a genetic basis.

Tell students that in this part of the course they will be learning more about the field of heredity (or genetics), which is the study of how traits are passed from parents to their offspring and subsequent generations. You will return to evidence about the heredity of each trait after students learn more about genetics.

The Analysis Questions in this activity are generally intended for class discussion, although students can begin by thinking about them individually or in their groups of four. The genetic basis of heredity will make more sense when students have an understanding later in the course of how we know whether a trait is inherited. Each of the traits has a hereditary component, but other factors can affect many of the traits.

Additional questions to ask include, ***What patterns do you see in the data for the different characteristics? What characteristics are easiest to categorize?*** Students often begin by focusing on which variants are most common. You may need to ask some leading questions to get them to consider the differences among PTC tasting, which is an all-or-nothing trait; height, which shows continuous variation over a large range; and eye color, which shows four or five distinct color families, but variations of those colors as well. For tongue rolling, some students may be difficult to categorize. See the Background Information in this activity for the genetic basis of each of these traits.

Analysis Question 1 can be used as a springboard for a discussion of variation and of the idea that

some traits can be quantified (height, arm span), while others are more qualitative (ear lobe connection, shape of nose, hair color, etc.). Some traits can be fairly easily categorized into separate categories (PTC tasting or eye color), while others are continuous or show so much variation that they can't be divided into simple categories (height, face shape, etc.).

EXTENSION

Students gather data on ten more people who are not in the class and add the results to the totals.

You can have students compare the class data to data from the larger group, to reinforce the importance of sample size in investigations of humans. Encourage students to think about the class as a sample of the community, which may or may not reflect the diversity of the community.

SUGGESTED ANSWERS TO QUESTIONS

1. *For each of the six characteristics you studied, how many versions, or traits, are observed in your class? Copy a table like the one below into your science notebook. (For example, if your class has people with brown and blue eyes only, then you would fill in the first column with "eye color," the second column with "brown and blue," and the third column with the number "2" to represent the two colors observed.)*

   Answers will depend on the variation in the class. Typical answers appear below.

2.  *Which of the traits you investigated—for eye color, tongue rolling, PTC tasting, crossing all your fingers, height, and arm span—do you think people inherit from their biological parents? Explain.*

   Some students think everything is inherited, some think very few traits are inherited, and others will say that it depends on the trait. The goal is to get them to think about the question and for you to find out what they think, rather than for them to learn about each trait at this point in the course.

3.  *If a trait is not inherited, what else might cause it? Explain, or give some examples.*

   The individual's environment and/or experience are factors that may affect a trait. For example, freckles are an example of a trait with genetic and environmental factors. Although a tendency to get freckles is inherited, exposure to the sunlight will greatly affect the degree to which an individual develops freckles. This is just one example; students are likely to come up with many others.

4.  *If you studied more people in your community, would you expect to find more traits for each characteristic? Explain your answer.*

   Answers will depend on the degree to which students reflect their community. However, they are certainly likely to find more alternatives for height and arm span. Some classes will not have students representing all five eye colors. One obvious way in which students do not reflect the entire community is age.

Characteristic	Traits	Number of Traits
eye color	brown, blue, green, gray, hazel	5 (fewer if class does not have all alternatives)
tongue-rolling	Yes, No (There may be a few hard to classify.)	2
finger-crossing	Yes, No (There may be a few hard to classify.)	2
PTC tasting	Yes, No (There may be a few hard to classify.)	2
height	many	variable, up to # of students in class
arm span	many	variable, up to # of students in class

Human Traits: Class Results

Trait	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Class Totals
Eye Color:									
blue									
brown									
gray									
green									
hazel									
Tongue Rolling:									
yes									
no									
Finger Crossing:									
yes									
no									
Height (in cm)									
cm									
cm									
cm									
cm									
cm									
cm									
cm									
Armspan (in cm)									
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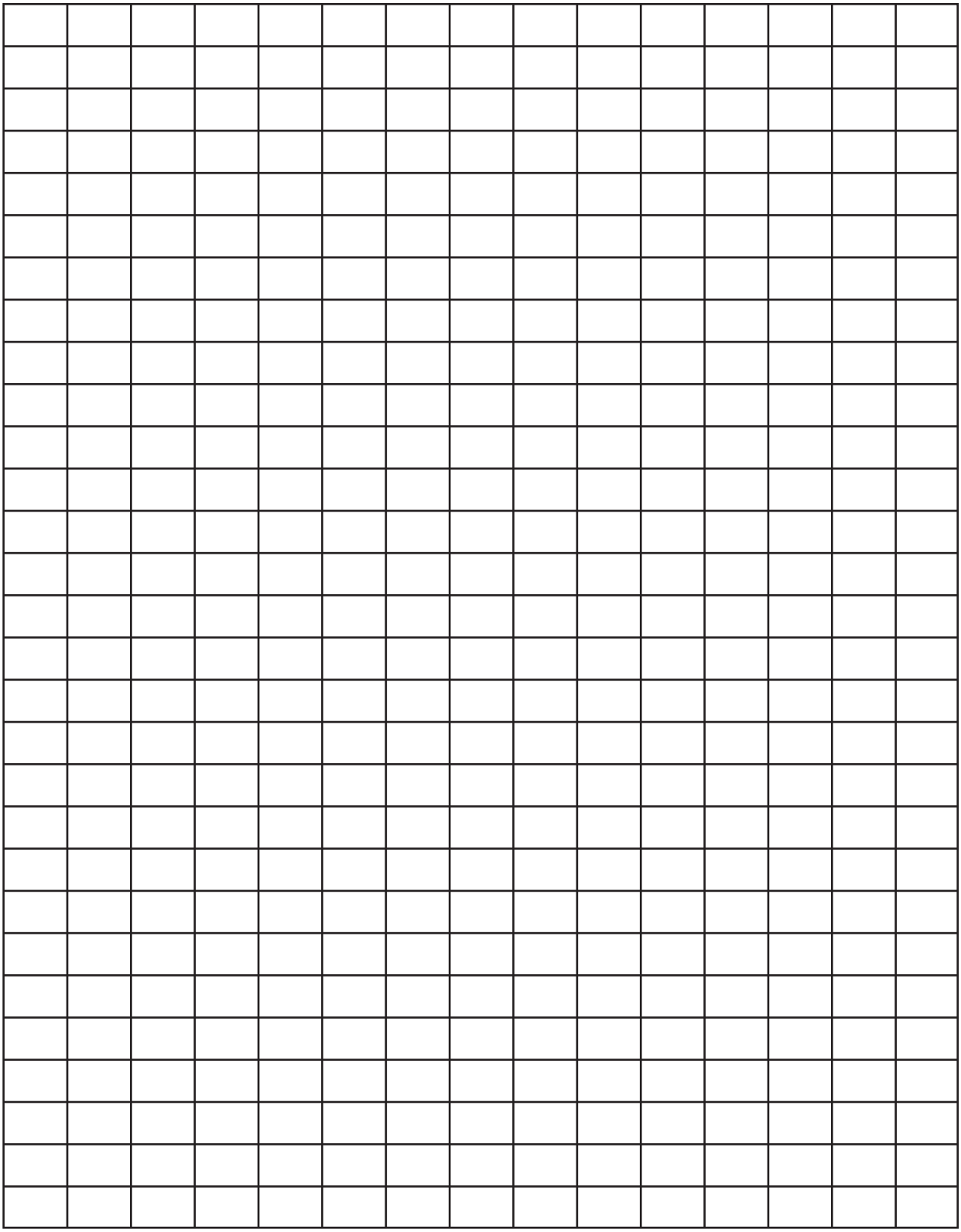
cm									
PTC Tasting:									
yes									
no									

Bar Graph Grid



Name _____ Date _____

Human Traits: Group Results

Trait	Name:	Name:	Name:	Name:	Group Totals
Eye Color:					
blue					
brown					
gray					
green					
hazel					
Tongue Rolling:					
yes					
no					
Finger Crossing:					
yes					
no					
Height (in cm)					
Armspan (in cm)					
PTC Tasting:					
yes					
no					

Name _____ Date _____

Human Traits: Class Results

Trait	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Class Totals
Eye Color:									
blue									
brown									
gray									
green									
hazel									
Tongue Rolling:									
yes									
no									
Finger Crossing:									
yes									
no									
Height (in cm)									
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PTC Tasting:									
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