SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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Student Materials

Learning Sequence Item:

902

Variation and Heredity

August 1996
Adapted by: Godrej Sethna

Contents

Lab Activities

1. Individual Differences
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Readings

1. What's Right About Being Left-Handed?

This micro-unit was adapted by **Godrej Sethna** (Baylor College of Medicine, Houston, Texas)

Science as Inquiry

Individual Differences

Can a small sample show variety?

Overview:

Look at the other people in your class. Each of them is special in some way. At the same time, everyone in your class has certain characteristics in common. In this activity you will use a couple of simple observations to study how individuals of the same species compare with one another.

Procedure:

Observe and record the eye color of each member of your lab group. Your teacher will help you organize your data and those collected by the other groups. Use the class data to draw a bar graph.

Measure the height of one member of your group as accurately as you can. Have another member of your group measure your height. Remember to take precautions to avoid errors in measurement. After the heights of every member of your group have been recorded, use data collected from the whole class to draw a bar graph. Your teacher may suggest ways to group data to make it easy to plot a graph.

Questions:

1. Regarding eye color, how many different eye colors were represented in your class?

2. How many students in your class have the exact same eye color as you do?

3. Will similar data collected from another class look like the one from your class? Explain.

4. What is the most common eye color in your class?

5. Regarding height observations, what is the height of the tallest person in your class?

6. What is the height of the shortest person in your class?

7. How many students in your class have the same height as you do?

8. What is the most common height in your class?

9. In what part of the graph is this height located?

10. What conclusions can you make about the existence of variety within a relatively small sample? If you were to repeat this activity next year, what would you expect to find?

Science as Inquiry

Yellow or . . .

How do organisms exhibit discontinuous variation?

Overview:

Obviously, not all plants are exactly alike, even those of the same species. But what types of varieties exist and in what numbers? As you do this activity, think about why variations exist and what might cause them.

Procedure:

Look carefully at the soybean plants provided. Count the number of plants of each color. Draw a bar graph of your observations and calculate the ratio of the three types. If all the plants came from the same parent plant, how can you explain the different types seen in this activity?

Next, examine the corn plants provided. Count the number of plants of each color. Draw a bar graph of your observations and calculate the ratio of the two types.

Questions:

1. Regarding the soybean plants, what were the three colors of leaves that you observed?

2. What is the ratio of the three types of soybean plants?

3. Regarding the corn plants, what were the two colors of leaves that you observed?

4. What is the ratio of the two types of corn plants?

5. What do your observations/data indicate about inheritance and variety within a species?

6. How does the variation seen in this activity compare to the type of variation seen in Activity 1, "Individual Differences"?

Science in Personal and Social Perspectives

Steven Thacker

How does our genetic ancestry affect us?

Overview:

Can you tell which people are related just by looking at them? It's true that there is sometimes a "family resemblance," but then why don't we look exactly like our parents? This activity deals with one example of human genetics. Do you have a similar story to tell?

Procedure:

Read the story about Steven Thacker and his relatives. Fill in the missing information in the pedigree chart. In the chart females are represented by circles and males by squares. A shaded symbol means that the person has the characteristic (trait) under investigation.

Steven's Family Tree*

"My name is Steven Thacker. I live in California. I'd like to tell about an experience that taught me some important lessons about genetics.

"Last summer the Thacker family decided to have a family reunion in the old home town of Cos Cob, Ohio. My twin sisters, Laura and Mary Jo, my brother, Tom, and I had heard a lot about the people in Cos Cob. We all were delighted at the thought of a trip to Ohio.

"We were the last of the Thacker family to arrive at the reunion. For about 15 minutes, there was a lot of hugging and kissing and squealing. I was introduced to all those aunts, uncles, and cousins I had heard about but had never met.

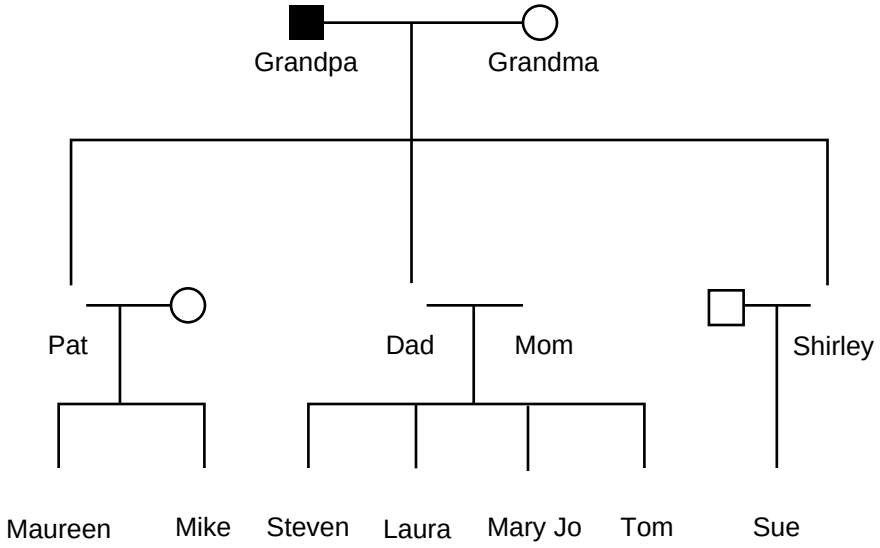
"Later, I was able to step back and take a better look at my relatives. It was obvious that we all are members of the same family. I thought my dad's brother and sister looked very much like him. My grandparents are older copies of their sons and daughter. The third generation—my sisters, my brother, our cousins, and I—are alike in many ways. At the same time, we all have special traits that make us different.

"Then, I noticed Grandpa Thacker's hands. I thought my dad was joking when he said that Grandpa Thacker has two little fingers on each hand. But, sure enough, it's true. I then looked at Aunt Shirley and Uncle Pat's daughter, Maureen, and his son, Mike, have the extra fingers. Nobody in my immediate family has this variation.

"I spent the rest of the day meeting, talking, and playing volleyball with my relatives. The big event of the day was a sit-down dinner that evening. We ate one of the best meals I have ever had. Before we knew it, it was time for the reunion to end.

"It wasn't until we were back in California that I remembered the variation I had observed in my grandpa, my aunt and uncle, and three of my cousins. I knew this had to be a genetic trait. But I was curious to find out more about it.

"In my biology class, I had learned that one of the first things you should do to learn about a trait is to make a pedigree and trace the trait through the family. I remembered that you use a square to stand for a man and a circle to represent a woman. You shade in the squares or circles that represent people who have the trait (in this case, an extra little finger). With that little background, I was able to make a pedigree for the trait in our family."



Questions:

1. Does the trait appear in each generation?

2. How is this trait related to gender?

3. Describe the pattern of inheritance for the trait.

4. Some traits are caused by heredity, others by environmental factors such as nutrition, exercise, or temperature. Based on the data, is the extra-finger trait in Steven's family inherited or environmentally induced? Explain your answer.

5. How does inheritance of traits happen? Be prepared to participate in a discussion about the mechanism of inheritance based on the activity you completed.

*Duplicated with permission from "Steven's Family Tree." *Biological Science: Patterns and Processes*, 3rd Edition (E.A. Combs, Ed.). Dubuque, Iowa: Kendall/Hunt, 1986.

Science as Inquiry

Tales of Data

What is the meaning of "mean"?

Overview:

Can just one number be created to represent an entire set of numbers? In this activity you will use your data from Activity 1 to determine the mean.

Procedure:

Look at the data for height that were collected during the "Individual Differences" activity. Begin by transferring to Column A of the table below the groups of numbers for height from your data table. The first row has been filled in as an example. To calculate the data for entry in Column B, you subtract 120 from 129 (129–20 = 9). Divide 9 by 2 (9 / 2 = 4.5), and add 4.5 to 120 (120 + 4.5 = 124.5).

Next, count the number of students whose height fell within the 120–129 cm range. Enter that count (frequency) in Column C. Now, multiply 124.5 by 2 (124.5 × 2 = 249.0). Repeat these steps until you have filled in all the data.

Add all the numbers in Column C to get the sum of F. Add all the numbers in Column D to get the sum of [F × MP]. Use the following formula to calculate mean:

Mean = sum of [F × MP] / sum of F

COLUMN A Height in cm	**COLUMN B** Midpoint (MP)	**COLUMN C** Frequency (F)	**COLUMN D** F × MP
120–129	124.5	2	249.0
Sums			
		Sum of F	**Sum of [F × MP]**

Questions:

1. Compare the mean you calculated with the bar graph that you plotted in the "Individual Differences" activity. What would happen to the value of the mean if five new students were added to your class and they were all in the 180–189 cm height range? Show mathematical evidence to support your answer.

2. How would the mean you calculated in this activity compare to the arithmetic mean (or average) of all the individual height measurements for your class?

3. What is the meaning of "mean" for this set of data?

4. What does the mean tell you about the occurrence of certain variations seen in nature?

Science in Personal and Social Perspectives

What's Right About Being Left-Handed?

Imagine you are Alice, stepping through the looking glass. Suddenly everything is reversed. Doorknobs are on the wrong side of doors. The gearshift in your car is in the wrong place. Handles on can openers are on the wrong side and turn the wrong way.

Twenty-five million Americans wake up every day in just such a predicament. They are the one in ten of us who are left-handed and must face the built-in bias of a world designed for the right-handed majority. In a society of rights (from Anglo-Saxon "riht," for "direct, upright, correct") and righteousness, the southpaw is left (Anglo-Saxon "lyft" for "weak") with leftovers and left-handed compliments. Why we are left- or right-handed remains one of the great unsolved mysteries of science. We know that nearly two out of three lefties are male and that left-handedness runs in families. According to one study, almost half the offspring of two left-handed parents will be southpaws. The Scots-Irish family Kerr (from the Gaelic word for "left") produced so many left-handers that in 1470 the family built its castle's spiral stairways with a reverse twist to favor southpaw swordsmen. On the other hand, heredity alone cannot explain lefties. At least 84 percent of them are born of two right-handed parents. And in 12 percent of genetically identical twins, one will be right-handed, the other left.

Perhaps the greatest puzzle of all is not why some people are left-handed, but rather why so few are. In virtually every other species, from chimpanzees to chinchillas, roughly equal numbers of individuals will favor either the right or the left. However, scientists are trying to set things right, and they are beginning to gain insight into the many ways southpaws differ from northpaws, by considering how their brains work.

Many of the circuits in the human central nervous system operate through crossed laterality—that is, the right hand is "wired" to the left side of the brain, and vice versa. In at least 95 percent of right-handers the speech-language center is in the brain's left hemisphere. Yet only about 15 percent of left-handers are similarly hooked up, with speech controlled by the opposite, or right, hemisphere. According to Jerre Levy, a biopsychologist at the University of Chicago, about 70 percent of left-handers have speech controlled by the left side of the brain, while the remaining 15 percent have their language-control centers in both hemispheres.

Broadly speaking, the left side of the brain is thought by some scientists to process linear, logical information, while the right side tends more toward processing emotion and mood. This may be why lefties are at significantly higher risk of schizophrenia, phobias and manic-depression, and in one study were shown to be three times more likely to attempt suicide.

Although southpaws make up only ten percent of the population, they account for between 14 and 18 percent of those treated for alcoholism, according to Dr. Wayne P. London of Dartmouth Medical School. They can be more sensitive to a variety of other drugs too. Peter Irwin, a research scientist at Sandoz Institute in East Hanover, N.J., found that,

By Lowell Ponte. "What's Right About Being Left-Handed?" *Reader's Digest*, July 1988, pp. 133–137. Reprinted with permission from the Reader's Digest. Copyright July 1988 by the Reader's Digest Assn., Inc.

after taking such medications as aspirin, antidepressants, sedatives and antihistamines, lefties had greater changes in electrical activity in the brain than righties did. As if this weren't enough, southpaws appear to be twice as prone to autoimmune diseases, including diabetes, ulcerative colitis, rheumatoid arthritis and myasthenia gravis.

With such liabilities, how have left-handers managed to survive at all? The good news is that there is a very bright side to being a lefty. Camilla Benbow, associate professor of psychiatry at Iowa State University, surveyed students who scored in the top 100th of one percent in math on the Scholastic Aptitude Test. She discovered that fully 20 percent of these math geniuses were left-handed—double the proportion of lefties in the population. Mensa, the high-I.Q. society, estimates that 20 percent of its members are left-handed.

Indeed, the ability to integrate what some researchers call the more "logical" left side of the brain and the more "intuitive" or "artistic" right side may have helped lefties excel in many fields. Some of our liveliest comedians, including Don Rickles, Jay Leno and Whoopi Goldberg, and a number of our better television interviewers, such as Ted Koppel and Oprah Winfrey, are southpaws. (Winfrey, in true left-handed style, named her production company Harpo—Oprah spelled backward. But then, Harpo Marx was a lefty too.)

Left-handers may also have an edge on the field of battle. Among history's most famous left-handed warriors were Alexander the Great, Julius Caesar, Charlemagne, Joan of Arc and Napoleon (as well as his consort, Josephine). Michelangelo sculpted David holding, in his left hand, the sling used to slay Goliath. (The Bible makes note of some 700 lefties who could "sling stones at a hairbreadth and not miss.")

Sports fans can see an edge on the playing field too. Almost one-quarter of history's greatest pitchers have been southpaws, and nearly half the batters in baseball's Hall of Fame are left-handers or switch-hitters. Baseball, admittedly, is a game biased to favor the lefty. The left-handed batter starts two steps closer to first base, and the southpaw pitcher has an easier time holding a runner on first base. But lefties excel in other sports, too, notably tennis and basketball.

Though most people believe that handedness is a simple either/or proposition, this is incorrect. Handedness is a spectrum. Chances are that you are more nearly ambidextrous than you realize. You can, for example, probably write quite well with your left hand even if you have always been right-handed.

To find out, take a large piece of paper, turned sideways, and pick up a pencil in each hand. With your right hand, slowly sign your name, and with your left hand match each movement in reverse, with both hands moving in opposite directions away from the paper's center. After a few tries, hold your left-handed reverse signature up to a mirror. You'll be surprised how much it resembles your forward right-handed writing.

For years many lefties have felt they are targets of discrimination. But they have begun to assert their rights. In 1980, when part-time police officer Franklin W. "Woody" Winborn was fired in Riverside, Mo., activists rallied to his cause. A southpaw, Winborn had refused to wear his gun holster on his right side. In Seattle, a postal clerk and lefty named Robert B. Green was told to follow the usual procedure of holding mail in the left hand and sorting with the right.

Winborn settled his case out of court, and Green was permitted to continue his left-handed sorting. Lefthanders International of Topeka, Kan., took a keen interest in both protests. Its founder, Dean Campbell, asks, "Why must the left-handed live in a world designed to handicap us?" His group has issued a "Bill of Lefts," which asserts in part that "left-handers shall be entitled to offer their dominant hand in a handshake, salute or oath. " Says Campbell, smiling impishly, "If the right side of the body is controlled by the left side of the brain, and vice versa, then we left-handed people are the only ones in our right mind."

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