Lesson 3. How Hairy is a Population of Radish Plants?

The *"Big Idea"*	Trait variants can be measured. A graph gives us a picture that describes trait variation collectively within a population.
Investigation Question	How hairy is a population of radish plants?
Summary	Students previously saw variation in germinating radish seedlings and snail populations. Students discuss their predictions about whether the radish hairiness trait will also vary. They examine live plant material, then count hairs on plant photographs and record their data. The class creates a graph to summarize class data. Students discuss what – and how – the graph tells us about hairiness trait variants in this population. Finally, they consider how a "hairy" trait variant might be beneficial.
Materials	For the class ● A graph template with "Number of Hairs" on the x-axis and "Number of Plants" on the y-axis ● Slide deck for this lesson For each group ● Live plant material (i.e., radish plants grown by the class, OR store-bought radishes that have leaves, OR samples of a hairy herb like mint or oregano) ● A set of 40 radish photos ● Hand lens ● Ruler ● 2 sticky notes ● Notebook page 9

Lesson Description and Rationale

In the previous lesson, students observed variation in radish and snail populations. Today, the class will look at another radish trait called "hairiness." The tiny hairs appear on both leaves and stems.

By addressing the question of how hairy a population of radishes is, students find that they need tools to describe what they discover. Any trait can be measured and graphed, and the mode and the range are one set of tools to describe the distribution of the trait in the population more generally.

First, students examine live plants to see if they can detect hairs, then they predict and discuss whether they expect every radish plant in a population to have the same number of hairs. To

test their prediction, they count hairs in a set of photographs and record their data. The students' data, written on individual sticky notes – each representing one plant – are compiled on a frequency graph (also known as a "line plot"). The class then discusses the shape of the data for this trait in the population. Based on these data, they respond to the question:

How hairy is a population of radish plants?

Finally, students do a thought experiment and speculate about how individual plants with particularly hairy trait variants might have an advantage when caterpillars invade their environment.

By the end of this lesson, students will have been (re)introduced to the concepts of population and trait variants and they will understand how the mode and the range can be used to describe the distribution of trait variants in a population. They will also begin to think about how trait variants may affect individuals, which prepares them for Lesson 4 where this idea takes center stage.

Learning Targets in this Lesson

- Traits such as hairiness can be measured and graphed.
- A graph can show how traits vary in a population.

Sequence of Experiences		
1. Introduction	All class	3 Minutes
2. Collect and Record Data from Plants	Small groups	15 Minutes
3. Make Meaning from Class Data	All class	10 Minutes
4. Conduct a Thought Experiment	All class	15 Minutes
5. Wrap Up	All class	2 Minutes

Preparation

- Assemble the plant material for each group. This could be a pot of radish plants the class has grown, OR radishes from the store that have leaves still attached OR a few sprigs from a bunch of fresh mint or fresh oregano
- Divide the set of radish photos to ensure that each student has 2 photographs.

Note: If you cannot grow radish plants, or your plants meet with disaster, consult the Back-Up Counting Hairs Back-up Plan

- Prepare a graph on the whiteboard with “Number of Hairs” on the x-axis and “Number of Plants” on the y-axis for the class to paste up their stickies with the data (sample illustrated below).

The Lesson

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1. Introduction (3 min)

Ask students:

Can you think of any living things that have hairs?
(Dogs, cats, us)

Do you think that plants have hairs?

Wait for a couple of student responses, then explain that today they are going to investigate this question.

Remember in Lesson 2 we observed differences in traits in a population of radish seedlings. We noticed that they all had rootlets, but the rootlets were different lengths. We discovered that radish seedlings in a population are not all the same. Now we are going to investigate a different trait in radish plants, the trait of “hairiness.”

Do you think that radishes have different numbers of hairs?

(Children are likely to say yes, given that they have now observed population variation.)

Ask for a couple of students to volunteer why they think this will be the case.

Possible student responses:
- We saw that radish rootlets varied in the population, so we expect hairs to as well
- We saw that snails and radishes were not all the same so we think that hairiness will also be different

In a minute you will count hairs and find out if this trait is the same or different for all radishes in our population.

Then we will consider a situation where caterpillars arrive in a garden where a population of radishes were growing.

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2. Collect and Record Data from Plants (15 min)

Distribute plant material, lenses and stickies to each group. Give students 3-5 minutes to observe the leaves and stems of the plants to see if they can see the leaves.

Note: If students have difficulty seeing the hairs with their hand lenses, it may help to shine a light on the leaf, hold the plant up to a light, or view it against a dark background.

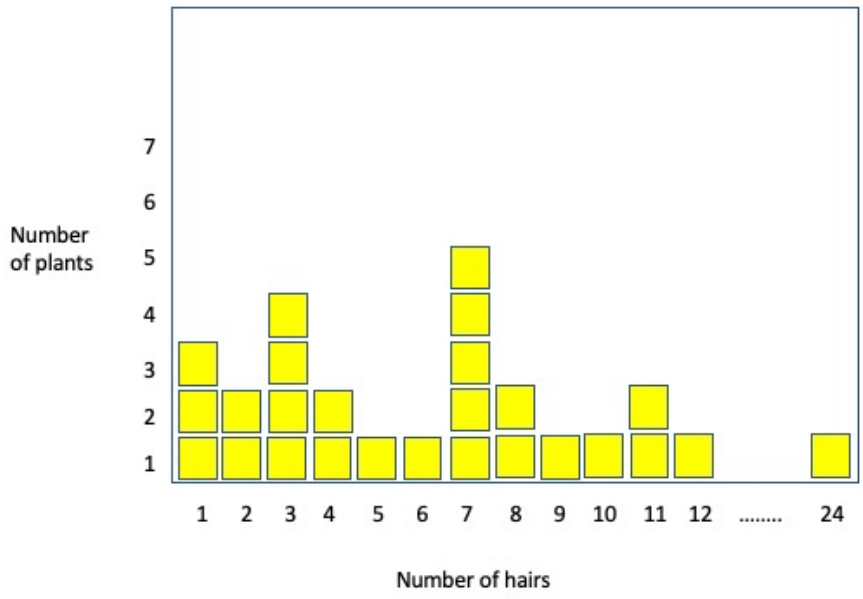
Once you are satisfied that all have observed hairs, explain:

A scientist named Nikola has been studying radishes for a long time. We are going to help her. We will count the hairs on her radish plants in the pictures she has provided.

Show students the picture of the leaf stalk of one leaf in a radish plant below. 13 hairs are visible.

Explain that each student will count hairs in 2 pictures. They count how many hairs can be seen and write each count on a separate sticky note.

Make a graph of the data by having students come up to the graph template you have prepared and, with your guidance, place their stickies in the appropriate place. A bar graph should be created where each sticky note corresponds to one plant. Stickies should be stacked along the x-axis, as shown in this example:



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3. Make Meaning of Class Data (10 min)

Gather the class for discussion.

The <u>purpose of this discussion</u> is to see if the class has evidence to answer the investigation question, "How can we describe hairiness trait variants in a population of radish plants?"

Looking at the graph displaying their class data, remind the class of their predictions, and the investigation question and ask:

> *How hairy are radishes in a population of radish plants?*

Listen for student responses. Students may have learned about measures of central tendency in math class and may offer the mode as one measure. Others may mention the range.
To support the discussion further, ask

> *Which stack of sticky notes is the tallest?*
> (Students will identify the tallest stack of stickies)
>
> *What does that mean?*
> Explain to students that *the count that appears most often is called the "mode" by scientists.* Label the mode on the graph.
>
> *What is the lowest number of hairs? The highest number?*

Once students have identified these, explain that scientists name the lowest and the highest numbers the "range." Draw a bracket underneath the stacks of stickies from lowest to highest and label it the range.

Note: 1. The mode describes the value on the x-axis in the graph that has more pieces of data than any other value. The range describes the "spread" between the lowest and highest numbers on the x-axis. 2. Scientists use these measures when they want to generally describe all the trait variants in a population without having to refer to each one.

Explain to students that scientists use these measures when they want a short way to describe all the trait variants in a population generally without having to say, "There was 1 plant with 1 hair, 3 plants with 2 hairs, 7 plants with 4 hairs, etc."

Ask

> *What do you think the mode and the range will be in the next generation of this same population of radishes?*

Listen to student responses for ideas that they will stay more or less the same because babies in the next generation will tend to look like their parents.

Optional: Time permitting, ask students:

> *What if we looked at a different population of animals? What if we looked at sea stars? They don't have hairs, but they do have spikes! If we graphed the number of spikes that a population of sea stars have, do you think the graph would look the same and have the same general shape as our radish graph?*

Listen to student responses for ideas that they expect a graph for sea stars to share certain characteristics with the radish graph. For instance, students may note that there will be a range because individual sea stars in a population will have different numbers of spikes from each other. Some would have fewer spikes and some would have many spikes, but there would be a number of sea stars somewhere in the middle. The big idea here is that all populations have variability.

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4. Conduct a Thought Experiment (15 min)

Project the two pictures of radish leaf stems above; the top one has 16 hairs while the bottom has 1. (These images are in the teacher slides.) Ask:

> *Do you think having lots of hairs, very few hairs, or no hairs might benefit individual radishes or harm them in some way?*

Listen for a few ideas from students.

Then explain that it's not possible to know whether a trait variant (like having lots of hairs) could be helpful or harmful without knowing more about the environment in which the plants live. Explain that there are caterpillars in the radishes' environment and ask them to think about the following question:

- *Which plants do you think caterpillars would choose to eat - hairier or less hairy ones?*

Give students a few minutes to discuss their thoughts with a neighbor, then write their responses in their notebooks. If time allows, ask a few students to explain their reasoning to the class.

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5. Wrap Up (2 min)

Summarize the discussion by highlighting that in a population (a group of radish seeds that came from the same packet and we grew in the same conditions, for instance) there are the same traits but the traits may vary.

Tell students that the class will follow up their thought experiment in Lesson 5 when they will explore some more data, but that in the next lesson the class will meet a population of storybook animals called piloses. There the trait they'll focus on is the piloses' noses.