Blossoms - Variation is Essential v3

[00:00:00:00] [MUSIC PLAYING]

[00:00:17:12] There are an estimated six to 100 million living species on Earth today.

[00:00:23:15] [MUSIC PLAYING]

[00:00:27:06] There are nearly 200 different kinds of monkeys, an estimated 315 different kinds of hummingbirds, nearly 1,000 bats, and nearly 350,000 species of beetles, and a quarter of a million different kinds of flowering plants.

[00:00:56:09] [MUSIC PLAYING]

[00:01:01:07] The variety is astonishing.

[00:01:03:02] [MUSIC PLAYING]

[00:01:06:20] Hello, my name is David Upegui. I'm a biology teacher at Central Falls High School in Rhode Island. Today, we're going to talk about diversity within a population.

[00:01:15:24] Have you ever thought about how much biological diversity we have in our world? Well, today, we're going to run a series of investigations that will allow us to appreciate biological diversity and how this relates to selection and to evolution.

[00:01:31:19] Today, we will explore several important ideas, including the general definition of biological evolution, the tenants for evolution, natural versus artificial selection, and selective pressure. By the time we're done today, we will have used a model organism-- kidney beans, in this case-- to explore variations within a population.

[00:01:52:17] We have measured differences in individuals, and used phenotypic differences to see how those impact biological evolution. Our first activity today entails the usage of something that you probably have in your own kitchen-- beans.

[00:02:09:02] The common bean, Phaseolus vulgaris, or frijoles, as my mom called them, is the world's most important green legume for human consumption, and were cultivated as early as 8,000 years ago. The red kidney beans are thought to have originated in Peru, but are now found around the globe.

[00:02:27:15] During this part of the lesson, you'll be working in small groups and you'll be using a bag of beans that your teacher has prepared for you to explore variations within a population. Once you receive your bag of beans, I want you to consider the following questions.

[00:02:41:14] What patterns do you notice when observing the beans? How are these patterns different? How are these patterns similar? And what might have caused these patterns?

[00:02:51:23] So why are patterns so important? Well, patterns are found in nature and in the design world, and by carefully observing those patterns, we may be able to find the causes of these patterns.

[00:03:04:16] As we begin our first activity, the key question I want you to consider is how can we identify patterns of variability within a population. In other words, how can we identify different physical attributes that are measurable and vary within a population?

[00:03:55:12] Welcome back. After examining your beans, how did you do with the questions that we asked earlier? Did you notice any interesting patterns? For instance, did you notice that all the dark beans were also long? Or were all the rough beans also short? Perhaps you noticed that there are lots of data which can be gathered from beans.

[00:04:15:17] For this next activity, we're going to focus on a single variable. We're going to measure the length of 50 beans to the nearest millimeter. We will be entering this data into Table Number One in the guide sheet.

[00:04:29:12] It's really important that you're careful and consistent when you're measuring your beans. This will increase your accuracy. That is to say, the precision of the measurements and the validity of your data.

[00:05:08:00] Well, hello. You just collected data, which is the only true currency for scientists. In fact, science is based on publicly verifiable evidence and data provides this for us. But you must know how to appropriately collect this data and subsequently organize it in a way that makes sense, and that is just what we're going to do right now. We're going to organize our data.

[00:05:31:14] As scientists, we often use graphs to organize our data and visualize data patterns. These patterns often make us ask new questions, such as what could possibly cause these patterns? There are different types of graphs that can be used for different types of data. The data you collected can be displayed using a bar graph.

[00:05:50:23] Bar graphs are used to compare things between different groups, and your data are classified as discrete and ordinal. In other words, for this exercise, each bean will belong to only one category-- say, 15 millimeters-- and there is an obvious sequence, which goes from smallest to largest.

[00:06:10:14] As a group, you and your partners will organize the data using table number two, which is the beans grouped by length. After you do that, you will analyze your data and you will use evidence from your analysis to share your information with the rest of the class.

[00:06:53:01] So how did you do? I hope you were able to graph your data and see some interesting patterns. Graphing can often do that for us. It can give us a visual representation of our results and reveal possible causes for what we are seeing within the system being studied.

[00:07:07:15] By organizing the data, scientists can more easily interpret what has been observed and begin to make sense of what the patterns are. As you begin to interpret your data, you may be wondering why the variation in the population is important.

[00:07:20:23] You noticed when you measured your beans that there were different sizes for them. In fact, variation within a population is an essential prerequisite for biological evolution. Let's consider why variation in the dimensions of kidney beans might be important for their evolutionary survival.

[00:07:37:29] Those differences among individuals may help to reveal the causes behind how some survive better than others. In other words, variation in the genetic pool could result in different survival rates. Perhaps the larger beans can have a better chance of surviving during times of drought, increasing those genes in the future generations.

[00:07:58:24] Or, perhaps because of their size, larger beans would be predated, in other words eaten, at a higher rate and therefore would be reduced in the population. And what would happen if there was no variation? In a scenario where all individuals were the same, whatever kills one individual, would end up killing all of them. Therefore, variation is essential.

[00:08:19:14] For this next activity, we will define evolution as the change in genetic frequency in a population over time. Each part of the definition is important here. Change just means change for its own sake, without regard to any direction for evolution. It is not about creating an ultimate species.

[00:08:37:20] Genetic frequency, because the frequency of genes must change. Population, because evolution creates a change in a population, not individuals. And over time, because it takes time for these changes to take place, namely in future generations.

[00:08:54:04] Charles Darwin, in 1859, argued in his book, On the Origin of Species, that in order for natural selection to occur, some conditions needed to be met. Number one, there is variation in some trait among individuals within a population.

[00:09:10:25] Number two, this variation is heritable. So there is a genetic basis for the variation such that offsprings tend to resemble their parents in this trait. And number three, variation in this trait is associated with variation in fitness. In other words, having this trait helps individuals increase their chance of survival and reproduction.

[00:09:34:20] For the next activity, you will write a description about why variation within a population is an important part of biological evolution. You will also create a model using a scenario that shows how this variation plays out in evolution.

[00:10:11:20] Hello, again. Were you able to represent and model the significance of variation in a population for biological evolution?

[00:10:19:22] We looked at variation within a population of beans, and as Darwin put it, variation is essential for evolution. Let's take a look at some pictures of beans that show how different species of beans have evolved from a common ancestor in Peru.

[00:10:35:01] Kidney beans and others, such as Pinto beans, navy beans, and black beans, are known scientifically as Phaseolus vulgaris. And although they originated in Peru, they are now planted and consumed all over the planet.

[00:10:50:02] The different geographical regions have provided environmental-- in other words, natural-- selection, as well as the artificial selection done by humans. But how do variations in a population, such as the one we saw today in the beans, play out in the real world?

[00:11:05:28] In this last activity, we are going to be putting together all the ideas from today's lesson. You and your partners will consider several questions. Your teacher will provide you with a strip of paper which will contain one question. You should carefully read that question.

[00:11:21:00] Think about the data you collected from your beans and come up with your best answer. You will then discuss your answer within your small group. Once you have arrived at a consensus for your answers in your small group, you will have a large, whole class discussion, where you will use evidence from the data you collected to support your claims.

[00:12:03:09] All right. I hope you had a good discussion in your class about biological variation. Now today we used the bean as a sample organism to look at variation within a population. But keep in mind, we could use any other biological organism to explore these concepts.

[00:12:19:01] As we conclude our time together, let's think back about the wonderful beans that are out there all over the world, but started 8,000 years ago in Peru. How do you think that what we discussed in the last activity, Activity 5, played a role into the development of different beans in different conditions?

[00:12:38:02] Remember that biological variation is not only a wonderful characteristic of living populations, it is also essential for biological evolution. Variation is, in fact, essential.

[00:12:52:24] Think about all the ideas that we covered in today's lesson. I hope you can continue to explore the evolution of beans and expand your knowledge about evolution.

[00:13:05:08] In thinking about biological variation, I am reminded of E.O. Wilson as he wrote, "Humanity is strengthened by a broad portfolio of genes that can generate new talents, additional resistance to diseases, and perhaps even new ways of seeing reality. For scientific as well as for moral reasons, we should learn to promote human biological diversity for its own sake, instead of using it to justify prejudice and conflict."

[00:13:40:22] I want to thank you for allowing me into your classroom today. Central Falls High School, the school where I teach, is also the same school where I graduated from and we serve

mostly low-income children. So therefore, education is pivotal and significant for them. Not just today, but in their future.

[00:14:00:05] This lesson is a hands-on and minds-on activity about biological evolution. It was designed to include the three dimensions of the framework that align to the Next Generation Science Standards.

[00:14:14:21] In this lesson, students will engage in several of the Next Generation Science Standards of the Science and Engineering Practices, as well as the cross-cutting concepts. This lesson is not designed to be a cookbook lesson, but instead, it's flexible enough that it can provide opportunities for students to figure out the concepts or variations by unpacking the phenomenon and exploring the cross-cutting concepts in the science and engineering practices.

[00:14:43:07] This lesson is not necessarily tied to any particular sequence within the curriculum, and it is flexible enough that it can be used in a variety of contexts.

[00:14:53:24] Based on student experiences, you can subsequently cover many of the traditional concepts that are related to evolution. For example, after this lesson, you may select to study Darwin in the historical context in which he wrote his book, or you may decide to present the material that is covered on selective pressures on evolution.

[00:15:13:14] You may also review and apply the vocabulary covered in this lesson. Words like natural selection, artificial selection, evolution, gene pool, genotype, phenotype, et cetera.

[00:15:26:01] During this lesson, students will complete five different activities. Number one, using parents to identify different physical attributes that are measurable and that vary among the population. Number two, measuring the length of 50 beans to the nearest millimeter in order to see variation within the patterns.

[00:15:46:09] Number three, graphing and analyzing data of the beans grouped by length. Number four, exploring patterns of variation as a possible and important cause for the survival of species. And last, number five, evaluating evidence about the causes and effects of variation.

[00:16:06:03] This lesson already includes a modification for students with strong mathematical backgrounds, or who would like the additional challenge, but this will require more time. By including the calculations for standard deviation, many additional ideas can also be explored, including standard or normal curves, population trends, data symmetry, measurements of central tendency, such as means, modes, medians, variance, et cetera.

[00:16:33:20] Here is a very important note pertaining to the teacher prompts and questions in this lesson. You will notice that the prompts written in this lesson have the language of the cross-cutting concepts. This is intentional and critically important in making the lesson truly three-dimensional.

[00:16:51:07] The cross-cutting concepts help to structure student thinking so that they focus on specific aspects of the phenomena which they are studying. In this case, why is biological variation so important in the survival of the species?

[00:17:04:26] Additionally, as a result of the instructional shifts of the NGSS, this lesson was designed to be student-focused, with the teacher serving mostly as a facilitator. The goal is for students to figure it out, rather than just learning about these concepts.

[00:17:22:10] This is a low-budget and engaging activity, but you need to make sure to warn students against, one, eating the raw beans, which can make them very sick, and two, throwing the beans because they're going to need all 50 beans in their bag in order to run this-- in order to run the experiment.

[00:17:40:05] Be sure to have the 50 beans counted and separated for the students before they arrive. This will save you some time.

[00:17:47:26] The accompanying guide sheet is designed to lead the students through each step of the lesson. And by the time the lesson is complete, the whole sheet should be filled out.

[00:17:58:09] Lastly, students need to be careful with their measurements in order to collect good data and think about the implications of the ideas within this lesson.

[00:18:08:21] It is my sincere hope that this lesson can lead to a better appreciation of biological diversity, including diversity of human populations. Thank you.

[00:18:19:01] [MUSIC PLAYING]