Common Student Ideas about Variation in Traits

Common Student Idea(s)	Scientific Explanation
1. Humans, dogs, and cats have different characteristics (trait variations). But some types of plants or animals all look the same (have no variations), like daisies, mosquitoes, blades of grass, or worms.	In some species, such as dogs or humans, physical variations among individuals are easy to see, and in other species, they may be harder to identify. For example, the size differences among beans may be too small to notice, or the color variations in insects may be so slight that all of the insects appear to be identical. Variations in behavior and other traits within a species can also be difficult to observe from the outside. Although trait variations may seem inconsequential, they can confer an advantage that allows some individuals to survive better than others. In other cases, variations may confer no advantage at all or make it more difficult for an individual to survive.
2. An example of variation within a species is that dogs look different from cats.	Although dogs and cats look different from one another, this isn't an example of variation *within* a species, since dogs and cats are entirely different species. Trait variations between cats and dogs don't bring about changes over time because they have separate lineages and don't interbreed. Variations among individuals of the *same* species are more important because they can affect what the population might look like in the future.
3. Individuals adapt or change their traits because they want to or need to. For example, individual moths change color on purpose to blend in with their environment because they don't want predators to see them. And giraffes stretch their necks to reach leaves high up in trees.	A species of organisms can change traits across generations because of natural selection. For example, moths show trait variations for color. During the Industrial Revolution, pollution caused tree trunks to become darker, which enabled birds to see light-colored moths on the bark more easily. This led to a selective pressure that gave dark-colored moths a survival advantage because they blended into their environment (the dark tree trunks) much better. As a result, the dark-colored moths lived longer and passed on the dark-colored trait to their offspring. After several generations, dark-colored moths vastly outnumbered light-colored moths. This trait change came about not because individual moths *chose* to become darker but as a result of random DNA mutations.
4. Individual plants and animals can change their traits to adapt to their environment. For example, a person who lives in very cold place develops a thicker skin to survive better.	Common usage contributes to student misconceptions regarding the word *adaptation*. In everyday language, *adaptation* means a change that makes something or someone suitable for a new use or purpose. But scientists use the term in a different way when discussing natural selection and changes in a species over time. In science, *adaptation* refers to a trait passed from parents to offspring that helps individuals survive or produce more offspring in a

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	particular environment. Over time, these traits and the genes that cause them become more frequent and common in a population. According to this definition, populations adapt, not individual organisms.
5. Individual organisms change because they observe the traits of other successful individuals and copy them.	Variations in a population depend on the traits that future generations inherit from their parents. These traits must be encoded in DNA, a complex molecule that contains all of the biological instructions for an organism that make a species unique. Simply observing the traits of another individual and mimicking them doesn't encode them in an individual's DNA or pass them on to future offspring or generations.
6. Changes from one generation of a population to the next are all or nothing. This means that only the most common traits in one generation will be passed on to the next generation, and less common traits will disappear. Over generations, variations will go away, and all individuals will end up having those traits that are best for survival.	For the most part, if a trait is inherited, its frequency in the next generation will be similar to its frequency in the parent generation unless the trait is under selection. Even under selection, a favorable trait usually increases in frequency rather than becoming the only trait in a population.
7. Models are exact copies of real-life phenomena.	Models are simplified *representations* of real-life phenomena that are useful for understanding the world, explaining or describing theories, visualizing things that are difficult to see or understand, and summarizing features and predicting outcomes, but they aren't exact replicas. Students often struggle with the idea that models are deliberate simplifications of reality that aren't completely precise and have limitations.