Appendix B

Module Storyline

Anchor Phenomenon: Individual Variation in Humpback Whales

Essential Question: What makes an individual humpback whale unique?

Conceptual Overview

Individuals have a variety of traits that are inherited from their parents, some of which can be influenced by interactions between individuals and their environments.

1. Individuals of the same species have the same characteristics but can have different traits.
2. Traits can be influenced by growth and development and interactions between an individual and its environment.
3. Individuals inherit traits from both parents. Different individuals inherit different combinations of traits.
4. Some traits provide individuals with advantages in surviving and reproducing. These advantageous traits help a species' life cycle continue.

NGSS Performance Expectations

3-LS1 From Molecules to Organisms: Structures and Processes

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LS3 Heredity: Inheritance and Variation of Traits

3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.

3-LS4 Biological Evolution: Unity and Diversity

3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

Concept 1: Describing Organisms (Lessons 1–6)

Focus Question: How can we identify individuals?

Lessons 1–3

Phenomenon Question: How do we know if an organism is a humpback whale?

Phenomenon: Whale Watching

Spotlight on Three-Dimensional Integration: Students describe patterns (CC.1) in the characteristics that humpback whales have in common and ask questions (SEP.1) about the differences between individuals (LS3.B).

Knowledge Statement: Individuals of the same species have characteristics in common.

Wonder: We begin by observing a distance marked on the ground and wondering what kind of organism it might represent. We learn that it represents the length of a humpback whale. We measure this length and compare it with the lengths of other kinds of whales. Our teacher tells us that we will learn more about these immense animals throughout the module. We share what we already know about whales, and we read the book *Here Come the Humpbacks!* (Sayre 2013). We identify the parts of a humpback whale and follow the story of a mother humpback whale and her calf along their migration journey. After we finish reading, we share what we notice and wonder about the humpback whales in the story. We observe real humpback whales by watching videos taken by whale watchers, and we add to our list of questions.

Organize: Our teacher introduces a whale watching event called the Sanctuary Ocean Count. We read an article about how volunteers at the event count the number of humpback whales they see during certain months of the year. Scientists who study humpback whales can use the data the volunteers gather. We determine important knowledge and skills we would need to participate in a Sanctuary Ocean Count event, such as the ability to tell the difference between humpback whales and other kinds of whales. We use our observations so far to try to identify humpback whales from a series of whale photographs.

Reveal: We work in pairs to sort cards with photos of different kinds of whales. We explain how we sorted the whales based on the characteristics they have in common. We discover that the cards show two whale species, or a group of organisms with the same characteristics. We then sort another set of cards with species photos. This set contains two tree species and two frog species. We list the characteristics of organisms in all the species we observed on the cards and learn that each species has a scientific name and a common name. For example, humpback whales and orcas are the common names of two different whale species.

Distill: We use what we have learned about humpback whales to draw a diagram of a humpback whale and label it with the characteristics of the species.

Organize: We revisit the requirements of participating in a Sanctuary Ocean Count event. We consider how we could avoid counting the same whale twice and decide that we should look for differences between humpback whales to tell individuals, or single organisms, apart.

We share experiences with noticing differences between individuals of other species. We share ideas such as these:

- *I saw koi fish in a pond at the museum. They were different colors and sizes.*
- *My cat had kittens last year. They were all tiny, and they looked very different from their mother.*
- *We have some ivy plants in the classroom. Some are green, but others have brown spots.*

We also participate in an activity to identify a person based on that person's appearance, and we discuss how each individual human is unique, or one of a kind. Our teacher introduces the Essential Question: What makes an individual humpback whale unique?

Reveal: We practice identifying and counting humpback whales by looking at a series of photographs and trying to determine how many individuals we see. Our teacher tells us four individual humpback whales are in the photographs and introduces the names that scientists and observers have given the four whales. We learn that the differences in the characteristics between these individual whales are known as their traits.

We develop an initial anchor evidence organizer to show our ideas about what makes these four individual humpback whales unique.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring. We still want to know what else can be unique about individual humpback whales and why they are different colors.

Salt	Migaloo	Abrasion	Moonstar
			
Salt is gray with a white patch on her dorsal fin.	Migaloo is all white.	Abrasion's tail is gray with white patches on it.	We're not sure what might be unique about Moonstar.

Wonder: We record our questions about the traits of humpback whales and what makes individuals unique on sticky notes and use them to build a driving question board. We want to answer the following questions: How can we identify individuals? How do individuals change over time? How do individuals get their traits? How do individuals' traits affect their lives? Our driving question board also includes the related phenomena we shared so we can reflect on these phenomena throughout the module.

Next Steps: Through class discussion, we determine that the best place to start answering the Essential Question is to investigate the question How can we identify individuals?

Lessons 4–6

Phenomenon Question: How can we describe differences between individuals of the same species?

Phenomenon: Individuals and Their Traits

Spotlight on Three-Dimensional Integration: Students analyze and interpret data (SEP.4) to describe variation between individuals of the same species (LS3.B) and to identify patterns (CC.1) in their observations.

Knowledge Statement: Individuals of the same species have the same characteristics but can have different traits.

Organize: Our teacher shows us tomatoes from different plants and asks us to describe each tomato. We use words such as *bumpy*, *red*, *smooth*, and *yellow*, and we determine that these words describe the different traits of tomatoes from different tomato plants. We discuss how the tomatoes' traits are related to the characteristics of all tomato plants and set up a table to organize our observations. Our teacher explains that we will observe individuals from other species and document observations in a table similar to the one we used for tomato plants.

Reveal: We visit four stations to observe the traits of individual Fast Plants, Peruvian scallops, humpback whales, and northern leopard frogs. At each station, we observe three individuals from the same species and record our observations about their traits in a data table. After visiting each station, we discuss our observations. We share ideas about similarities and differences in characteristics and traits between individuals of the same species. We notice the following pattern: Within a species, individuals have the same characteristics but can have different traits. We learn that one individual's combination of traits can be different from another individual's combination of traits and that differences between individuals in a species is called variation.

We consider all the characteristics and traits we have observed so far and realize that we have focused on observing physical structures. Our teacher shares an example of a behavioral characteristic in humpback whales: catching fish. We view videos and diagrams of different feeding styles humpback whale use to catch fish, and we document our observations in a table to describe different traits of individuals.

Distill: Based on the stations and videos, we evaluate three claims and select the claim that best describes the pattern in characteristics and traits for all the species we observed. We write an explanation to support the claim and support our explanation with evidence from multiple species. We then summarize our learning on an anchor chart.

Traits

Describing Organisms

- Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails.
- Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern.
- Variation describes differences between individuals in a species.

We work in small groups to view information about the four humpback whales we observed earlier, and we apply our learning to describe the traits of each individual. We focus our descriptions on body color, fluke color and pattern, feeding style, and body size. As a class, we share our findings about what makes each of these humpback whales unique, and we decide how to represent our findings on our anchor evidence organizer. We also share questions we still have about the differences between individual humpback whales.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring, body size, and feeding style. We still want to know why they have these different traits.

Characteristic	Different Traits	What influences traits?
Fluke color and pattern	Each individual humpback whale has a unique color pattern on its tail flukes.  Abrasion  Salt  Migaloo  Moonstar	
Fish catching behavior	Individual humpback whales can use different feeding styles to catch fish.  Abrasion uses kick feeding.  Moonstar uses trap and lunge feeding.	
Body size	Adult humpback whales are typically 15 meters long, but individuals can be larger or smaller. Migaloo is about 13 meters long.	

	Know: We apply what we have learned about describing individuals as we complete a Conceptual Checkpoint. We observe two photographs of plants along with field guide entries showing two different plant species. Based on the patterns of similarities and differences in the plants' characteristics and traits, we select a claim about which species each plant belongs to and support the claim with evidence. *Next Steps:* Now that we know that we can identify individuals of the same species by observing and describing their traits, our teacher shows us a video of a white humpback whale whose identity scientists are not sure about. We compare the whale in the video with one of the whales we have identified (Migaloo), and we realize that they have very similar traits. However, we learn that some observers think that the whale in the video might have been smaller in 2015 than Migaloo is now. We wonder whether the size of a humpback whale can change over time. We decide to investigate how individuals change over time.
Concept 2: Growth, Development, and Environmental Influences (Lessons 7–11) *Focus Question: How do individuals change over time?*	
Lessons 7–8	
Phenomenon Question: How do individuals change throughout their lives? **Phenomenon:** Growth and Development **Spotlight on Three-Dimensional Integration**: Students analyze photographs (SEP.4) to describe patterns (CC.1) in the processes that all organisms go through during their lives: birth, growth and development, and death (LS1.B). **Knowledge Statement:** All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change.	**Wonder:** We observe baby photographs of familiar people. We work in pairs to match the baby photographs to the people's present-day photographs, and we discuss how people's traits can change as they get older. **Organize:** We revisit our learning from Module 2 about the changes that occur during a butterfly's life, and we sequence a set of cards showing these changes. We observe a photograph of a dead butterfly and determine that this card represents the end of a butterfly's life. Our teacher explains that we will apply this thinking to sequence additional sets of cards that show the changes that individuals of other species go through during their lives. **Reveal:** We work in small groups to sequence cards for three other species. For each species, we place the cards in the order that we think what they depict occurs during an individual's life. Then we meet with another group that sequenced cards for three other species. We share our sequences and record similarities and differences. **Distill:** As a class, we discuss similarities in the beginning of life for individuals of all six species, and we realize that all individuals are born from parents. We begin a class model to represent the life of an individual, and we record birth on the model. We continue to discuss similarities by focusing on the end of life for individuals of all six species, and we record death on our model. Finally, we discuss what is similar about the period between birth and death for individuals of all six species, and we record growth and development on our model. After completing the model, we confirm that all individuals go through birth, growth and development, and death. **Organize:** We consider whether our model describes how long individuals live. We decide that it does not, and we share prior knowledge about differences between the lengths of life for individuals of different species. We try to sequence the species we observed earlier in order of the length of their lives, from shortest to longest, but we realize that we need more information. **Reveal:** We view a data table that shows the typical life span, or length of life, for each species. We discover that some species live much longer than others.

Distill: We add our new learning to our anchor chart.

Traits

Describing Organisms

- Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails.
- Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern.
- Variation describes differences between individuals in a species.

Growth and Development

- All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change.

Wonder: Our teacher shows us a photograph of a cassowary chick and asks us to think about how the chick might change as it gets older. Our teacher then shows us three photographs of adult birds and asks us which one we think is an adult cassowary.

Organize: We realize that a cassowary's traits change in many ways as the bird gets older.

Reveal: We observe photographs of a litter of one-day-old rabbits and think about how the rabbits might change as they grow and develop. Our teacher asks us to work in groups to create a timeline of photographs showing these rabbits during the six-week period after they are born. We record what we notice about how their traits change as they get older. We notice that the rabbits get bigger and that their fur changes color over time. We also notice that most changes occur near the beginning of the rabbits' lives.

We create a timeline of chicken photographs to notice how the chickens' traits change from when they are eggs to when they are six weeks old. We record what we notice about how their traits change as they get older. We notice that the chickens get bigger and that their feathers change over time. We also notice that, like the rabbits, most of the changes occur near the beginning of the chickens' lives.

Distill: We discuss patterns in the growth and development we observed for the rabbits and chickens. We agree that although life spans differ across species, growth and development often follow similar patterns. For example, individuals usually grow and develop quickly early in their lives, and their growth and development slow as they age. In addition, individuals of the same species develop the same characteristics as they grow, but their traits can develop differently. These patterns of growth and development can influence the similarities and differences between individuals.

Know: We revisit the white humpback whale we observed in Lesson 6 and consider whether our new learning helps us determine its identity. We conclude that knowing the body size of the whale in the video along with Migaloo's body size in 2015 would help us determine whether the whale in the video is Migaloo or whether it is a younger whale. As a class, we work to explain how an individual's body size can change over time, and we use this information to update our anchor evidence organizer.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring, body size, and feeding style. These traits can change as a whale grows and develops.

Characteristic	Different Traits	What influences traits?
Fluke color and pattern	Each individual humpback whale has a unique color pattern on its tail flukes.  Abrasion  Salt  Migaloo  Moonstar	
Fish catching behavior	Individual humpback whales can use different feeding styles to catch fish.  Abrasion uses kick feeding.  Moonstar uses trap and lunge feeding.	
Body size	Adult humpback whales are typically 15 meters long, but individuals can be larger or smaller. Migaloo is about 13 meters long.	Growth and Development: A baby humpback whale gets bigger as it becomes an adult.

Next Steps: We wonder what other factors might influence an individual's traits.

Lessons 9–11

Phenomenon Question: What can influence the development of traits?

Phenomenon: Environmentally Influenced Traits

Spotlight on Three-Dimensional Integration: Students make observations and describe cause and effect relationships (CC.2) to use as evidence to support explanations (SEP.6) about how interactions between an individual and its environment can influence the individual's traits (LS3.A, LS3.B).

Knowledge Statement: Interactions between an individual and its environment can influence the individual's traits.

Wonder and Organize: To summarize our learning so far, we create a trait influence chart to describe factors that can influence an individual's traits. We record what we know about how growth and development influence traits, such as how a rabbit's fur color can change as the rabbit gets older and how a pine tree's trunk gets larger over time.

Our teacher shows us photographs of two radish plants, and we compare their traits. We notice that the plants have leaves that are the same shape and color. However, one of the plants has long, stringy stems that are red, and the other plant has stems that are short, green, and upright. We think about what might have caused these differences, and our teacher tells us that the radish plants are the same age. We realize that something other than normal growth and development must have caused the differences between them. We add this information to our trait influence chart.

Reveal: Our teacher explains that we will visit Trait Influence Stations to explore other causes of trait changes. At each station, we participate in a model, record observations, and consider our results.

Distill: After visiting each station, we discuss what we observed as a class. Our teacher creates a cause and effect chart to capture our ideas. We realize that at each station, an interaction between an individual and its environment caused a change in the individual's trait. The interaction was the cause, and the change in the trait was the effect. We also realize that an individual's environment can influence physical traits, such as feather color, and behavioral traits, such as feeding style. We add our new learning to our anchor chart.

Traits

Describing Organisms

- Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails.
- Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern.
- Variation describes differences between individuals in a species.

Growth, Development, and Environmental Influences

- All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change.
- Interactions between an individual and its environment can influence the individual's traits.

Our teacher explains that the radish plants we observed in Lesson 9 were grown in different light conditions, and we revise our trait influence chart to include traits that are influenced by interactions with an individual's environment.

Know: We think about how we can use what we have learned about environmental influences on traits to update our anchor evidence organizer. We return to *Here Come the Humpbacks!* and read about traits of humpback whales. We discuss how a humpback whale's weight can change during its migration and how humpback whales can learn new feeding styles from other humpback whales in their environment. We add this learning to our anchor evidence organizer.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring, body size, and feeding style. These traits can change as a whale grows and develops. Interactions between a whale and its environment can also influence a whale's traits.

Characteristic	Different Traits	What influences traits?
Fluke color and pattern	Each individual humpback whale has a unique color pattern on its tail flukes.  Abrasion  Salt  Migaloo  Moonstar	
Fish catching behavior	Individual humpback whales can use different feeding styles to catch fish.  Abrasion uses kick feeding.  Moonstar uses trap and lunge feeding.	Environment: Humpback whales can learn new feeding styles from other whales they spend time with.
Body size	Adult humpback whales are typically 15 meters long, but individuals can be larger or smaller. Migaloo is about 13 meters long.	Growth and Development: A baby humpback whale gets bigger as it becomes an adult. Environment: When whales migrate to colder water where there is more food, they gain weight.

	We apply what we have learned in a Conceptual Checkpoint. We analyze data about the traits of two puppies over time. We describe how the puppies' traits change over time, identify which traits are most likely environmentally influenced, and identify how each puppy's environment could have influenced the traits. *Next Steps:* Our teacher explains that we will further explore how traits can be influenced by an individual's environment by designing our own investigation in a science challenge.

Application of Concepts (Lessons 12–13): Science Challenge

Phenomenon Question: How does the water in a plant's environment influence the plant's traits?

Lessons 12–13 (Science Challenge, Part 1)

Phenomenon Question: How does the water in a plant's environment influence the plant's traits? **Phenomenon:** Science Challenge **Spotlight on Three-Dimensional Integration:** Students plan and carry out an investigation (SEP.3) to explore how interactions between an individual and its environment (LS3.B) can cause changes to the individual's traits (CC.2). **Knowledge Statement:** Different environmental conditions can influence the development of an individual's traits in different ways.	**Wonder:** We look at three different varieties of Fast Plants. Our teacher asks us how the water conditions in these plants' environment might influence their traits. We think that getting too much or too little water might cause changes to the plants' stems or leaves. **Organize:** Our teacher explains that we will continue exploring our ideas as we investigate how the water in a plant's environment can influence the plant's traits. We imagine how the water in a plant's environment might change and what might cause those changes. We discuss how changes in weather conditions could cause a plant to get more or less water. Our teacher also explains that the water in a plant's environment can change if salt gets into the water, such as if a salt truck puts salt on a road during icy conditions. We consider specific water conditions that a plant may experience and develop three investigation questions: ▪ How does **more** water in a plant's environment influence the plant's traits? ▪ How does **less** water in a plant's environment influence the plant's traits? ▪ How does **salt** water in a plant's environment influence the plant's traits? Our teacher explains that we will continue to explore these questions by planning and carrying out investigations. Before we begin, our teacher shares an investigation scenario to help us learn to develop a fair test. By thinking about the investigation scenario, we learn that we should only change one variable—the amount or the quality of the water—at a time so we can be sure which variable causes changes in a plant's traits. We also agree that we need to consider whether changes in a plant's traits are caused by normal growth and development or environmental influences. Our teacher explains that growing another plant that is the same age will help ensure a fair test because we will know what normal growth and development look like for these plants. We work in groups to use what we have learned about fair tests to come up with investigation plans to test each water condition. We also predict an answer to our group's investigation question. **Reveal:** We set up our investigations and determine how much water each group will give the plants. Groups investigating salt water also determine how much salt to mix into the water for one of their plants. Then we observe our plants and record information about their traits. We plan to observe and water our plants each day for the next several days. **Wonder:** Our teacher asks us to think about the traits of the Fast Plants we are investigating and reminds us that the plants have been growing in the same environmental conditions until this lesson. We notice that some plants have different-colored leaves and stems, but we are not sure why. We add this uncertainty to the class trait influence chart and think about what else might influence an individual's traits. *Next Steps:* Our teacher explains that in upcoming lessons, we will learn more about traits that are not the result of interactions between an individual and its environment.

Concept 3: Inherited Traits (Lessons 14–18)

Focus Question: How do individuals get their traits?

Lessons 14–15

Phenomenon Question: Why do offspring look like their parents?

Phenomenon: Inherited Traits in Offspring

Spotlight on Three-Dimensional Integration: Students analyze and interpret data (SEP.4) to describe the pattern (CC.1) that offspring inherit traits from their parents (LS3.A).

Knowledge Statement: Parents and offspring look similar because offspring inherit traits from both parents.

Wonder: Our teacher displays photographs of two sets of rabbit parents and explains that each of set of parents has an offspring. We observe two possible offspring and work in pairs to try to match each set of parents with their offspring. We realize that we expect the offspring to look similar to their parents and begin to think about whether this is true for other species.

Organize: We work in pairs to make an initial claim about why offspring look like their parents. We share our claims with the class and develop the following class claim: Offspring get traits from their parents. To determine whether our class claim is true, we decide that we need more evidence. Our teacher tells us that we will begin collecting evidence by observing families of Gouldian finches.

Reveal: Our teacher displays photographs of three Gouldian finches and asks us to use we what have learned about characteristics and traits to describe the ways each individual finch is different. We develop a list of characteristics that show significant differences between individuals: head color, chest color, belly color, back color, and tail color.

We work in groups to analyze posters of different Gouldian finch families that each show two parents and one offspring. We observe both parents and the offspring closely and record each finch's traits on the poster. We place our posters in different areas around the classroom and observe other groups' posters. As we visit each poster, we discuss how the offspring's traits compare with each parent and how each family compares with the other finch families.

Distill: After we observe each poster, we discuss the patterns we noticed for all the parents and their offspring. We conclude that a finch offspring's traits are influenced by both parents and that each offspring's traits can appear similar to one parent's trait, similar to both parents' traits, or as a mixture of the parents' traits.

We revisit our initial class claim and conclude that the evidence from the finch families supports the claim: Offspring get traits from their parents. Our teacher explains that traits offspring receive from their parents are called inherited traits and that all individuals inherit traits from their parents. We use our new learning to write a more precise class claim: Offspring inherit traits from both parents.

Wonder and Organize: Our teacher displays a set of Fast Plants that we are not using in the science challenge along with our trait influence chart. We consider what else might influence the traits of the Fast Plants. We wonder whether plants have parents and, if so, whether plants inherit traits from their parents.

Reveal: Our teacher reminds us that there are three different varieties of Fast Plants. We learn that these different varieties represent two parent plants and their offspring. We work in groups to observe and record the traits of each plant variety. We realize that the offspring plant has some traits that look similar to one parent and other traits that look similar to the other parent.

Distill: We revisit our class claim and consider whether the evidence from the Fast Plants supports the claim. We decide that it does, and we refine our class claim to include that both plant and animal offspring inherit traits from both parents. We use evidence and reasoning to support our revised claim, and we update our anchor chart based on our new learning.

Traits

Describing Organisms

- Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails.
- Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern.
- Variation describes differences between individuals in a species.

Growth, Development, and Environmental Influences

- All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change.
- Interactions between an individual and its environment can influence the individual's traits.

Inherited Traits

- Plant and animal offspring inherit traits from both parents.

Next Steps: We think about families that have multiple offspring and wonder whether all offspring from the same parents look the same. Our teacher explains that in the next lesson, we will explore similarities and differences between siblings.

Lessons 16–18

Phenomenon Question: What causes differences between siblings?

Phenomenon: Inherited Traits in Siblings

Wonder and Organize: Our teacher shows us a photograph of a mother finch in a nest with her chicks. We share questions we have about the finch offspring. We decide that we need more information to answer our questions about siblings' traits.

Reveal: We observe photographs of a finch family that includes two parents and four offspring that are siblings. We work in pairs to record and analyze the traits of each family member. After we record our observations, we discuss how the traits of the offspring compare with the traits of the parents. Then we compare the traits of the offspring with one another.

Spotlight on Three-Dimensional Integration: Students analyze data (SEP.4) to notice patterns (CC.1) in order to explain that siblings look different from one another because they inherit different combinations of traits (LS3.B).

Knowledge Statement: Siblings look different from one another because they inherit different combinations of traits from their parents.

Distill: We use our observations to explain that all offspring inherit traits from both parents but not all offspring inherit the same traits. Instead, offspring inherit a unique combination of traits.

Know: Our teacher shows us a photograph of a finch flock and asks us how we could determine which finches are part of the same family. We think it might be difficult because offspring do not always inherit the same traits. We learn that scientists who study organisms in the wild do not always know which individuals are related but that they can make observations to develop arguments.

Our teacher shows us an image of a mystery frog. We observe its traits and discuss what its family members might look like. We then examine the traits of frogs from four different families and develop an argument about which family the mystery frog belongs to. We discuss our reasoning as a class and conclude that the mystery frog could belong to any of the families depending on the combination of traits it inherited from its parents.

We add our new learning to the anchor chart.

Traits
Describing Organisms • Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails. • Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern. • Variation describes differences between individuals in a species.
Growth, Development, and Environmental Influences • All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change. • Interactions between an individual and its environment can influence the individual's traits.
Inherited Traits • Plant and animal offspring inherit traits from both parents. • Siblings look similar but not exactly alike because they inherit different combinations of traits from their parents.

We complete a Conceptual Checkpoint to demonstrate our learning about the inheritance of traits. We closely observe pea plant parents and offspring. We write a response explaining why the offspring look different from one another. Then we consider how humpback whales' traits might be influenced by inheritance. Our teacher shows us videos and photographs of humpback whale mothers and their calves. One humpback whale calf is white even though its mother is gray. Our teacher tells us that some scientists and observers think it is possible that the white whale calf's father is Migaloo, but they do not know for sure. We use what we have learned about inheritance to update our anchor evidence organizer.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring, body size, and feeding style. Each individual humpback whale inherits a unique combination of traits from its parents. These traits can change as a whale grows and develops. Interactions between a whale and its environment can also influence a whale's traits.

Characteristic	Different Traits	What influences traits?
Fluke color and pattern	Each individual humpback whale has a unique color pattern on its tail flukes.  Abrasion  Salt  Migaloo  Moonstar	Inheritance: We think humpback whales inherit skin color (including fluke color) from their parents, but the color pattern isn't exactly the same. We need more evidence to confirm this idea.
Fish catching behavior	Individual humpback whales can use different feeding styles to catch fish.  Abrasion uses kick feeding.  Moonstar uses trap and lunge feeding.	Environment: Humpback whales can learn new feeding styles from other whales they spend time with.

Characteristic	Different Traits	What influences traits?
Body size	Adult humpback whales are typically 15 meters long, but individuals can be larger or smaller. Migaloo is about 13 meters long.	Growth and Development: A baby humpback whale gets bigger as it becomes an adult. Environment: When whales migrate to colder water where there is more food, they gain weight.

Next Steps: Our teacher reviews our work earlier in the module, where we began a science challenge to investigate how different environmental conditions influence the development of a plant's traits. We learn that in the next lesson, we will conclude our investigation and interpret our results.

Application of Concepts (Lessons 19–20): Science Challenge

Phenomenon Question: How does the water in a plant's environment influence the plant's traits?

Lessons 19–20 (Science Challenge, Part 2)

Phenomenon Question: How does the water in a plant's environment influence the plant's traits?

Phenomenon: Science Challenge

Spotlight on Three-Dimensional Integration: Students analyze and interpret data (SEP.4) from their investigation to describe how quickly or slowly the plants' traits changed over time (CC.7) and to support a claim that an individual's inherited traits can be influenced by the individual's environment (LS3.A).

Knowledge Statement: An individual's inherited traits can be influenced by interactions between the individual and its environment.

Reveal: We make final observations about our plants. Then we draw pictures to show how the traits of the plants changed from the first day of the investigation to the last day of the investigation. We discuss what we notice as a class.

We analyze our collected data to describe how quickly or slowly the plants' traits changed throughout the investigation. We notice that groups that tested the same water condition had similar results, so we decide to look for other similarities or differences between plants grown in the same water condition.

Distill: After comparing results, we use the data gathered throughout the investigation as evidence to answer our group's investigation question. We also return to the prediction we made at the investigation's beginning to determine whether it is correct, and we update our trait influence chart to include our results for Fast Plants.

Our teacher shows us two paintings created by Bruegel the Elder and Brueghel the Younger, a father and son. Our teacher points out the painting by Brueghel the Younger and asks us to think about what might have influenced his ability to paint. We determine that his ability to paint could have been influenced by inheritance, environment, or both.

Organize: We make a claim about whether the environment can cause an individual's inherited traits to change. As a class, we make the following claim: The inherited traits of an individual can be influenced by the individual's environment. To find out whether this claim is true, we agree to observe both inherited traits and environmental influences on traits for Fast Plants.

Reveal: We recall that we learned that Fast Plants inherit traits such as stem color and leaf color from their parents. We decide to use the results of the science challenge to determine whether the plants' environment during the investigation influenced those traits. We review our collected data from the science challenge and compare the traits of the plants before and after the change in their water conditions.

Distill: We reevaluate our class claim and determine that our data support the claim. We record evidence and reasoning to support the claim and conclude that a plant's inherited traits can change as a result of changes to its environment. We update our anchor chart with our new learning.

Traits
Describing Organisms • Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails. • Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern. • Variation describes differences between individuals in a species.
Growth, Development, and Environmental Influences • All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change. • Interactions between an individual and its environment can influence the individual's traits.
Inherited Traits • Plant and animal offspring inherit traits from both parents. • Siblings look similar but not exactly alike because they inherit different combinations of traits from their parents. • Many traits are influenced by both inheritance and environment.

Next Steps: Our teacher tells us that in the next lesson, we will investigate the function of traits to learn how traits affect an individual's life.

Concept 4: Advantages of Traits (Lessons 21–25)

Focus Question: How do individuals' traits affect their lives?

Lessons 21–22

Phenomenon Question: How do the traits of different individuals function differently?

Phenomenon: Traits That Provide an Advantage

Spotlight on Three-Dimensional Integration: Students model differences in how well the traits of different individuals perform the same function (CC.6) to construct explanations (SEP.6) about how an individual's traits can provide the individual with an advantage in surviving (LS4.B).

Knowledge Statement: An individual's traits can provide it with an advantage in surviving in its environment.

Organize: We revisit our driving question board and anchor evidence organizer to summarize how growth and development, interactions between an individual and its environment, and inheritance can all influence an individual's traits. We realize that we still have questions about how traits affect individuals' lives.

Reveal: We visit Trait Function Stations to learn how individuals of the same species that have different traits interact with their environment. At each station, we model different traits to determine which trait is better for a specific function, such as catching fish.

Distill: We use evidence from the stations to conclude that a trait can provide an individual with an advantage, or a better position or condition. Our teacher explains that an advantageous trait is one that performs a function more effectively.

Wonder: Our teacher displays photographs of two different-colored rock pocket mice and explains that the mice are the same species. We wonder what might have caused the mice to have different-colored fur. Our teacher explains that the rock pocket mice live in desert environments in places such as Arizona, Utah, and northern Mexico. We observe photographs of two different desert environments and notice that the ground is dark brown in one environment and light brown in the other.

Organize: We consider what the function of fur color might be for rock pocket mice. We decide to investigate whether having dark fur or light fur provides an advantage.

Reveal: Our teacher explains that we will model an interaction between rock pocket mice and their environment for two different environments. We use white and black paper squares to represent rock pocket mice with light fur and dark fur. We place the paper squares on white and black sheets of paper that represent light- and dark-colored environments. We use our fingers to model an owl picking up mice and eating them. We record how many white squares and how many black squares we picked up on each sheet of paper. Then we review our data. We notice that we were able to pick up more white squares on the black sheet of paper and more black squares on the white sheet of paper.

Distill: We consider how our model relates to rock pocket mice. We conclude that having fur that matches the environment is an advantageous trait because the mouse is less likely to be eaten by a predator. We consider how traits affect an individual's ability to survive. We realize that having an advantageous trait increases an individual's chance of survival.

Next Steps: We think about other traits that may affect an individual's chance of survival and share our ideas with the class. We also consider other ways that advantageous traits might affect an individual's life.

Lessons 23–25	
Phenomenon Question: How can an individual's traits affect its ability to reproduce? **Phenomenon:** Life Cycles and Reproduction **Spotlight on Three-Dimensional Integration:** Students use cause and effect relationships (CC.2) to construct an explanation (SEP.6) for how advantageous traits provide an individual with an advantage in finding a mate and reproducing (LS4.B). **Knowledge Statement:** An individual's traits can provide it with an advantage in finding a mate and reproducing.	**Organize:** We observe the photographs of the rock pocket mice again and think about which one is more likely to reproduce. We think that a mouse with an advantageous trait might be more likely to reproduce, but we need more information. **Reveal:** Our teacher gives us each a mouse card and a model of the life of an individual. We follow our mice through their lives as different events occur. Some mice get caught by an owl and die. Other mice survive, find a mate, and reproduce. We count how many mice of each fur color die, how many survive, and how many reproduce. **Distill:** We use our data to determine how a mouse's fur color affected its chances of surviving and reproducing. We realize that mice that have advantageous traits are more likely to survive long enough to reproduce. We consider what might happen over time if no mice reproduced. We predict that the species would eventually become extinct. Our teacher uses our ideas to draw a new model that builds on the life of an individual model. This model includes reproduction. Our teacher explains that this model represents the life cycle of a species, or the continuing processes of birth, growth and development, and reproduction of many individuals in a species. **Wonder and Organize:** We observe a photograph of two Gouldian finches, and our teacher asks us to share questions we have about how a finch's traits affect the finch's ability to survive and reproduce. We determine that we cannot yet explain whether different traits provide finches with an advantage. **Reveal:** Our teacher explains that we will visit two stations to collect and analyze data about how traits can affect an individual's chance of finding a mate and reproducing. At the stations, we learn about southern elephant seals and long-tailed widowbirds and observe traits of different individuals. **Distill:** We analyze the data from each station to explain how different traits provide an individual with an advantage in finding a mate and reproducing. We realize that it is advantageous for male elephant seals to have long bodies and male widowbirds to have long tails. Our teacher asks us to think about all the species we have observed and to consider what might influence whether an individual has an advantageous trait. We think that advantageous traits might be inherited from an individual's parents. **Know:** We return to the book *Here Come the Humpbacks!* and read about male whales challenging one another to be a female's mate. We also read about orcas attacking a whale calf. We notice that the orcas do not attack the calf's mother. We think this might be because the calf is too small to defend itself. We use what we have read to think about traits that might provide humpback whales with advantages in surviving and reproducing. We think that having a larger body size might prevent a whale from getting eaten by orcas and might also allow it to defeat other whales and find a mate. We analyze data to see whether body length affects a male humpback whale's ability to find a mate. We notice that male whales that are longer are more successful at challenging other whales and becoming a female whale's mate. We conclude that a long body provides a male whale with an advantage in reproducing.

We update our anchor chart and anchor evidence organizer with our new learning.

Traits

Describing Organisms

- Individuals of the same species have the same characteristics. For example, all humpback whales have skin, side flippers, and tails.
- Differences in characteristics are called traits. Individuals of the same species can have different traits. For example, each humpback whale's tail has a unique color pattern.
- Variation describes differences between individuals in a species.

Growth, Development, and Environmental Influences

- All individuals are born, grow and develop, and die. As individuals grow and develop throughout their lives, their characteristics and traits can change.
- Interactions between an individual and its environment can influence the individual's traits.

Inherited Traits

- Plant and animal offspring inherit traits from both parents.
- Siblings look similar but not exactly alike because they inherit different combinations of traits from their parents.
- Many traits are influenced by both inheritance and environment.

Advantages of Traits

- An individual's traits may provide advantages in surviving, finding mates, and reproducing.

What makes an individual humpback whale unique?

Humpback whales have the same characteristics because they are the same species. They also have differences that make them unique, such as their coloring, body size, and feeding style. Each individual humpback whale inherits a unique combination of traits from its parents. These traits can change as a whale grows and develops. Interactions between a whale and its environment can also influence a whale's traits. Some traits provide a whale with advantages in surviving, finding mates, and reproducing.

Characteristic	Different Traits	What influences traits?	How do traits affect individuals' lives?
Fluke color and pattern	Each individual humpback whale has a unique color pattern on its tail flukes.  Abrasion  Salt  Migaloo  Moonstar	Inheritance: We think humpback whales inherit skin color (including fluke color) from their parents, but the color pattern isn't exactly the same. We need more evidence to confirm this idea.	We don't know if a whale's fluke color or pattern gives it an advantage.
Fish catching behavior	Individual humpback whales can use different feeding styles to catch fish.  Abrasion uses kick feeding.  Moonstar uses trap and lunge feeding.	Environment: Humpback whales can learn new feeding styles from other whales they spend time with.	A feeding style that helps a whale catch more fish will give it an advantage in surviving.

Characteristic	Different Traits	What influences traits?	How do traits affect individuals' lives?
Body size	Adult humpback whales are typically 15 meters long, but individuals can be larger or smaller. Migaloo is about 13 meters long.	Growth and Development: A baby humpback whale gets bigger as it becomes an adult. Environment: When whales migrate to colder water where there is more food, they gain weight.	Having a larger body size can provide a male whale with an advantage in finding a mate and reproducing. It might also help a whale defend itself against predators.

We complete a Conceptual Checkpoint to demonstrate our learning about how individuals' traits affect their lives. We learn that some brown anole lizards have long legs and some have short legs. We analyze data about the lizards collected over time to draw conclusions about how a lizard's traits can affect its ability to survive and reproduce.

Next Steps: We are ready to reflect on our progress throughout the module and complete an End-of-Module Assessment.

Application of Concepts (Lessons 26–28): Socratic Seminar, End-of-Module Assessment

Essential Question: What makes an individual humpback whale unique?

Lessons 26–28 (Socratic Seminar, End-of-Module Assessment, End-of-Module Assessment Debrief)

Phenomenon Question: What makes an individual humpback whale unique? (Essential Question)

Phenomenon: Individual Variation in Humpback Whales

Spotlight on Three-Dimensional Integration: Students use their knowledge of factors that influence traits and how traits affect individuals' lives (LS1.B, LS3.A, LS3.B, LS4.B) to construct explanations (SEP.6) about the patterns (CC.1) students observed throughout the module.

Knowledge Statement: Traits are influenced by inheritance, growth and development, and interactions between an individual and its environment. Some traits provide an individual with advantages in surviving and reproducing.

Distill: As a class, we participate in a Socratic Seminar and discuss our Essential Question: What makes an individual humpback whale unique? We use our driving question board, anchor chart, and anchor evidence organizer to help us answer this question.

Know: We show our understanding of factors that influence traits and how traits affect an individual's life in the End-of-Module Assessment, and then we reflect on our learning throughout the module.

Next Steps: We discuss remaining questions about factors that influence traits and how traits affect an individual's life.

Appendix C

Module Glossary

These are Level 3–appropriate descriptions of the module terminology and are not intended to be complete definitions.

Term	Description	Lesson
Advantage	a better position or condition	21
Behavior	the way an organism acts or responds to its environment	5
Birth	the beginning of an individual's life	7
Camouflage	an organism blending in with its surroundings because of its natural coloring or form	22
Death	the end of an individual's life	7
Development	changes in an individual's characteristics or traits throughout the individual's life	7
Growth	an individual getting bigger over time	7
Individual	a single organism	2
Inherit	to receive traits from one's parents	14
Life cycle	the continuing processes of birth, growth and development, and reproduction of many individuals in a species	23

Term	Description	Lesson
Mate	the individual with which another individual produces one or more offspring through the process of reproduction	23
Reproduction	the production of offspring by two adult individuals	14
Species	organisms that have the same characteristics and can reproduce with one another	2, 14
Traits	differences in the characteristics of individuals of the same species	3
Unique	one of a kind	3
Variation	differences between individuals in a species	5