

## Appendix B

# Module Storyline

### Anchor Phenomenon: Butterfly Survival

*Essential Question: How do butterflies survive over time in a changing environment?*

#### Conceptual Overview

Organisms have characteristics that help them survive over time in changing environments.

1. Fossils provide evidence of the kinds of organisms that lived long ago and the nature of their environments.
2. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. Some animals form groups that help members survive.
3. When an environment changes, the kinds of organisms that live there may change. Some organisms may stay and survive, some may move in or out, and some may die.

#### Focus Content Standards

- 3.9A Observe and describe the physical characteristics of environments and how they support populations and communities of plants and animals within an ecosystem.
- 3.9B Identify and describe the flow of energy in a food chain and predict how changes in a food chain affect the ecosystem such as removal of frogs from a pond or bees from a field.
- 3.9C Describe environmental changes such as floods and droughts where some organisms thrive and others perish or move to new locations.
- 3.10A Explore how structures and functions of plants and animals allow them to survive in a particular environment.
- 3.10B Investigate and compare how animals and plants undergo a series of orderly changes in their diverse life cycles such as tomato plants, frogs, and lady beetles.

**Concept 1: Fossil Evidence (Lessons 1–8)***Focus Question: What do fossils reveal about the past?***Lessons 1–2**

**Phenomenon Question:** How long have butterflies survived on Earth?

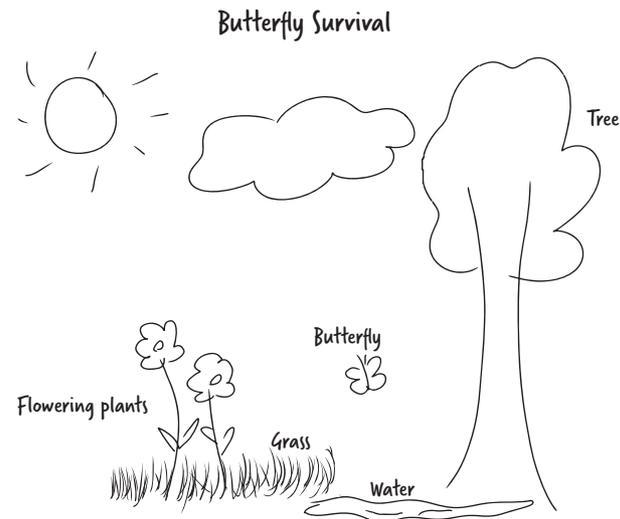
**Phenomenon:** Butterfly Survival

**Lesson Set Objective:** Students develop an initial anchor model to record their current understanding of butterfly survival, make observations about a butterfly fossil, and create a timeline representing elapsed time between Earth's formation and the present day to better understand when the earliest butterflies appeared on Earth.

**Knowledge Statement:** Butterflies have survived on Earth for millions of years.

**Wonder:**\* First, our teacher shows us a woodcut called *The Rhinoceros* by Albrecht Dürer and a photograph of a rhinoceros. We notice that Dürer's woodcut is not an accurate representation of the animal. We keep this in mind as we use what we know about butterflies to draw a sketch of a butterfly. Our teacher shows us illustrations of butterflies from a book called *A Butterfly Is Patient* (Aston and Long 2015). We compare our sketches with the illustrations and realize that butterflies are insects that have long, thin bodies and four wings that are often brightly colored. We then create a sketch to show where butterflies live. Next, we sort photographs of plants and animals into categories and learn that all the photographs show organisms, or living things, that can be found where butterflies live. We update our sketches of where a butterfly lives, and our teacher tells us that we have drawn a butterfly's environment, or the area surrounding an organism that includes what the organism needs to survive.

**Organize:** We discuss the difference between an organism and an environment. Then we work together to develop a class anchor model that shows the components of a butterfly's environment that help it survive.



Butterflies live in environments that have water and plants such as flowering plants, grass, and trees. Butterflies get what they need to survive from their environment.

\* The purple headings indicate the relevant content stage within the content learning cycle. See the Implementation Guide for more information on the content learning cycle.

We make a list of questions we have about butterflies and share ideas about other organisms we know of and what they need to survive. We share ideas such as these:

- *I have a pet horseshoe crab. It needs sand to live in and worms to eat.*
- *Elephants need a lot of space because they are really big. Elephants I have seen at the zoo eat hay and grass and have water to drink.*
- *My favorite animal is a dolphin. It needs water to live in and fish to eat.*

**Wonder:** Next, we create sketches of what we think butterflies looked like in the past. Our teacher shows us a photograph of a butterfly fossil, or the remains or impression of an organism that lived long ago. This fossil makes us wonder how long butterflies have been on Earth.

**Organize:** To help us understand how long butterflies have survived, we create a class timeline that represents the elapsed time between Earth's formation and the present day. We learn that butterflies have been on Earth for millions of years.

Our teacher asks us to record questions we have on sticky notes. We use these questions to develop a driving question board. We want to answer these questions: What do fossils reveal about the past? How do organisms get what they need to survive? What happens to organisms when the environment changes? We use the theme of our questions to develop the main question we want to answer: How do butterflies survive over time in a changing environment? Our driving question board also includes the related phenomena we shared earlier so we can reflect on these phenomena throughout the module.

**Essential Question: How do butterflies survive over time in a changing environment?**

<p><b>What do fossils reveal about the past?</b></p> <table border="1"> <tr> <td style="background-color: #e0f2f1;">How do we know how long butterflies have been on Earth?</td> <td style="background-color: #e0f2f1;">Did butterflies live with dinosaurs?</td> </tr> <tr> <td style="background-color: #e0f2f1;">Why didn't butterflies become extinct when dinosaurs did?</td> <td style="background-color: #ffe0b2;">Are there fossils of other organisms?</td> </tr> <tr> <td style="background-color: #e0f2f1;">How have butterflies survived for so long?</td> <td></td> </tr> </table>	How do we know how long butterflies have been on Earth?	Did butterflies live with dinosaurs?	Why didn't butterflies become extinct when dinosaurs did?	Are there fossils of other organisms?	How have butterflies survived for so long?		<p><b>How do organisms get what they need to survive?</b></p> <table border="1"> <tr> <td style="background-color: #ffe0b2;">What do butterflies eat?</td> <td style="background-color: #e0f2f1;">Do butterflies live on flowers?</td> </tr> <tr> <td style="background-color: #e0f2f1;">What eats butterflies?</td> <td style="background-color: #e0f2f1;">Do butterflies always live in the same environment?</td> </tr> <tr> <td style="background-color: #ffe0b2;">What is found near butterflies?</td> <td></td> </tr> </table>	What do butterflies eat?	Do butterflies live on flowers?	What eats butterflies?	Do butterflies always live in the same environment?	What is found near butterflies?		<p><b>What happens to organisms when the environment changes?</b></p> <table border="1"> <tr> <td style="background-color: #e0f2f1;">What happens to butterflies when it gets cold?</td> <td style="background-color: #e0f2f1;">Do butterflies die in the winter?</td> </tr> <tr> <td style="background-color: #e0f2f1;">Do butterflies migrate like birds do?</td> <td style="background-color: #ffe0b2;">Why are butterflies found in certain places at certain times?</td> </tr> <tr> <td style="background-color: #e0f2f1;">Do butterflies need to leave in the winter?</td> <td></td> </tr> </table>	What happens to butterflies when it gets cold?	Do butterflies die in the winter?	Do butterflies migrate like birds do?	Why are butterflies found in certain places at certain times?	Do butterflies need to leave in the winter?	
How do we know how long butterflies have been on Earth?	Did butterflies live with dinosaurs?																			
Why didn't butterflies become extinct when dinosaurs did?	Are there fossils of other organisms?																			
How have butterflies survived for so long?																				
What do butterflies eat?	Do butterflies live on flowers?																			
What eats butterflies?	Do butterflies always live in the same environment?																			
What is found near butterflies?																				
What happens to butterflies when it gets cold?	Do butterflies die in the winter?																			
Do butterflies migrate like birds do?	Why are butterflies found in certain places at certain times?																			
Do butterflies need to leave in the winter?																				
<p><b>Related Phenomena:</b></p> <table border="1"> <tr> <td style="background-color: #e0f2f1;">Horseshoe crabs need sand and worms.</td> <td style="background-color: #e0f2f1;">Elephants need space, hay, grass, and water.</td> <td style="background-color: #ffe0b2;">Dolphins live in water and eat fish.</td> </tr> </table>			Horseshoe crabs need sand and worms.	Elephants need space, hay, grass, and water.	Dolphins live in water and eat fish.															
Horseshoe crabs need sand and worms.	Elephants need space, hay, grass, and water.	Dolphins live in water and eat fish.																		

*Next Steps:* Through class discussion, we determine that the best place to start answering the Essential Question is to investigate the question What do fossils reveal about the past?



## Lesson 3

**Phenomenon Question:** What can we learn by studying fossils?

**Phenomenon:** Butterfly Fossils

**Lesson Set Objective:** Students revisit the butterfly fossil from the previous lesson, compare it with a clay fossil model, and attempt to match the clay fossil with the plastic butterfly that formed it by using patterns in measurements and other observations.

**Knowledge Statement:** Fossils provide information about the organisms that formed them.

**Wonder and Organize:** We look again at the photograph of the butterfly fossil from the last lesson, and we wonder how the fossil formed. We learn that the fossil is an impression of a butterfly on a rock and it formed when a butterfly was buried by material such as rock. We also learn that paleontologists are scientists who study fossils. We decide to study more about fossils to find out what they can reveal.

**Reveal:** Our teacher gives us a clay fossil model to compare with the butterfly fossil. We notice that both the fossil and the clay fossil model were formed by butterflies, but we wonder if they were formed by the same butterfly. We make observations and measurements to compare the fossil with the clay fossil model. We determine that the butterfly fossil and the clay fossil model were formed by two different butterflies.

Next, we discuss the limitations of the clay fossil model, and our teacher explains that it was made by pressing a plastic butterfly into a ball of modeling clay. Our teacher shows us plastic butterflies and tells us that one of them was used to create the clay fossil model. We use these plastic butterflies to create our own clay fossil models. We then measure the models and make other observations, and as a class, we compare the data and use evidence to determine which plastic butterfly was used to make the original clay fossil model.

**Distill:** Through discussion, we recognize that fossils can reveal information about the organisms that formed them, such as the organism's size and body shape.

*Next Steps:* Our teacher shows us a fossil found in our region, and we decide to learn more about regional fossils.

## Lessons 4–5

**Phenomenon Question:** What can fossils reveal about our region?

**Phenomenon:** Regional Fossils

**Lesson Set Objective:** Students make observations about regional fossils to describe the past environment of their region and compare the past environment with the present-day environment to learn that patterns in fossils can provide evidence of changes in an environment.

**Knowledge Statement:** Fossils can provide evidence of changes in an environment over time.

**Wonder:** Our teacher shows us a photograph that represents the region where we live, and we look at a regional map. We identify the states in our region and describe the present-day environment of our region. We revisit the regional fossil we looked at in the previous lesson and wonder what other fossils might be found nearby.

**Reveal:** Our teacher gives us a set of photographs of fossils found in our region and asks us to match them with illustrations of the organisms that formed them. We work together to match the photographs with the illustrations and notice that all the organisms look as if they lived in water. We determine that our region must have been covered by water at some point. Our teacher displays an illustration that shows what paleontologists think our region looked like when the organisms that formed the fossils were alive. We think it looks like an ocean. We use our observations about our region's fossils and the illustration to draw a sketch that shows what our region's environment was like in the past.

**Wonder:** Our teacher shows us two different photographs of Pedersen Glacier in Alaska. One of the photographs was taken in 1917, and the other was taken in 2005. We notice that the environment has changed over time. We decide to investigate how our own region has changed over time.

**Reveal:** To make observations about our present-day environment, our teacher takes us outside. We make observations by writing descriptions and drawing sketches. We then compare the past environment of our region with the present-day environment. We realize that our environment has changed over time. In the past it was covered by water, but now it is mostly land.

**Distill:** Through discussion we realize that fossils can tell us not only about the organisms that lived in an area long ago but also about the environments in which they lived. We begin an anchor chart to capture our learning.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.

*Next Steps:* We decide to apply what we have learned about fossils to try to learn more about the past environment of the butterfly fossil we have been studying.

## Lessons 6–8

**Phenomenon Question:** What do fossils found near the butterfly fossil reveal about the Florissant area?

**Phenomenon:** Fossil Evidence

**Lesson Set Objective:** Students analyze and interpret data to describe the past environment of the Florissant area and observe patterns in the kinds of organisms that live there today to learn that the environment has changed over time.

**Knowledge Statement:** Fossils provide evidence of the nature of organisms and environments from long ago.

**Wonder:** Our teacher reveals that the butterfly fossil we have been studying was found at the Florissant Fossil Beds National Monument near Florissant, Colorado. We wonder what the environment was like when the butterfly lived there.

**Organize:** Our teacher tells us that we will observe photographs of other fossils found near the butterfly fossil. We discuss what kind of information to record about the fossils and decide to draw sketches and record observations about what the fossils look like and what kinds of organisms might have formed them.

**Reveal:** We work in pairs to observe the fossils, and our teacher helps us confirm what kind of organism formed each one. We use our observations about the fossils to describe what each one tells us about the past environment. Then we use evidence and reasoning to develop a claim about what the past environment of the Florissant area was like and create a model to visualize our thinking.

Next, our teacher shows us an illustration that represents what paleontologists think the Florissant area looked like when the butterfly that formed the fossil was alive. We update our models based on what we see in the illustration. We want to know what the environment is like in the Florissant area today. Our teacher shows a picture of the present-day environment. We also observe photographs of animals and plants that live in the Florissant area today. We use our observations to create a model of the present-day environment and compare it with our model of the past environment. We notice that some organisms are new to the area and that other organisms no longer live there. This makes us think that the environment has changed over time.

Next, our teacher shows us a mammoth fossil that was found in the Florissant area. We also look at maps that show the past and present distribution of mammoths. We realize that mammoths are extinct, or no longer in existence.

We also observe fossils of redwood trees that were found in the Florissant area. We find out that redwood trees do not grow in the Florissant area anymore but they do grow in California. This makes us wonder whether the environment of the Florissant area no longer has what redwood trees need to survive. To learn more, we compare temperature and precipitation data for the Florissant area with temperature and precipitation data for Eureka, California. We find out that Eureka is warmer and wetter than the Florissant area. Then we compare past temperature and precipitation data for the Florissant area with present-day data. We realize that the Florissant area was warmer and wetter in the past. This makes us think that redwood trees probably do not grow in the Florissant area anymore because the environmental conditions changed.

**Distill:** We update our anchor chart based on our new learning.

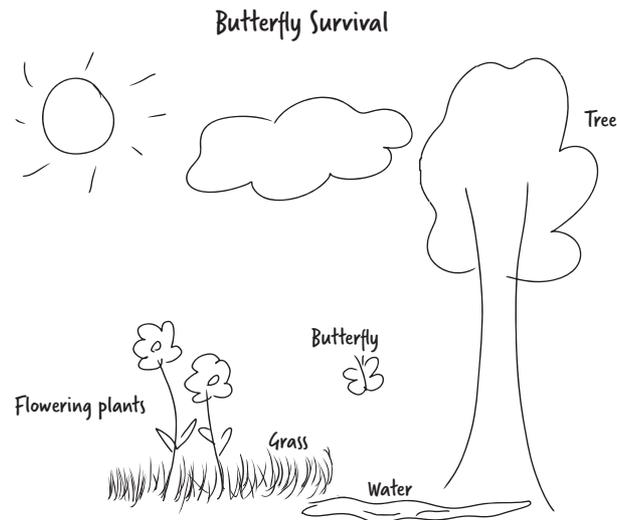
## Survival

### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

**Know:** We participate in a Conceptual Checkpoint in which we observe fossils found in a new area and determine what the environment was like when the organisms were alive. We draw a model of the environment that includes the organisms that lived there and explain what each fossil reveals about the environment.

**Distill:** Finally, we discuss what we have learned about butterflies by studying fossil evidence. We add our new ideas to the class anchor model.



Butterflies live in environments that have water and plants such as flowering plants, grass, and trees. Butterflies get what they need to survive from their environment. Butterflies have lived on Earth for millions of years, so we think they can survive in changing environments, but we're not sure how.

**Next Steps:** We revisit the driving question board and determine that our next step should be to explore how organisms get what they need to survive.

**Concept 2: Suitability to Environment (Lessons 9–15)***Focus Question: How do organisms get what they need to survive?***Lessons 9–12**

**Phenomenon Question:** Why do plants and animals live where they do?

**Phenomenon:** Suitability

**Lesson Set Objective:** Students develop a model of an artificial habitat. They determine that a habitat is a system and that changing one component of the system affects all the others. Students also evaluate the suitability of organisms to different environments and defend their reasoning with scientific evidence.

**Knowledge Statement:** Organisms are suited to survive in particular environments because of their characteristics.

**Wonder:** First, we look at a photograph of caterpillars and plants. We make a list of what we think caterpillars need to survive. Our teacher then reads us a section from *A Butterfly Is Patient*, and we consider how the caterpillars in the photograph will change over time. We also use evidence from the text to update our list of caterpillar needs. We learn that the photograph and our list of caterpillar needs represent a caterpillar’s habitat, a part of an environment that has everything a particular kind of organism needs to grow and survive. We wonder what would happen to caterpillars if their habitat did not have plants. We think they would probably die. Then we consider what plants need to survive and make a list of plant needs.

**Reveal:** Next, we consider whether caterpillars could survive in our classroom. We think that our classroom does not have what caterpillars need to survive. So we design and draw a model of an artificial, or man-made, habitat that caterpillars could live in. Our teacher then shows us live caterpillars in an artificial habitat. We notice that the artificial habitat does not look anything like the ones we drew. Our teacher explains that the caterpillars have everything they need to survive in the artificial habitat.

We compare the artificial habitat with a natural habitat and notice that the artificial habitat is controlled by humans and that many of its components are not found in a natural habitat. Our teacher tells us that even though the artificial habitat and natural habitat have differences, they are both examples of a system, or a group of components that interact and depend on one another. We then consider potential changes we could make to the artificial habitat and apply our ideas to brainstorm changes that could occur in a natural habitat. We also explain the effects those changes would have on the habitat system.

**Distill:** To summarize our learning, we update our anchor chart.

**Survival****Fossil Evidence**

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

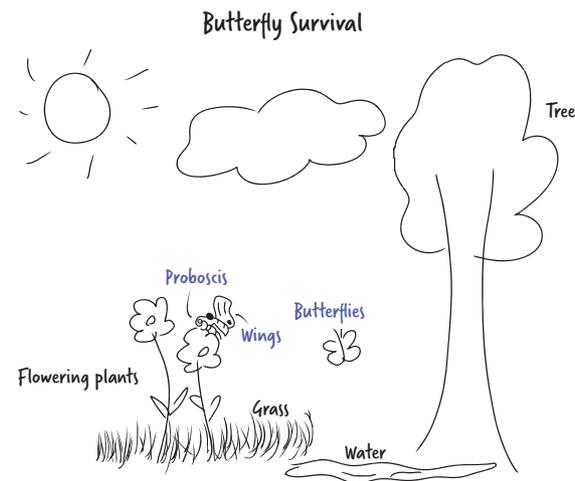
**Suitability to Environment**

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.

**Wonder:** Next, we consider the parts that humans have to help them get what they need to survive, such as their mouths and noses. We learn these parts are called characteristics, or the observable parts of an organism. We then observe radish plants and caterpillars and notice and wonder about the characteristics of these organisms. We wonder how their characteristics help them survive.

**Reveal:** To learn more about characteristics, we observe other organisms to identify their characteristics and analyze how those characteristics might help each organism survive. We then apply this learning to butterflies as we observe a photograph of a butterfly and read more about butterflies in *A Butterfly Is Patient*. We record some characteristics of butterflies and explain how each characteristic helps butterflies survive.

**Distill:** We update the anchor model to represent our new learning.



Butterflies live in environments that have water and plants such as flowering plants, grass, and trees. Butterflies get what they need to survive from their environment. Butterflies have characteristics that help them get what they need, such as a proboscis to get nectar and wings to fly. Butterflies have lived on Earth for millions of years, so we think they can survive in changing environments, but we're not sure how.

**Reveal:** Next, we observe characteristics of a mouse and a whale. Our teacher begins to read us a fictional story called *Amos & Boris* (Steig 2009) that is about a mouse who is building a boat to travel across the sea. We connect this story to how an organism's characteristics help it survive in a particular environment as we think about the characteristics of Amos, a mouse, and consider whether his characteristics make him well suited to the ocean.

Our teacher introduces us to the idea of suitability. We learn that an organism is suited to an environment if its characteristics allow it to survive there and an environment is suitable for an organism if the environment meets all the organism's needs. To learn more about suitability, we think about which parts of a particular environment would be suitable for a variety of organisms based on the organisms' characteristics.

Our teacher reads us more of the story about Amos and Boris, and we consider what happens to an organism when an environment is not suitable for it. We determine that a mouse is not suited to the ocean because the ocean does not meet the mouse's needs. Because the ocean is not suitable for a mouse, we think a mouse would die in an ocean environment. Next, we consider why a whale is suited to an ocean environment. We determine that because the ocean meets all the whale's needs, the whale can survive well in an ocean environment.

We use our knowledge about suitability to evaluate the ability of other organisms to survive in a variety of environments. We each pick an organism and consider whether the organism would die or survive well in a mountain environment. We determine that some organisms fall in the middle because they probably would not die in the mountain environment but they probably would not survive well either. As we evaluate our organisms' ability to survive in four additional environments, we add the option of an organism surviving less well.

**Distill:** To summarize our learning, we update our anchor chart.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

#### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.

*Next Steps:* Our teacher shows us an illustration from *Amos & Boris* in which whales are swimming together in a group. This makes us want to investigate why some animals live in groups.

## Lessons 13–15

**Phenomenon Question:** Why do some animals live in groups?

**Phenomenon:** Animal Groups

**Lesson Set Objective:** Students learn about the different purposes of living in groups, construct an argument from evidence to explain how living in a group can benefit individual members, and model how animal groups cope with changes to the systems in which they live.

**Knowledge Statement:** Patterns in behavior reveal that living in groups helps animals survive.

**Wonder:** To begin, our teacher shows us a video of huddling penguins. We notice that the penguins move around and stand really close together. We wonder why penguins behave this way.

**Organize:** We decide to model the penguins' behavior to test how huddling might help penguins survive. To investigate this phenomenon, we decide to measure the temperature of one test tube placed in ice and compare it with the temperature of a test tube bundled inside other test tubes placed in ice. We predict what we think will happen and decide that if the temperature inside the single test tube is colder than the temperature in the bundled test tube, then penguins probably huddle together to stay warm.

**Reveal:** We measure the temperature of both test tubes and discover that the single test tube is colder than the bundled test tube after both were placed in ice for 3 minutes. We conclude that penguins huddling in a group benefits individual penguins in the group by keeping them warm.

Next, we model group behaviors of other animals. We model how ants work together to collect and store leaves, how wildebeests work together to protect one another, how lions work together to get food, and how musk oxen work together to protect their young from wolves. These models help us realize that animals benefit from living in groups in a variety of ways.

To further learn about animal groups, we work together to read about the animals that we modeled and share our knowledge through a Jigsaw discussion. We discuss why each kind of animal lives in a group, the size of different animal groups, and where each kind of animal group lives. We make a chart to record our ideas. We compare the different kinds of animals and notice that animal groups vary in size and animals form groups for different purposes. We notice that animals that live in a group behave in ways that help the whole group survive. We use what we have learned to make claims about why animals live in groups and use evidence and reasoning to support our claims.

**Distill:** We share our individual claims to create a single class claim that describes our understanding of why animals live in groups. We then update our anchor chart to add our class claim.

### Survival

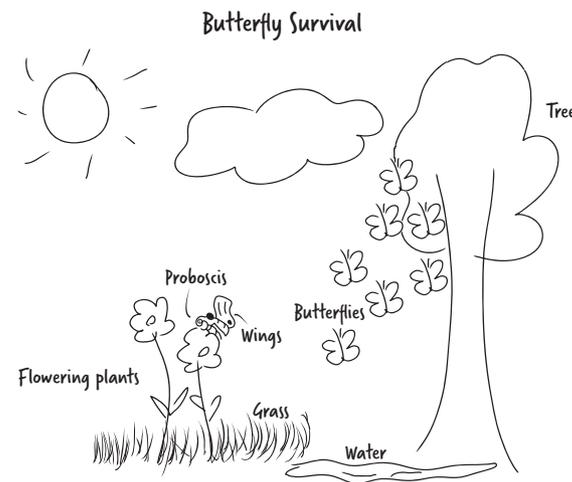
#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.
- Some animals live in groups that help members survive. Living in groups can help animals get food and defend themselves.

We watch a video of butterflies clustering and learn that scientists are not exactly sure why butterflies gather in groups, but they think it might be a way for butterflies to protect themselves from the environment or predators. We update our anchor model to summarize our current understanding of butterfly groups.



Butterflies live in environments that have water and plants such as flowering plants, grass, and trees. Butterflies get what they need to survive from their environment. Butterflies have characteristics that help them get what they need, such as a proboscis to get nectar and wings to fly. Like many other animals, butterflies can be found in groups. Butterflies have lived on Earth for millions of years, so we think they can survive in changing environments, but we're not sure how.

**Reveal:** Next, our teacher reads us a scenario about a change that could occur in our classroom system. We discuss the change, how the change will affect the classroom system, and how we could work together as a group to deal with the change. Our teacher explains that we identified ways we would cope with changes in our classroom system. We learn that cope means to deal successfully with a difficult situation.

To understand how animal groups cope with changes, we model how meerkats respond to a change in their system. We also read scenarios about how other animal groups cope with a change to the system in which they live. We determine that living in a group helps members of the group cope with change.

**Distill:** We discuss what additional information we have learned about animal groups and add our thinking to our anchor chart.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

#### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.
- Some animals live in groups that help members survive. Living in groups can help animals get food, defend themselves, and cope with change.

**Know:** We use our new knowledge to observe a group of elephants and explain in a Conceptual Checkpoint how we think elephants get what they need to survive.

**Next Steps:** Our teacher shows us the video of clustering butterflies again and asks us what would happen to the butterflies if the temperature suddenly became very cold. This question makes us want to investigate how butterflies and other organisms survive changes in their environments.

**Concept 3: Effects of Environmental Change (Lessons 16–21)***Focus Question: What happens to organisms when the environment changes?***Lessons 16–19****Phenomenon Question:**

How do organisms survive seasonal changes?

**Phenomenon:** Surviving Seasonal Changes

**Lesson Set Objective:** Students create a visual representation of monarch sighting data to understand the cause and effect relationship between seasonal change and the migration of monarch butterflies. Students also study how plants and other kinds of animals respond to seasonal changes to determine that when seasonal changes occur in an environment, some organisms are able to survive better than others in the changed environment. Students conclude that an organism's ability to survive in the changed environment affects the organism's response to the change.

**Knowledge Statement:** Seasonal changes affect the suitability of organisms to their environment, which may cause some organisms to survive less well than others.

**Wonder:** First, we watch the video of clustering butterflies again. Our teacher tells us that these butterflies are called monarch butterflies. We watch another video of monarch butterflies that shows the butterflies flying around together and wonder why they behave that way.

**Organized:** We consider what questions we could research to better understand the behavior of monarch butterflies. We want to know where monarchs live and where they are flying to in the video. To help us answer our questions, our teacher shows us a monarch butterfly range map and a climate zone map. We notice that monarchs live mostly in North and South America and that they can be found in all climate zones. We decide that we need more information to better understand why monarchs behave as they do.

**Reveal:** Our teacher shows us a website with sighting data for monarch butterflies and tells us that people across North America reported these sightings. To help us analyze the data more easily, our teacher shows us a map on the website with the sightings marked. Our teacher then gives us individual maps for each month and we compare them with the map on the website to analyze where the butterflies are each month. We then put our monthly maps together to create a flipbook that helps us visualize what is happening with butterfly movement throughout the year. We notice that butterflies fly north and then return south again in different months.

Our teacher displays another map that shows where butterflies are each season of the year. We analyze the map to record where butterflies move season to season. We notice that butterflies start to move north in the spring and that they are in a lot of places in the summer. They then start to move back south in the fall, and they are in only a few small areas in the winter. We apply our new knowledge by acting out in the classroom the butterflies' movements season by season. Our teacher tells us that this movement is called migration, or the movement of animals from one region or environment to another, usually according to the seasons.

**Wonder:** Next, we look at pictures of a caterpillar and a butterfly in the snow. We consider how these pictures challenge our thinking about butterflies and migration. We wonder why the butterfly did not migrate and how the caterpillar and the butterfly can survive in the snow.

**Reveal:** To understand how butterflies other than monarchs survive seasonal changes, we learn about the butterfly life cycle. We view a diagram of the monarch life cycle and notice that monarchs are adults during winter. We already know that they migrate to survive winter.

We view the life cycles of four other kinds of butterflies. We record what stage each butterfly is in during the winter and consider what this might reveal about how the butterfly survives seasonal changes. We notice that all butterflies go through the same life cycle stages but that different kinds of butterflies spend the winter in different stages. This makes us think that different kinds of butterflies can survive seasonal changes better in different life cycle stages.

Next, we consider how animals other than butterflies survive seasonal changes. We sort animals into categories based on how we think they respond to seasonal changes in their environment. We think some animals stay and survive, some animals move away, and some animals die. We then read about how each animal survives during winter and re-sort our animals based on this new information. We examine some of the animals more closely to recognize that the animals that are suited to the environment even during the winter are able to stay, while the animals that are not suited to the environment during the winter must move away or die.

**Distill:** We use our new learning to update our anchor chart.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

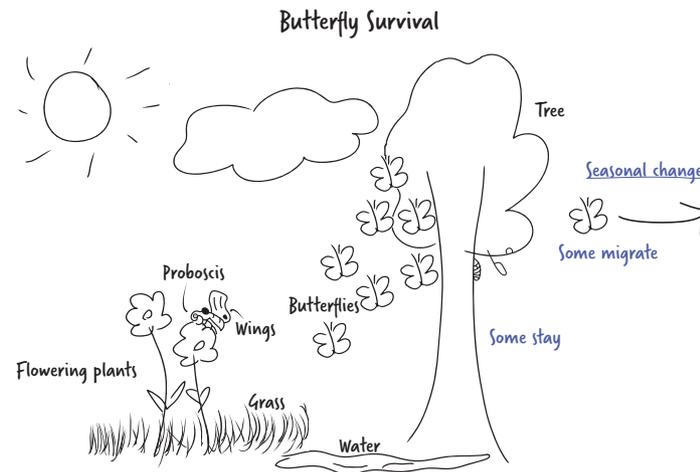
#### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.
- Some animals live in groups that help members survive. Living in groups can help animals get food, defend themselves, and cope with change.

#### Effects of Environmental Change

- When the conditions of an environment change, some of the animals that live there stay and survive, some move away, and some die.

We also update our anchor model based on what we have learned about how butterflies survive seasonal changes.



Butterflies live in environments that have water and plants such as flowering plants, grass, and trees. Butterflies get what they need to survive from their environment. Butterflies have characteristics that help them get what they need, such as a proboscis to get nectar and wings to fly. Like many other animals, butterflies can be found in groups. Butterflies have lived on Earth for millions of years, so they can survive in changing environments. *When seasonal changes occur in environments where butterflies live, some butterflies must migrate or die. Other butterflies have characteristics that allow them to stay and survive in the environment even after it changes.*

**Organize:** Next, our teacher shows us photographs of a birch forest in the summer and winter, and we consider how birch trees and other plants respond to seasonal changes. We think plants must use strategies different from those animals use because plants are not able to move to leave an area. We consider how we can simulate seasonal changes to test how plants respond. We decide to observe plants in different light conditions to investigate one example of a seasonal change.

**Reveal:** We make observations and measurements of a plant grown in direct sunlight and a plant grown in the dark. We notice that both plants grew but the plant grown in direct sunlight looks healthier than the plant grown in the dark. We think the plant grown in the dark would probably die if it was left in the dark for a long time, but it would probably survive if it was placed in an area where it could get sunlight.

**Distill:** We revise our anchor chart to include how some plants survive seasonal changes.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

#### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.
- Some animals live in groups that help members survive. Living in groups can help animals get food, defend themselves, and cope with change.

#### Effects of Environmental Change

- When the conditions of an environment change, some of the plants and animals that live there stay and survive, some move away, and some die.

**Next Steps:** We discuss how seasonal changes are temporary, which makes us want to know what happens to organisms when a long-term change occurs in an environment.

## Lessons 20–21

**Phenomenon Question:** How do long-term changes in an environment affect the organisms that live there?

**Phenomenon:** Long-Term Changes in an Environment

**Lesson Set Objective:** Students model a long-term change in an environment and communicate the effects of that change to learn that when a change occurs in an environment, some organisms stay and survive, some move in or out, and some die. Students also evaluate proposed solutions to problems caused by changes in an environment.

**Knowledge Statement:** When an environment experiences a long-term change, some organisms will stay and survive, some will move away, some will die, and other organisms will move to the changed environment.

**Organize:** Our teacher shows us a photograph of a forest environment, and we imagine ways the forest could change. We sort our ideas into different categories. We notice that some of the changes we listed are caused by the weather while others are caused by humans. Our teacher explains that we will first focus on how humans can change environments as we consider how long-term changes in an environment affect the organisms that live there.

**Reveal:** Next, we observe an illustration of a forest, identify the plants that live there, and place animals in locations where we think they would live in the forest environment. We also describe the components of the habitats of each organism in the environment. Our teacher then explains that a parking lot will be built in this environment. To model the construction of the parking lot, we cover a portion of the illustration with a black piece of construction paper. We notice that the parking lot will cause some organisms to lose their habitat. We then consider the effect of the change on each organism. We summarize the effects into three categories that we record on a chart. We think some organisms will stay, some will move away, and some will die.

Our teacher then gives us a new set of organisms to read about and consider. We determine that these organisms are suited to living in an environment with a parking lot, so we add a new category to our chart to represent organisms that move to the environment. We list the new organisms we read about under this category.

**Distill:** We discuss what we have learned about how organisms respond to long-term changes in their environment and add our new ideas to the anchor chart.

### Survival

#### Fossil Evidence

- Fossils provide evidence about the kinds of organisms that once lived and what their environments were like.
- Some environments looked very different in the past from the way they look now.
- The kinds of organisms that live in an area can change over time. Sometimes organisms live in new areas, and sometimes they no longer live anywhere on Earth.

#### Suitability to Environment

- A habitat contains everything a particular kind of organism needs to survive. Environments include multiple interconnected habitats.
- For any particular environment, some kinds of organisms can survive well, some can survive less well, and some cannot survive at all.
- Some animals live in groups that help members survive. Living in groups can help animals get food, defend themselves, and cope with change.

### Effects of Environmental Change

- When the conditions of an environment change, some of the plants and animals that live there stay and survive, some move away, and some die. *New organisms may also move to the changed environment.*

**Reveal:** Our teacher tells us that the company building the parking lot we modeled in the previous lesson is developing a plan to reduce the effects of this construction on cardinals that live there. We come up with solutions that we think the company could use to make the environment more suitable for cardinals after the parking lot is built. Our teacher then displays some of the solutions the company has proposed. We consider each solution and discuss how each one would help the cardinals. We also consider potential drawbacks. We then review a comparison chart of the proposed solutions, choose the solution that we think is best, and explain why we think it is the best solution. Finally, we discuss the solutions as a class and learn that real companies engage in similar processes to agree on and select the best solution for reducing the effects of human-caused changes in environments.

**Know:** Our teacher reminds us that not all long-term changes are caused by humans. In a Conceptual Checkpoint, we explore a long-term change caused by a natural Earth event, a volcanic eruption. We use our knowledge of long-term changes to determine whether an organism would stay in the changed environment, move away, or die. We also consider whether a different organism could move to the changed environment and survive there.

**Next Steps:** We are ready to use what we know about how organisms survive in their environment to develop a solution to a problem caused by changes in an environment.

## Application of Concepts (Lessons 22–28): Engineering Challenge, Socratic Seminar, End-of-Module Assessment

*Essential Question: How do butterflies survive over time in a changing environment?*

### Lessons 22–25 (Engineering Challenge)

**Phenomenon Question:** How can we help monarchs survive in a changing environment?

**Phenomenon:** Saving Monarch Butterflies

**Lesson Set Objective:** Students use the engineering design process to design a solution to help monarchs survive in a changing environment. During this engineering challenge, students identify the criteria and constraints for their solution, develop a detailed design of their solution, and draft a letter to a community leader that outlines the specific components of their solution.

**Knowledge Statement:** Humans can change an environment to make it more suitable for an organism.

**Organize:** We view a graph showing the number of monarch butterflies in Mexico during winter over time. We notice a decline in the number of monarchs and we wonder what is happening to them. Our teacher tells us that since monarch butterflies migrate back to the United States in the spring, there must also be a decrease in the number of monarchs in the United States. Our engineering challenge will focus on designing a solution to help monarchs survive. We review the engineering design process to help us prepare to design our solutions.

**Know:** To learn more about the problem, we look again at the monarch sighting maps to study the pattern of monarch migration and discuss problems monarchs might face as they migrate. Our teacher then reads us an article about several threats to monarchs. As we listen, we create a list of these threats. We use our lists to define environmental changes that pose a problem for monarchs and how these problems affect the monarchs' needs. We work in groups and each select one of the monarch threats as a problem to focus on in the engineering challenge.

We think about the criteria and the constraints of our design solutions. Our teacher explains that since the problem is complex and might require international collaboration and permission, planning, and long-term studies, our goal is to develop a detailed diagram of our design and to present the design solution in a letter addressed to a community leader. We imagine and plan our solution. During the plan stage, we develop a draft diagram of our solution.

Next, our teacher shows us a photograph of a monarch butterfly waystation. We use ideas from the waystation to improve our solutions. We finalize our diagrams and letters and share them with another group. We use feedback to reflect on how we could improve our solutions. Finally, we reflect on how our design solution would help address the problem of the declining number of monarchs.

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

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

**Phenomenon Question:** How do butterflies survive over time in a changing environment?

**Phenomenon:** Butterfly Survival

**Lesson Set Objective:** Students apply their knowledge of systems to construct explanations of how fossils provide evidence of past organisms and the nature of their environments, how organisms survive in their environments, and how changes in an environment affect the organisms that live there.

**Knowledge Statement:** Organisms have characteristics that help them survive over time in changing environments.

**Distill:** As a class, we participate in a Socratic Seminar and discuss our Essential Question: How do butterflies survive over time in a changing environment? We use the driving question board, anchor chart, and anchor model to help us answer this question.

**Know:** We show our understanding of how organisms survive over time in changing environments in the End-of-Module Assessment, and then we reflect on our learning throughout the module.

**Next Steps:** We discuss any remaining questions about fossil evidence, suitability, and changing environments.