Project-Based Inquiry Science: Animals In Action
Storyline

Targeted Performance Expectations:
· MS–PS4–2 · MS–LS1–4 · MS–LS1–8 · MS–LS2–2 · MS–LS4–4 · MS-ETS1-1 · MS-ETS1-2 · MS-ETS1-3 · MS-ETS1-4

Unit Goals:
Students are introduced to and engage in the practices of science and the social practices of the classroom. As students engage in the social practices of scientists they learn what scientists do, and how they do it. Students identify ways that scientists collaborate to answer questions and solve problems. Students work collaboratively to engage in scientific practices, and use science knowledge (related to animal behaviors, specifically feeding and communication, and how an animal's physical structures and environment affect their behavior) to ask and answer questions and define and address problems.

Animals In Action: What's the Big Question? How Do Scientists Answer Big Questions and Solve Big Problems?

Storyline	Science and Engineering Practices
In the introduction to *Animals In Action*, students are introduced to the *Big Questions* of the unit: *How do scientists work together to answer big questions and solve big problems?* and *Why do animals behave the way they do?* Students begin thinking about the *Big Question* by observing pictures of different types of animal enclosures, reading about the purpose of zoos, and considering how zoos have changed over time. They are then introduced to the *Big Challenge* for the unit: to design a zoo enclosure that will accommodate feeding or communication of one of the animals in the unit. After reading the specific requirements of the zoo enclosure challenge, students create a criteria and constraints table as a class. They then create the *Animals in Action Project Board*, including what they think they know and questions they would like to investigate to help answer the *Big Challenge*. **Disciplinary Core Ideas:** **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)	**Obtaining, Evaluating, and Communicating Information** (students are provided the challenge and criteria and constraints, and identify the critical information for defining the challenge)

Animals In Action: Learning Set 1 How Do Biologists Study Animal Behavior?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices
Introduction to *Learning Set 1*: At the beginning of *Learning Set 1,* the text reminds students that they will be conducting a design challenge (a zoo enclosure) in order to answer a big question about how animals behave. They are told that in order to tackle the big questions they need to answer smaller questions, and are introduced to the smaller question for this *Learning Set: How do biologists study animal behavior?*	**Planning and Carrying Out Investigations** (students collect observational data) **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data)

Section 1.1: Students begin to engage in the social practices of science as they engage in the work of ethologists, and they observe middle school students' (their classmates') behavior while feeding. Students record their observations, which are framed in the text as collecting data, and they communicate and share their observations with each other, discussing any challenges that arose. Through this activity, students learn about the importance of making detailed observations and keeping clear records.	**Planning and Carrying Out Investigations** (students collect observational data) **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data)	
Section 1.2: Now that students have some initial experience making careful observations of behavior, they develop more detailed plans for observing and recording their classmates' feeding behavior. The text provides guidance for students about procedural design decisions, such as whether they will watch an individual or the whole group, whether they divide the observational task amongst group members, and what notes will they record. Then the student groups again observe student behavior using their plan. They analyze their data, identify categories of data, and look for trends. Groups share their data, their categories, and trends with the class, and through a discussion come to see that the students all saw the same thing, but identified different categories. This leads into a discussion about appropriate category labels, and the importance of reliable data.	**Planning and Carrying Out Investigations** (students plan for how to collect observational data) **Analyzing and Interpreting Data** (students analyze observational data) **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories)
Section 1.3: Now that students have had the opportunity to observe behavior, they apply their observational skills to explore the difference between observation and interpretation (and the importance of both) by observing pictures of humans, and discussing their observations with their groups. Through conferencing with their group, then communicating and sharing their observations with the class, students come to see that they actually included interpretations of behavior as well as observations, and that their interpretations are not all the same. They also come to realize that interpretations require supporting reasons. A conceptual support provided in the text helps students separate their interpretations from their observations, and helps them provide reasons for their interpretations. After learning more about keeping good records, students again use the support to continue to practice observing animal behavior. They observe pictures of different animals and discuss their observations, inferences, and reasoning with the class, learning to keep their observations separate from their interpretations. Through this activity they also realize some of the challenges of observing animal behavior.		
Section 1.4: In this section, students evaluate and apply their observations, interpretations, and reasoning, to craft an initial explanation for an animal's behavior. They make claims based on their interpretations and support those claims with evidence (their observations). At this point, the science knowledge that they incorporate into their explanations are based on what they already know about the animal in the picture from the previous section. Students then share their draft explanations with each other to help support explanation writing, determine the validity of each other's explanations, and to gain access to and include others' ideas in their revised explanations in the next section. **Disciplinary Core Ideas:** **LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)	**Constructing Explanations** (students use their observations and interpretations to craft explanations) **Obtaining, Evaluating, and Communicating Information** (students share their explanations and receive feedback)	Section Level: **Cause and Effect** (students attempt to explain animal behavior, making connections between an animal's characteristics and its behavior)

Section 1.5: In this section, students read about the science of what animals need to survive. The reading supports students' understanding of animal behavior, and that an animal's behavior is driven by its need to survive. They read about animal adaptations, kinds of behavior (e.g., instinctive or learned), and specific behaviors in which animals engage to survive, such as searching for food, protecting oneself, and reproducing. The students then use the science knowledge from this reading to revise their scientific explanation of animal behavior from the previous section. They present their explanations to the class, and realize that their revised explanations are more convincing. **Disciplinary Core Ideas:** **LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)	**Constructing Explanations** (students use their observations and interpretations to craft explanations) **Obtaining, Evaluating, and Communicating Information** (students share their explanations and receive feedback)	Section Level: **Cause and Effect** (an animal's behavior is driven by its need to survive)
Back to the Big Question: The goal of *Animals in Action* is to provide a series of anchoring experiences through which students begin to collaborate to answer questions and solve problems like scientists and engineers. All of the units' learning tasks are focused on these ideas. In *Learning Set 1* students have learned to work in small groups to solve problems collaboratively and to persevere through iterative observational experiences, updating their own ideas with additional information and using the ideas of others when appropriate. They have used criteria and constraints to define the boundaries of the challenge and have learned the importance of record keeping, and using science knowledge. In *Back to the Big Question,* students learn about the importance of iteration and revision, and incorporate what they have done and learned in this *Learning Set* about designing plans, observing, interpreting, and describing and explaining results to develop a new observational plan. With their revised observational plan they again observe and record their classmates' feeding behavior. They analyze their data, and realize that they obtained accurate data using their improved plans. They categorize and interpret their observations, and share them with the rest of the class. This *Learning Set* concludes with the students reflecting upon what they learned from revising and retrying their observation procedure, about observations and interpretations, and about how this might help them meet the zoo enclosure design challenge. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) · Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Planning and Carrying Out Investigations** (students plan for and collect observational data) **Analyzing and Interpreting Data** (students analyze and interpret observational data) **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories)

Animals In Action: Learning Set 2
What Affects How Animals Feed?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
Introduction to *Learning Set 2*: In *Learning Set 2*, students continue to work as ethologists studying animal behavior, and engage in the practices of science, by studying one behavior: the feeding behaviors of animals. They focus on how animals' physical characteristics and environment affect their feeding behavior. **Disciplinary Core Ideas:** **LS1.B: Growth and Development of Organisms** · Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)	**Obtaining, Evaluating, and Communicating Information** (students collect and share observational data and textual information; updating *Project Board*) **Asking Questions** (students develop a list of questions to add to the *Project Board*)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories)
Section 2.1: Students begin to think about how animals feed by first reading about how different animals eat different things. They learn about herbivores, carnivores, omnivores, foragers, and predators. Students are told in the text that knowing about how animals feed will help them with their design for the zoo enclosure challenge. To help them begin to think about the challenge, and about animal feeding, they observe a video of chimpanzees feeding. During a discussion with their group, students identify what they know and do not know about chimpanzee feeding. Based on this, they develop a set of questions they have about animals' feeding behavior and add these to the *Project Board*. **Disciplinary Core Ideas:** **LS1.B: Growth and Development of Organisms** · Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)	**Obtaining, Evaluating, and Communicating Information** (students collect and share observational data and textual information; updating *Project Board*) **Asking Questions** (students develop a list of questions to add to the *Project Board*)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories)
Section 2.2: Students use their experiences from *Learning Set 1* to create a plan for observing chimpanzees in a video, and use the plans to make careful and detailed observations of the feeding behaviors of the chimpanzees. Student groups share and analyze their observational data. In order to organize their data, they create lists of observations they all agree on, and observations they do not agree on. Groups create posters showing how they collected and organized their data of chimpanzee behaviors, and present their posters to the class in an *Investigation Expo*. The class evaluates each other's posters, and together they think about how animals' body structures and environments affect their behavior. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	**Planning and Carrying Out Investigations** (students plan for and collect observational data) **Analyzing and Interpreting Data** (students analyze and interpret observational data) **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data in *Investigation Expo*)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (students think about how the animals' body structure works to support behaviors) **Section Level:** **Cause and Effect** (students think about how animals' body structures and environments affect their behavior)

Section 2.3: In this section students read a case study about Jane Goodall and her observations of chimpanzees in the wild. They also read about some of the conclusions about the feeding behavior of chimpanzees that the scientific community has drawn from Goodall's work, which reinforces to students that scientists collaborate and build on each other's work. Specifically, they read that chimpanzees are omnivores, and foragers, and use tools to help them find food. Using this information, and the conceptual support from *Learning Set 1*, students revise and update their interpretations based on their observations of chimpanzee behaviors from the video in the previous section. These interpretations become the claims students make as they craft explanations of how chimpanzees feed. This section concludes with students updating the *Project Board*, this time focusing on the third (*What are we learning?*) and fourth (*What is our evidence?*) columns. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	**Obtaining, Evaluating, and Communicating Information** (students collect and share textual data; updating *Project Board*) **Analyzing and Interpreting Data** (students revise interpretations of observational data) **Constructing Explanations** (students use interpretations to form claims in their explanations about how chimpanzees feed)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (students see that chimpanzees' body structure works to support feeding behavior) Section Level: **Cause and Effect** (students explain about how chimpanzees' body structures and environment affect their behavior)
Section 2.4: Students begin this section by reading about the feeding behavior of bees, specifically, the foraging behavior of bees, how their bodies support this behavior, and how this is similar to and different from chimpanzees. They also read about life in a beehive. Students will use the information from these brief readings as they simulate the foraging behavior of bees using a nectar-collecting model. During the simulation, student groups follow a set of simulation rules to decide on a strategy to most efficiently collect nectar. Before and after engaging with the model students discuss models and simulations generally, and reflect on their use and limitations in science. Groups then share their strategies and results with the class, and the class discusses and decides upon the best strategy for bee foraging.	**Obtaining, Evaluating, and Communicating Information** (students collect and share textual and simulation data) **Developing and Using Models** (students simulate bees' foraging behaviors) **Analyzing and Interpreting Data** (students analyze and interpret their simulation data) **Engaging in Argument from Evidence** (students decide upon the best strategy for bee foraging)	Unit Level: **Patterns** (students identify patterns in their simulation data to determine the best strategy) **Structure and Function** (students begin to see that bees' body structure works to support feeding behavior) Section Level: **Systems and System Models** (students simulate the foraging behavior of bees) **Cause and Effect** (students begin to see a connection between bees' bodies and their foraging behavior)
Section 2.5: Students extend the model from the previous section by using a UV flashlight to represent bees' eyes, and run the same simulation using this flashlight to detect markings on the flower cards in their model that are sensitive to UV light. As they did in the previous simulation, students calculate their nectar collecting efficiency and compare their results from this simulation to the previous simulation. Students see how much better everyone does when the model takes into account what the bees see. The students then read that, unlike humans, bees are capable of seeing in the UV region of the electromagnetic spectrum because of different receptor cells in their eyes. Students then use the conceptual support they have been using to organize their observations and interpretations about bees foraging behavior. They collaborate with their groups and share their thinking as they do this. Using data from the simulations, and science knowledge from the readings, students develop explanations of bees' foraging behavior. Lastly, students update the *Project Board* with the information they have learned about how bees forage. **Disciplinary Core Ideas:** **PS4.B: Electromagnetic Radiation** · When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)	**Obtaining, Evaluating, and Communicating Information** (students collect and share simulation data; updating *Project Board*) **Developing and Using Models** (students simulate bees' foraging behaviors) **Analyzing and Interpreting Data** (students analyze and interpret their simulation data) **Engaging in Argument from Evidence** (students decide upon the best strategy for bee foraging) **Constructing Explanations** (students explain foraging of bees)	Unit Level: **Patterns** (students identify patterns in their simulation data to determine the best strategy) **Structure and Function** (students begin to see that bees' body structure works to support feeding behavior) Section Level: **Systems and System Models** (students simulate the foraging behavior of bees) **Cause and Effect** (students begin to see a connection between bees' bodies and their foraging behavior)

More to Learn: Students read more about the electromagnetic spectrum, and how humans see colors. **Disciplinary Core Ideas:** **PS4.B: Electromagnetic Radiation** · When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)	**Obtaining, Evaluating, and Communicating Information** (students collect and textual information)	Unit Level: **Patterns** (electromagnetic spectrum is a pattern) Section Level: **Scale, Proportion, and Quantity** (different energies, wavelengths, and frequencies of light result in what we can see)
Section 2.6: Students read about the mutually beneficial relationship of bees and flowers. They read about how flowers reproduce, and how they have adapted to attract bees and other small animals that will spread their pollen, and about how bees have adapted to identify which flowers have nectar. Students also read about wind-pollinated flowering plants, in contrast to animal-pollinated flowering plants. The class discusses the reading, focusing on mutualistic relationships. They also use what they learned in the reading to update the *Project Board*, connecting science knowledge from the reading to the *Big Question* about animal behavior. **Disciplinary Core Ideas:** **LS1.B: Growth and Development of Organisms** · Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)	**Obtaining, Evaluating, and Communicating Information** (students collect and share textual information; update *Project Board*)	Unit Level: **Structure and Function** (flower's structure attracts bees to assist pollination; bees eyes allow bee to locate nectar) Section Level: **Cause and Effect** (flowers have adapted to attract bees, and bees can identify flowers with nectar)
More to Learn: Students read about and use a diagram to help them understand the anatomy of a flower, including identification of the flower's reproductive parts. The knowledge from this reading supports students in being able to identify the parts of a flower when they dissect a flower. Each student group carefully dissect a different kind of flower, documenting their observations, in order to better understand how their particular flower spreads pollen. They then prepare a poster with the results of their flower dissection to present to the class in an *Investigation Expo*.	**Obtaining, Evaluating, and Communicating Information** (students collect textual information, share information from their investigation on a poster) **Planning and Carrying Out Investigations** (students follow procedure to dissect a flower) **Analyzing and Interpreting Data** (students analyze their flower dissection findings)	Unit Level: **Structure and Function** (structure of flowers and the function of its parts)

Section 2.7: In this section, students explore the feeding behavior of carnivores by observing cheetahs, lions, and alligators in a video. They begin by first conferencing with their group to discuss what they already know about how a carnivore feeds.Based on this, the groups predict what characteristics and behaviors of carnivores help them get food, specifically hunting prey. They then watch the videos of carnivores to develop a more detailed observational plan, as they have done in previous sections. Using their plan the students watch the video a second time and record their observational data to share with their group. Student groups analyze their data as they have done in previous sections, by sharing observations, categorizing them, then using the conceptual support to capture the observations and their interpretations of the animals' behaviors. Students are told by their teacher to focus their observations and interpretations on the similarities and differences of the bodies of the carnivores. Groups share their procedures, observations, categories, and interpretations of the different carnivores' behavior in an *Investigation Expo*, and receive feedback. The observations and interpretations are then used to create explanations for the feeding behavior of carnivores, including why the carnivores feed differently from each other. Students then read about the physical features of predators, learning that the joints in predators' bodies are the fulcrums of levers that help predators capture and overpower their prey. Using this new information from the reading, students revise their explanations, which they share with their classmates. As a class students create a consensus explanation of carnivores feeding behavior, and update the *Project Board* with what they learned and the supporting evidence. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3) **LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)	**Obtaining, Evaluating, and Communicating Information** (students share what they already know about carnivores; collect observational data from videos; share findings with class) **Planning and Carrying Out Investigations** (students develop and carry out an observational plan) **Analyzing and Interpreting Data** (students analyze and interpret their observational data) **Constructing Explanations** (students create and revise an explanation of carnivores' feeding behavior) **Engaging in Argument from Evidence** (students must create as a class a consensus explanation)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (students see that carnivores' body structure works to support feeding behavior) Section Level: **Cause and Effect** (students explain about how carnivores' body structures and environment affect their feeding behavior)

Back to the Big Challenge: *Learning Set 2* concludes with students returning to the *Big Challenge* and creating their initial recommendations for zoo enclosure designs, based on the animals they learned about in this *Learning Set*. Their design must allow the animal to feed as if in its natural environment. Students read that recommendations take a similar form as the explanations they have been creating, with their recommendation as their claim. Groups communicate their recommendations to the class in a *Solution Briefing*, in which they engage in a discussion to share and refine their ideas about meeting the challenge, including the criteria and constraints. Through the *Solution Briefing* and class discussion, students will get ideas on how to revise and refine their recommendations at a later time. The class concludes this *Learning Set* by updating the *Project Board*, focusing on the last column (*how does this relate to the Big Question?*). **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) · Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Constructing Explanations** (students create a recommendation for the zoo enclosure) **Obtaining, Evaluating, and Communicating Information** (students share their recommendations with peers; identify a list of criteria and constraints; collect feedback on ideas; update *Project Board*) **Engaging in Argument from Evidence** (students share their recommendation, including how it met the criteria and constraints)	Unit Level: **Structure and Function** (students use information about how animals' body structure works to support feeding behavior) Section Level: **Cause and Effect** (students use information about how animals' body structures and environment affect their feeding behavior)

Animals In Action: Learning Set 3
What Affects How Animals Communicate?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
Introduction to *Learning Set 3*: In *Learning Set 3*, students continue to work as ethologists studying animal behavior, and engage in the practices of science, by studying another behavior: the communication behavior of animals. They focus on how animals' physical characteristics and environment affect their communication.		
Section 3.1: Students begin thinking about how animals communicate by listing the different ways humans communicate, recording also the situation in which they would communicate in that way, and why humans communicate that way. This supports students in thinking about what affects communication, and the purposes of communication more generally. By conferencing with their groups, students classify the different ways of communicating, and they share their lists with the class. The class then generates a class list of communication categories. By conferencing again with their groups, and with the communication categories in mind, students generate questions about how other animals communicate. Students update the *Project Board*, adding these questions. Thinking about animal communication in this way, students begin to identify verbal (i.e., via sounds) and nonverbal ways (e.g., gestures) in which animals communicate.	**Obtaining, Evaluating, and Communicating Information** (students conference to discuss ways of communicating; update *Project Board*) **Asking Questions** (students identify questions about how animals communicate)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) Section Level: **Cause and Effect** (what things affect human communication)

Section 3.2: Students explore how humans communicate verbally and nonverbally by first engaging in a puzzle-solving activity in which one student in each group knows the solution and has to communicate it either verbally or nonverbally to another person in the group to solve it. The remaining group members observe. Prior to engaging in this activity, students make predictions about which condition (verbal or nonverbal) will be more successful at solving the puzzle together, and why. Both conditions must also operate under a set of criteria and constraints, reinforcing for students that all problems are bounded by criteria and constraints. After completing the task, groups compile and analyze their data, which they use to draw conclusions about the different forms of communication used. The observations and interpretations of each group are shared in an *Investigation Expo*. The class examines the data from each group to look for similarities and differences between the conditions. Reflecting on these results, students begin to consider how communication is determined by the constraints of an animal's physical features and/or their environment. Students add ideas gained from this activity to their *Project Board*.	**Obtaining, Evaluating, and Communicating Information** (students share their puzzle activity results in an *Investigation Expo*; update *Project Board*) **Planning and Carrying Out Investigations** (students carry out the puzzle activity) **Analyzing and Interpreting Data** (students analyze and interpret their observational data)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (animals' physical structure works to support certain modes of communication) Section Level: **Cause and Effect** (students identify factors affecting communication)
Section 3.3: Students revisit their exploration of the behavior of bees in this section as they learn about how bees communicate the location of food to the hive. After a brief reading about the bees' waggle dance, students observe a video of bees doing the waggle dance. As they have done several times now in this unit, they first watch the video, then develop a plan to make detailed observations, then watch the video again using their plan to capture observations in an attempt to interpret the purpose of the bees' waggle dance. Students analyze their data using the conceptual support they have used throughout the unit to develop interpretations of the waggle dance. In doing this, students consider how both the bees' bodies and environments affect their communication. Students then read about the history of scientific thinking on the waggle dance and learn that the meaning of the waggle dance is still debated. They read that new technologies are making it possible for scientists to make more detailed observations of bees' behavior, collecting evidence to support the claim that the waggle dance is how bees communicate. Using the information learned in this section, students update their *Project Board*.	**Patterns** (students identify patterns in their observational data, organizing their data into categories) **Cause and Effect** (students identify factors affecting communication) **Structure and Function** (animals' physical structure works to support certain modes of communication)	Section Level: **Obtaining, Evaluating, and Communicating Information** (students collect textual information, observations data from video; update Project Board) **Planning and Carrying Out Investigations** (students plan for and collect observational data) **Analyzing and Interpreting Data** (students analyze and interpret their observational data)
Section 3.4: The idea that has been developing throughout this *Learning Set* that communication methods are affected by an animal's body structure is again examined in this section. Students observe elephants' communication behavior, making connections between what they have learned about how humans and bees communicate. Before making their observations, students predict how elephants communicate, taking into consideration the physical characteristics of elephants and the needs of elephants that might affect how they communicate. Students then observe elephant communication in a video, develop an observation plan, and then view the video again, making detailed observations following their plans. They analyze their data, separating observations and interpretations using the conceptual scaffold used previously. They present these observations and interpretations to the class in an *Investigation Expo*. After listening to the ideas of their classmates, they build on the observations and interpretations of the class to develop explanations of how elephants communicate. Through this section, students continue to build on their understanding of the relationship between communication and an animal's body structure as they consider the ways in which elephants' physical features (e.g., their ears, head, trunk) and their environment allow for the communication they observe.		**Section Level:** **Obtaining, Evaluating, and Communicating Information** (students collect and share observational data from video; share and receive feedback on their explanations) **Planning and Carrying Out Investigations** (students plan and carry out observational plans) **Analyzing and Interpreting Data** (students analyze and interpret their observational data) **Constructing Explanations** (students create an explanation for how elephants communicate)

Section 3.5: Students read about the ways elephants communicate, and how these forms of communication are determined by elephants' physical characteristics and by the environment. They read about how until fairly recently scientists did not know how elephants communicated, and by using technology to collect sounds beyond human hearing, they found that elephants' bodies allow them to produce low-pitched rumbles which can be heard across long distances, and a variety of other sounds. They also read about how elephants communicate through gestures, by touch and by using chemicals with their keen sense of smell. Students then revise their explanations, supporting their claim with new science knowledge gained from the reading. They share their revised observations with the class, create a class explanation for elephant communication, and update the *Project Board*. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3) **PS4.A: Wave Properties** · A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) · A sound wave needs a medium through which it is transmitted. (MS-PS4-2)	**Obtaining, Evaluating, and Communicating Information** (students collect textual data; share their revised explanations; update *Project Board*) **Constructing Explanations** (students revise their explanations; create a class explanation) **Engaging in Argument from Evidence** (students must create as a class a consensus explanation)	Unit Level: **Structure and Function** (animals' physical structure works to support certain modes of communication) Section Level: **Cause and Effect** (students identify factors affecting communication)
More to Learn: Students read about how sound is created, about sound waves and their characteristics, and about how the human ear hears. **PS4.A: Wave Properties** · A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) · A sound wave needs a medium through which it is transmitted. (MS-PS4-2)	**Obtaining, Evaluating, and Communicating Information** (students collect textual information)	Unit Level: **Patterns** (in how sound travels) **Structure and Function** (of the human ear) Section Level: **Cause and Effect** (what affects how sound travels and how humans hear)
Section 3.6: The idea that has been developing throughout this *Learning Set* that communication methods are affected by an animal's body structure and environment is again examined in this section. Students observe dolphins' communication behavior, making connections between what they have learned about how humans, bees, and elephants communicate. Before making their observations, students predict how dolphins communicate, taking into consideration the physical characteristics of dolphins, their environment, and the needs of dolphins that might affect how they communicate. Students then observe dolphin communication in a video, develop an observation plan, then view the video again, making detailed observations following their plans. They analyze their data, separating observations and interpretations using the conceptual scaffold used previously. They present these observations and interpretations to the class in an *Investigation Expo*. After listening to the ideas of their classmates, they build on the observations and interpretations of the class to develop explanations of how dolphins communicate. Through this section, students continue to build on their understanding of the relationship between communication and an animal's body structure as they consider the ways in which dolphins' physical features and their environment allow for the communication they observe. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	**Obtaining, Evaluating, and Communicating Information** (students collect and share observational data from video; share and receive feedback on their explanations) **Planning and Carrying Out Investigations** (students plan and carry out observational plans) **Analyzing and Interpreting Data** (students analyze and interpret their observational data) **Constructing Explanations** (students create an explanation for how dolphins communicate)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (animals' physical structure works to support certain modes of communication) Section Level: **Cause and Effect** (students identify factors affecting communication)

Section 3.7: Students read about the ways dolphins communicate, and how these forms of communication are determined by dolphins' physical characteristics and by the environment. They read about how dolphins use echolocation and have signature whistles that allow them to identify and find one another. They also read about how dolphins communicate visually and by touch. Students read, too, about how scientists use echolocation to study the ocean. Students then revise their explanations, supporting their claim with new science knowledge gained from the reading. They share their revised observations with the class, create a class explanation for dolphin communication, and update the *Project Board*. **Disciplinary Core Ideas:** **LS1.A: Structure and Function** · In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	**Obtaining, Evaluating, and Communicating Information** (students collect textual data; share their revised explanations; update *Project Board*) **Constructing Explanations** (students revise their explanations; create a class explanation) **Engaging in Argument from Evidence** (students must create as a class a consensus explanation)	Unit Level: **Patterns** (students identify patterns in their observational data, organizing their data into categories) **Structure and Function** (animals' physical structure works to support certain modes of communication) Section Level: **Cause and Effect** (students identify factors affecting communication)
Back to the Big Challenge: Throughout *Learning Set 3* students have been learning about animal communication behavior, and how an animal's physical structure and environment affect that behavior. They use this information to make recommendations for designing zoo enclosures that encourage communication. They work with their groups to develop several recommendations, which they share with the class, and receive feedback in the *Solution Briefing*. They are challenged by prompts in the text to consider how their recommendation, their claim, addresses the communication needs of their animal, and how the enclosure satisfies the criteria and constraints of the challenge. During the *Solution Briefing*, students also hear and may choose to build on the ideas of others' when they later address the *Big Challenge*. To conclude this *Learning Set*, the class records recommendations on the *Project Board*. Students will be able to refer to their *Project Board* in the next section when they address the *Big Challenge*. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) · Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Obtaining, Evaluating, and Communicating Information** (students use information from the unit to make recommendations, which they share and receive feedback on; update the *Project Board*) **Constructing Explanations** (students make a recommendation for a zoo enclosure) **Engaging in Argument from Evidence** (students identify how their recommendation meets the criteria and constrains of the challenge)	Unit Level: **Structure and Function** (animals' physical structure works to support certain modes of communication, or certain ways of feeding) Section Level: **Cause and Effect** (students identify factors affecting communication or feeding)

Animals In Action: Address the Big Challenge
Design an Enclosure for a Zoo Animal That Will Allow It to Feed or Communicate as in the Wild

Storyline	Science and Engineering Practices
Students apply the concepts learned in this unit as they develop design plans for a zoo enclosure. Students begin by identifying the criteria and constraints of the challenge, introduced in previous *Learning Sets*. Using these as a guide, groups plan their designs for zoo enclosures that will allow an animal to feed or communicate as in the wild. The text also encourages students to utilize the information found in the *Project Board*, as well as their interpretations, explanations, and recommendations as resources as they design their enclosures. They share their designs with the class in *Plan Briefings*, where they receive feedback from their classmates. Using this feedback, they update the criteria and constraints, revise their design plans, present them, receive more feedback, and redesign. Students are encouraged by the text to build on their classmates' ideas, while acknowledging the original idea. Through this process, students gain understanding of the value of iteration in design. They present their final plans to the class in a *Solution Showcase*, and update the *Project Board* a final time. **Disciplinary Core Ideas:** **ETS1.C: Optimizing the Design Solution** · Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) · The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	**Obtaining, Evaluating, and Communicating Information** (students use information from the unit to make recommendations, which they share and receive feedback on; identify the criteria and constraints; use information from the *Project Board*; update the *Project Board*) **Constructing Explanations** (students make a recommendation for a zoo enclosure) **Engaging in Argument from Evidence** (students identify how their recommendation meets the criteria and constrains of the challenge)

Animals In Action: Answer the Big Question
How Do Scientists Answer Big Questions and Solve Big Problems?

Storyline
Throughout the unit students, like scientists, have planned, recorded, analyzed, and explained observations of animal behavior. The text provides question prompts that support students' thinking about how scientists answer big questions. Students reflect on working in teams, learning from their peers, the importance of iterations, meeting criteria and dealing with constraints, differentiating between observations and interpretations, explaining, and supporting recommendations with evidence.