Eastampton Community School

Third Grade Science Curriculum

Unit 1: Weather and Climate Instructional Days: 15

In this unit of study, students organize and use data to describe typical weather conditions expected during a particular season. By applying their understanding of weather-related hazards, students are able to make a claim about the merit of a design solution that reduces the impacts of such hazards. The crosscutting concepts of *patterns, cause and effect*, and the *influence of engineering, technology, and science on society and the natural world* are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in a*sking questions and defining problems, analyzing and interpreting data, engaging in argument from evidence*, and *obtaining, evaluating, and communicating information*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-#WW2-1, 3-ESS2-2, 3-ESS3-1, and 3-5-ETS1-1.

Unit 2: Force and Motion Instructional Days: 15

In this unit of study, students determine the effects of balanced and unbalanced forces on the motion of an object. The crosscutting concepts of *patterns and cause and effect* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *planning and carrying out investigations*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-PS2-1 and 3-PS2-2.

Unit 3: Electrical and Magnetic Forces Instructional Days: 15

In this unit of study, students determine the effects of balanced and unbalanced forces on the motion of an object and the cause-and-effect relationships of electrical or magnetic interactions to define a simple design problem that can be solved with magnets. The crosscutting concept of *cause and effect*, and the *interdependence of science, engineering, and technology, and the influence of engineering, technology, and science on society and the natural world* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *asking questions and defining problems*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-PS2-3, 3-PS2-4, and 3-5-ETS1-1.

Unit 4: Traits Instructional Days: 15

In this unit of study, students acquire an understanding that organisms have different inherited traits and that the environment can also affect the traits that an organism develops. The crosscutting concepts of *patterns* and *cause and effec*t are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency *in analyzing and interpreting data, constructing explanations*, and *designing solutions*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-LS3-1 and 3-LS3-2.

Unit 5: Continuing the Cycle Instructional Days: 10

In this unit of study, students develop an understanding of the similarities and differences in organisms' life cycles. In addition, students use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. The crosscutting concepts of *patterns* and *cause and effect* are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in *developing and using models and constructing explanations and designing solutions*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-LS1-1 and 3-LS4-2.

Unit 6: Organisms and the Environment Instructional Days: 15

In this unit of study, students develop an understanding of the idea that when the environment changes, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. The crosscutting concepts of *cause and effect* and the *interdependence of science, engineering, and technology* are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in *engaging in argument from evidence*. Students are also expected to use this practice to demonstrate understanding of the core ideas.

This unit is based on 3-LS2-1 and 3-LS4-3.

Unit 7: Using Evidence to Understand Change in

Environments **Instructional Days: 15**

In this unit of study, students develop an understanding of the types of organisms that lived long ago and also about the nature of their environments. Students develop an understanding of the idea that when the environment changes, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. The crosscutting concepts of *systems and system models*; *scale, proportion, and quantity*; and *the influence of engineering, technology, and science on society and the natural world* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *asking questions and defining problems*, *analyzing and interpreting data*, and *engaging in argument from evidence*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-LS4-1, 3-LS4-4, and 3-5-ETS1-1.

Note: *The number of instructional days is an estimate based on the information available at this time. 1 day equals approximately 42 minutes of seat time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.*

Recommended Instructional Days: 15 days

Grade 3 Unit 1: Weather and Climate

NGSS:

Students who demonstrate understanding can:

3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [*Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.*]

3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.* [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]

Unit Summary
What is the typical weather near our home? ***How can we protect people from weather-related hazards?*** In this unit of study, students organize and use data to describe typical weather conditions expected during a particular season. Byapplying their understanding of weather-related hazards, students are able to make a claim about the merit of a design solution thatreduces the impacts of such hazards. The crosscutting concepts of *patterns, cause and effect*, and the *influence of engineering,technology, and science on society and the natural world* are called out as organizing concepts for these disciplinary core ideas.Students demonstrate grade-appropriate proficiency in a*sking questions and defining problems, analyzing and interpreting data,engaging in argument from evidence*, and *obtaining, evaluating, and communicating information*. Students are also expected to use

these practices to demonstrate understanding of the core ideas.

This unit is based on 3-ESS2-1, 3-ESS2-2, 3-ESS3-1, and 3-5-ETS1-1.

Student Learning Objectives

Develop a model using an analogy, to describe how weather and climate are related**.** (**ESS2.D**) *[Note: This SLO is based on the disciplinary core ideas found in the Framework. It is intended to serve as a scaffold to 3-ESS2-1.]*

Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. *[Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]* **(3-ESS2-1)**

Obtain and combine information to describe climates in different regions of the world. (3-ESS2-2)

Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. *[Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]* **(3-ESS3-1)**

Unit Sequence

Part A: *Can we predict the kind of weather that we will see in the spring, summer, autumn, or winter?*

Concepts	Formative Assessments
● Patterns of change can be used to make predictions. ● People record patterns of the weather across different times and areas so that they can make predictions about what kind of	*Students who understand the concepts can:* ● Make predictions using patterns of change. ● Represent data in tables, bar graphs, and pictographs to

weather might happen next.	reveal patterns that indicate relationships. ● Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. *(Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.)* Examples of data could include: ✓ Average temperature ✓ Precipitation ✓ Wind direction

Unit Sequence

Part B: *How can climates in different regions of the world be described?*

Concepts

● Patterns of change can be used to make predictions.

● Climate describes the range of an area's typical weather conditions and the extent to which those conditions vary over years.

Unit Sequence

Formative Assessments

Students who understand the concepts can:

- Make predictions using patterns of change.
- Obtain and combine information from books and other reliable media to explain phenomena.

Part B: *How can we protect people from natural hazards such as flooding, fast wind, or lightening?*

Concepts Formative Assessments

- Cause-and-effect relationships are routinely identified, tested, and used to explain change.
- Science affects everyday life.
- People's needs and wants change over time, as do their demands for new and improved technologies.
- A variety of natural hazards result from natural processes (e.g., *flooding, fast wind, or lightening).*
- Humans cannot eliminate natural hazards but can take steps to reduce their impacts.
- Engineers improve technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones).
- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria).
- Different proposals for solutions can be compared on the basis of how well each one meets the criteria for success or how well each takes the constraints into account.

What It Looks Like in the Classroom

Students who understand the concepts can:

- Identify and test cause-and-effect relationships to explain change.

- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.
- Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. Examples of design solutions to weather-related hazards could include:
  - ✓ Barriers to prevent flooding
  - ✓ Wind-resistant roofs
  - ✓ Lightning rods
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and include several criteria for success and constraints on materials, time, or cost.
- Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

In this unit of study, students organize and use data to describe typical weather conditions expected during a particular season. They notice patterns as they analyze and interpret weather data, and they use this data to determine cause-and-effect relationships. By applying their understanding of weather-related hazards, students make claims about the merit of a design solution that reduces the impacts of such hazards, using evidence to support their claims.

Initially, students learn that scientists record patterns of weather across different times and locations in order to make predictions about future weather conditions. To understand how scientists use weather data, students need time, tools, and resources (both print and digital) to collect weather data. They can use a variety of tools (e.g., thermometers, anemometers, rain gauges) to collect firsthand data and multiple resources (e.g., Weather Bug, NOAA) to gather weather data that has been

collected over longer periods of time. Multiple units of measurement (e.g., m, cm, °C, km/hr) should be used when recording weather conditions such as temperature, types and amounts of precipitation, and wind direction and speed. To organize the data they collect, students create graphical displays (bar graphs and pictographs) and tables. Once a sufficient amount of data is collected, students need opportunities to analyze data, looking for patterns of change that can be used to make predictions about typical weather conditions for a particular region and time of year. As they collect and analyze data over time, students learn that certain types of weather tend to occur in a given area and that combinations of weather conditions lead to certain types of weather (e.g., it is always cloudy when it rains or snows, but not all types of clouds bring precipitation).

Weather is a combination of sunlight, wind, precipitation, and temperature in a particular region at a particular time. Climate describes the range of an area's typical weather conditions and the extent to which those conditions vary over the years. After learning to analyze and use data to make weather predictions, students use long-term patterns in weather to describe climates in a variety of regions around the world. To accomplish this, students use books and other reliable media to obtain information and weather data collected over a long period of time for a variety of regions. With guidance, students analyze the available data and information in order to describe the climate (e.g., average temperatures, average precipitation, average amount of sunlight) in each region.

Science affects everyday life. Whenever people encounter problems, engineers use scientific knowledge to develop new technologies or improve existing ones to solve our day-to-day problems.

After studying weather and climate, students investigate how weather-related hazards can be reduced. Students learn

that

there are a variety of natural hazards that result from severe weather. Severe weather, such as high winds, flooding, severe thunderstorms, tornados, hurricanes, ice or snowstorms, dust storms, or drought, has the potential to disrupt normal day-to day routines and cause damage or even loss of life. While humans cannot eliminate natural hazards, they can take steps to reduce their impact. Students can use trade books and media resources to research types of severe weather hazards and their effects on communities and find examples of how communities solve problems caused by severe weather. As a class, students determine the types of severe weather that are common to the local area and discuss the effects on the community.

(Define the problem.) In pairs or small groups, students can research ways that the community reduces the effects of severe weather. (Determine ways in which the problem is solved.) Given criteria, groups can determine how well each solution reduces the effects of severe weather. Groups can also prepare a presentation that

- Describes the solution that the group thinks is best for reducing the effects of a given type of weather hazard,
- Lists evidence to support their thinking, and
- Lists at least one possible constraint, such as materials, time, or cost.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts/Literacy

As students engage in the science described in this unit of study, they use books and other reliable media resources to collect weather and climate information for a given region. They compare information found in two different texts and use information to answer questions about weather and climate. To integrate writing, students can take brief notes as they conduct research and sort evidence into provided categories. Opinion pieces and short research projects should be included to build knowledge about weather and climate.

Mathematic

Like literacy, mathematics is integrated in a variety of ways. Students use appropriate tools and units of measure when collecting and recording weather and climate data. They model with mathematics when organizing data into scaled bar graphs, pictographs, and tables. Throughout the unit, students reason abstractly and quantitatively as they analyze and compare weather data. They will use that information to answer questions and solve multistep problems.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning

N/A

Prior Learning

Kindergarten Unit 3: Weather

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a

particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.
- Asking questions, making observations, and gathering information are helpful in thinking about problems. *(secondary)*

Future Learning

Grade 4 Unit 1: Weathering and Erosion

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Grade 4 Unit 5: Transfer of Energy

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

Grade 4 Unit 7: Using Engineering Design with Force and Motion Systems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary)*

Grade 5 Unit 5: Earth Systems

- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

Connections to Other Units

The Disciplinary Core Ideas in this unit are not related to other units in this grade.

Sample of Open Education Resources

Weather Science content for Kids and Teens: The National Weather Service has several education resources available at this website.

NOAA Education Resources: The National Oceanic and Atmospheric Administration (NOAA) provides education resources at

this website.

(Note: Students in grades Kindergarten, 4, and 5 make sense of weather and climate. Each model science unit related to Weather and Climate will include these two websites. Therefore, it is important that teachers of science in these grades to collaborate to prevent redundancy in the K-5 weather and climate curriculum.)

Teacher Professional Learning Resources

Carla Zembal-Saul, Professor of Science Education at Penn State University, Mary Starr, Executive Director of Michigan Mathematics and Science Centers Network, Kathy Renfrew, K-5 Science Coordinator for VT Agency of Education and Kimber Hershberger, co-author of "What's Your Evidence?" introduced an overview of the NGSS for Third Grade. The web seminar began with explaining how to unpack the performance expectations. It continued with a focus on scientific practices in relation to the specific standard and performance expectations. Science talk - what it looks like and sounds like, and how to use it in the classroom, as well as claims, evidence and reasoning strategies were discussed.

Visit the resource collection.

Continue discussing this topic in the community forums.

NSTA Web Seminar: Teaching NGSS in K-5: Constructing Explanations from Evidence

Carla Zembal-Saul, Mary Starr, and Kathy Renfrew, provided an overview of the *NGSS* for K-5th grade. The web seminar focused on the three dimensional learning of the *NGSS*, while introducing CLAIMS-EVIDENCE-REASONING (CER) as a framework for introducing explanations from evidence. The presenters highlighted and discussed the importance of engaging learners with phenomena, and included a demonstration on using a KLEWS chart to map the development of scientific explanations of those phenomena.

To view related resources, visit the resource collection.

Continue discussing this topic in the community forums.

NGSS Core Ideas: Earth's Systems

The presenter was Jill Wertheim from National Geographic Society. The program featured strategies for teaching about Earth science concepts that answer questions such as "What regulates weather and climate?" and "What causes earthquakes and volcanoes?"

Dr. Wertheim began the presentation by introducing a framework for thinking about content related to Earth systems. She then showed learning progressions for each concept within the Earth's Systems disciplinary core idea and shared resources and strategies for addressing student preconceptions. Dr. Wertheim also talked about changes in the way *NGSS* addresses these ideas compared to previous common approaches. Participants had the opportunity to submit questions and share their feedback in the chat.

Continue the discussion in the community forums.

Appendix A: NGSS and Foundations for the Unit

Develop a model using an analogy, to describe how weather and climate are related**.** (**ESS2.D**) *[Note: This SLO is based on the disciplinary core ideas found in the Framework. It is intended to serve as a scaffold to 3-ESS2-1.]*

Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. *[Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]* **(3-ESS2-1)**

Obtain and combine information to describe climates in different regions of the world. (3-ESS2-2)

Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. *[Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]* **(3-ESS3-1)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas
	Crosscutting Concepts

Patterns

● Patterns of change can be used to make predictions. (3-ESS2-1),(3- ESS2-2)

Cause and Effect

● Cause and effect relationships are routinely identified, tested, and used to explain change. (3-ESS3-1)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

● Engineers improve existing technologies or develop new ones to

Planning and Carrying Out Investigations

● Plan and conduct investigations collaboratively to produce evidence to answer a question. (1-PS4-1),(2- LS2-1)

Analyzing and Interpreting Data

● Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships. (3-ESS2-1)

Engaging in Argument from Evidence

● Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-ESS3-1)

Obtaining, Evaluating, and

ESS2.D: Weather and Climate

- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)

ESS3.B: Natural Hazards

- A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)*

Communicating Information

- Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)

English Language Arts

increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). (3-ESS3-1)

--- --- ***Connections to Nature of Science*** **Science is a Human Endeavor**

- Science affects everyday life. (3- ESS3-1)

Mathematics

Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-ESS2-2) **RI.3.1**

Compare and contrast the most important points and key details presented in two texts on the same topic. (3-ESS2-2) **RI.3.9**

Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-ESS3-1) **W.3.1**

Conduct short research projects that build knowledge about a topic. (3-ESS3-1) **W.3.7**

Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-ESS2-2) **W.3.9**

Reason abstractly and quantitatively. (3-ESS2-1),(3-ESS2- 2),(3-ESS3-1) **MP.2**

Model with mathematics. (3-ESS2-1),(3-ESS2-2), (3-ESS3-1) **MP.4**

Use appropriate tools strategically. (3-ESS2-1) **MP.5**

Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-ESS2-1)

3.MD.A.2

Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one and two-step “how many more” and “how many less” problems using information presented in bar graphs. (3-ESS2-1) **3.MD.B.3**

Recommended Instructional Days: 20

Grade 3 Unit 2: Forces and Motion

NGSS:

Students who demonstrate understanding can:

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]

3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.* [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

Unit Summary

How do equal and unequal forces on an object affect the object?

In this unit of study, students are able to determine the effects of balanced and unbalanced forces on the motion of an object. The crosscutting concepts of patterns and cause and effect are identified as organizing concepts for these disciplinary core ideas. In the third-grade performance expectations, students are expected to demonstrate grade-appropriate proficiency by planning and carrying out investigations. Students are expected to use these practices to demonstrate understanding of the core ideas.

Student Learning Objectives

Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. *[Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.]* [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]* **(3-PS2-1)**

Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. *[Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.]* [Assessment Boundary: Assessment does not include technical terms such as period and frequency.*]* **(3-PS2-2)**

Unit Sequence

Part A: *How do scientists play soccer?*

Concepts	**Formative Assessment**
• Science investigations use a variety of methods, tools, and techniques.	*Students who understand the concepts are able to:*

• Cause-and-effect relationships are routinely identified. • Objects in contact exert forces on each other.

• Each force that acts on a particular object has both strength and a direction.

• An object at rest typically has multiple forces acting on it, but they add to zero net force on the object.

● Forces that do not sum to zero can cause changes in the object's speed or direction of motion. *(Qualitative and conceptual, but not quantitative, addition of forces are used at this level.)*

● Identify cause-and-effect relationships.

● Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence.

● Use fair tests in which variables are controlled and the number of trials considered.

● Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. *(Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is also limited to gravity being addressed as a force that pulls objects down.) Examples could include:*

✓ *An unbalanced force on one side of a ball can make it start moving.*

✓ *Balanced forces pushing on a box from both sides*

Unit Sequence	
Part B: *Can we use patterns that we observed to predict the future?*	
Concepts	**Formative Assessment**

● Science findings are based on recognizing patterns. ● Patterns of change can be used to make predictions. ● The patterns of an object's motion in various situations can be observed and measured. ● When past motion exhibits a regular pattern, future motion can be predicted from it. *(Technical terms, such as magnitude, velocity, momentum, and vector quantity, are*	*Students who understand the concepts are able to:* ● Make predictions using patterns of change. ● Make observations and/or measurements to produce data to serve as the basis of evidence for an explanation of a phenomenon. ● Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to

not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)	predict future motion. *(Assessment does not include technical terms such as period and frequency.) Examples of motion with a predictable pattern could include:* ✓ *A child swinging in a swing.* ✓ *A ball rolling back and forth in a bowl.* ✓ *Two children on a seesaw.*

What It Looks Like in the Classroom

In this unit of study, students look for cause-and-effect relationships as they investigate the effects of balanced and unbalanced forces on the motion of an object. They learn that objects in contact exert forces on each other, and these forces have both strength and direction. When forces are balanced, there is no change in the motion or the position of an object. In other words, an object at rest typically has multiple forces acting on it, but the forces balance out to equal a zero net force on the object. For example, if two children stand with their hands together and push against each other, the pushing force each exerts balances to a net zero effect if neither child moves. Pushing a box from both sides also demonstrates a balanced force if the forces do not produce any change in motion or position of the box.

When forces are unbalanced, however, there is a change in the motion and/or position of the object the forces are acting on. If the same two children from the example above were pushing against each other, and one child moves his/her hands, arms, or feet forward while the other child moves backward, this would demonstrate an unbalanced force. The first child is pushing with greater force than the second.

Through planning and conducting investigations, students will come to understand that forces that result in changes in an object's speed or direction of motion are unbalanced. Students can observe everyday examples on the playground, with seesaws and swings and by kicking and throwing soccer balls. As they conduct investigations and make observations, students should identify the cause-and-effect relationships at work and identify the objects that are exerting forces on one another. They should also use qualitative descriptions when identifying the relative strength (greater than, less than, equal) and direction of the forces, even if an object is at rest.

Investigating the effects of forces on objects will also give students opportunities to observe that patterns exist

everywhere.

Patterns are found in shapes, structures, natural environments, and recurring events. Scientists and engineers analyze patterns to make predictions, develop questions, and create solutions. As students have opportunities to observe forces interacting with objects, they will ask questions and analyze and interpret data in order to identify patterns of change in the motion of objects and to make predictions about an object's future motion. When students are on the playground, they can

observe multiple patterns of change in the back-and-forth motion of a child swinging on a swing or in the up-and-down motion of a seesaw. In the classroom, students can observe a variety of objects, such as marbles rolling back and forth in bowls or tops spinning across the floor.

Throughout this unit, as students plan and carry out investigations, it is extremely important that they routinely identify cause and-effect relationships and look for patterns of change as objects interact. As students interact with objects, such as when they push a door closed, bounce a ball, or roll a ball down a ramp, they may ask, “What caused the changes that I observed? How can I change the way in which the object moved?” Students need to have many experiences in order to deepen their understanding of the cause-and-effect relationships between balanced and unbalanced forces on the motion of an object, and they should be guided to plan and conduct fair tests, testing only one variable at a time.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

- In order to integrate the CCSS for ELA into this unit, students need opportunities to read content-specific texts to deepen their understanding of force and motion. As they read, teachers should pose questions such as, “What interactions can you identify between the objects in the text?” and “What patterns of motion are described in the text?” Students should be encouraged to answer questions and cite evidence from the text to support their thinking.
- To further support the integration of the ELA standards, students can also conduct short research projects about simple force-and-motion systems and the interactions that occur among forces and objects within the systems. For example, students could be asked to conduct a short study by bouncing a ball 10 times and identifying the patterns they observe. Next students could predict, based on the patterns they saw, what would happen if they bounced the ball 10 more times. Students then could draw a model of the force and motion system, identifying the structures and forces that interact within the system. This would also give students the opportunity to develop note-taking skills and use multiple sources to collect information about force and motion.

Mathematics

- In order to integrate the Common Core State Standards for Mathematics, students can use measurement tools in a

variety of ways to conduct investigations. Students could find the mass of an object in order to understand that the heavier something is, the greater the force needed to cause a change in its motion. Students could use rulers or tape measures to measure the distance an object moves. Student can then record and analyze their data to determine patterns of change and explain cause-and-effect relationships, while reasoning abstractly and quantitatively.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

● Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

● Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).

● Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

● Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.

● Use project-based science learning to connect science with observable phenomena.

● Structure the learning around explaining or solving a social or community-based issue.

● Provide ELL students with multiple literacy strategies.

● Collaborate with after-school programs or clubs to extend learning opportunities.

● Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning

Students believe constant speed needs some cause to sustain it. In addition, students believe that the amount of motion is proportional to the amount of force; that if a body is not moving, there is no force acting on it; and that if a body is moving there is a force acting on it in the direction of the motion. Students also believe that objects resist acceleration from the state of rest because of friction -- that is, they confound inertia with friction (NSDL, 2015).

Prior Learning

Kindergarten Unit 1: Pushes and Pulls

- Pushes and pulls can have different strengths and directions.
- Pushing or pulling on an object can change the speed or direction of the object's motion and can start or stop it. ● When objects touch or collide, they push on one another and can change motion.
- A bigger push or pull causes things speed up or slow down more quickly.

Grade 1 Unit 1: Patterns of Change in the Sky

- Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.

Future Learning

Grade 4 Unit 5: Energy Transfer

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when water meets a beach.
- Waves of the same type can differ in amplitude (height) and length (the spacing between wave peaks). **Grade 5 Unit 6: Interactions Within the Earth, Sun and Moon System**

● The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. **Grade 6 Unit 4: Force and Motion**

● For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).

● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, the object's motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

● All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

● The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

● This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short term but is tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

● The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

● Water continually cycles among land, ocean, and the atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.

● The complex patterns of the changes in the movement of water in the atmosphere are determined by winds, landforms, and ocean temperatures and currents; which are major determinants of local weather patterns.

● Global movements of water and its changes in form are propelled by sunlight and gravity.

● Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

● Water's movements—both on land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Connections to Other Units

In **Unit 1, Weather and Climate**, students identified patterns that can help them make predictions about the weather. They will build on their understanding of patterns as they interact with objects in order to identify the patterns of change in an object's motion and use those patterns to make predictions.

In **Unit 3, Electric and Magnetic Forces**, students will further develop an understanding of forces. They will determine the effects of balanced and unbalanced forces on the motion of an object and the cause-and-effect relationships of electrical or magnetic interactions.

Sample of Open Education Resources

Puffing Forces: Students will predict and observe what happens when a force is applied to an object, and compare the relative effects of a force of the same strength on objects of different weights by using a straw to gently puff air at a ping pong ball then a golf ball and measuring the distance the ball travels with a ruler. Students will repeat this procedure using a harder puff. This lesson was adapted from the Utah Education Network http://www.uen.org/Lessonplan/preview?LPid=14858

Robo Arm: This fun activity is one of five in a series of space based engineering challenges developed by NASA and Design Squad where students are engaged in implementing the Engineering Design process to build a robotic arm that can lift a cup off a table using cardboard strips, brass fasteners, paper clips, straw, string, tape and a cup. The activity includes an instructor's guide, questioning techniques, discussion questions, extension activity, a rubric, and 3 short video clips that enhance the purpose of the activity and its relevance to NASA.

Teacher Professional Learning Resources

Using the NGSS Practices in the Elementary Grades

The presenters were Heidi Schweingruber from the National Research Council, Deborah Smith from Penn State University, and Jessica Jeffries from State College Area School District. In this seminar the presenters talked about applying the scientific and engineering practices described in A Framework for K–12 Science Education in elementary-level classrooms.

Continue the discussion in the community forums.

Teaching *NGSS* in K-5: Constructing Explanations from Evidence

Carla Zembal-Saul, Mary Starr, and Kathy Renfrew, provided an overview of the NGSS for K-5th grade. The web seminar focused on the three dimensional learning of the NGSS, while introducing CLAIMS-EVIDENCE-REASONING (CER) as a framework for introducing explanations from evidence. The presenters highlighted and discussed the importance of engaging learners with phenomena, and included a demonstration on using a KLEWS chart to map the development of scientific explanations of those phenomena.

View the resource collection.

Continue discussing this topic in the community forums.

NSTA Web Seminar: NGSS Core Ideas: Motion and Stability: Forces and Interactions

Dr. Alonzo began the presentation by providing an overview of how disciplinary core ideas fit into the overall structure of NGSS. Then she and Mr. Robinson discussed common student preconceptions related to Motion and Stability: Forces and Interactions. They also showed how this disciplinary core idea progresses across grade bands. Participants had the opportunity to ask questions and discuss ideas for classroom application with other participating teachers.

View the resource collection.

Continue discussing this topic in the community forums.

Science Object: Newton's First Law

This Science Object is the second of four Science Objects in the Force and Motion SciPack. It provides a conceptual and real world understanding of Newton's First Law of Motion. All objects will maintain a constant speed and direction of motion unless an unbalanced outside force acts upon it. When an unbalanced force acts on an object, its speed or direction (or both) will change. The tendency of objects to maintain a constant speed and direction of motion (velocity) in the absence of an unbalanced force is known as inertia. Even in the most familiar, everyday situations, frictional forces can complicate the analysis of motion, although the basic principles still apply.

Appendix A: NGSS and Foundations for the Unit

Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. *[Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.]* [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]* **(3-PS2-1)**

Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. *[Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.]* [Assessment Boundary: Assessment does not include technical terms such as period and frequency.*]* **(3-PS2-2)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are

Planning and Carrying Out Investigations

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-1)
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (3-PS2-2)

PS2.A: Forces and Motion ●

Each force acts on one particular

addition of forces are used at this level.) (3-PS2-1)

- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other. (3-PS2-1)

object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative

routinely identified. (3-PS2-1)

Patterns

- Patterns of change can be used to make predictions. (3-PS2-2)

Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns. (3-PS2-2)

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods, tools, and techniques. (3- PS2-1)

English Language Arts

Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. **RI.3.1** (3-PS2-1)

Conduct short research projects that build knowledge about a topic. **W.3.7** (3-PS2-1),(3-PS2-2)

Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. **W.3.8** (3-PS2-1),(3- PS2-2)

Mathematics

Reason abstractly and quantitatively. **MP.2**

(3-PS2-1) Use appropriate tools strategically.

MP.5 (3-PS2-1)

Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. **3.MD.A.2** (3- PS2-1)

Recommended Instructional Days: 15 days

Grade 3 Unit 3: Electrical and Magnetic Forces

NGSS:

Students who demonstrate understanding can:

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [Assessment Boundary: Assessment does not include technical terms such as period and frequency.]

3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.] **3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.*** [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Unit Summary

How can we use our understandings about magnets be used to solve problems?

In this unit of study, students determine the effects of balanced and unbalanced forces on the motion of an object and the cause-and effect relationships of electrical or magnetic interactions to define a simple design problem that can be solved with magnets. The crosscutting concept of *cause and effect*, and the *interdependence of science, engineering, and technology, and the influence of engineering, technology, and science on society and the natural world* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *asking questions and defining problems*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 3-PS2-3, 3-PS2-4, and 3-5-ETS1-1.

Student Learning Objectives

Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. *[Clarification Statement: Examples of an electric force could include the force on hair from an electrically*

charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.] **(3-PS2-3)**
Define a simple design problem that can be solved by applying scientific ideas about magnets.* *[Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]* **(3-PS2-4)**
Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

Unit Sequence	
Part A: *What are the relationships between electrical and magnetic forces?*	
Concepts	**Formative Assessment**
• Cause-and-effect relationships are routinely identified, tested, and used to explain change. • Electric and magnetic forces between a pair of objects do not require that the objects be in contact. • The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	

Students who understand the concepts are able to:

- Identify and test cause-and-effect relationships in order to explain change.
- Ask questions that can be investigated based on patterns such as cause-and-effect relationships.
- Ask questions to determine cause-and-effect relationships in electric or magnetic interactions between two objects not in contact with each other. *(Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static*

	electricity.) ● Magnetic forces could include: ✓ The force between two permanent magnets; ✓ The force between an electromagnet and steel paperclips; ✓ The force exerted by one magnet versus the force exerted by two magnets. ● Cause-and-effect relationships could include: ✓ How the distance between objects affects the strength of the force ✓ How the orientation of magnets affects the direction of the magnetic force.

Unit Sequence	
Part B: *How can we use our understandings about magnets be used to solve problems?*	
Concepts	**Formative Assessment**

● Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.

● People's needs and wants change over time, as do their demands for new and improved technologies.

● Electric and magnetic forces between a pair of objects do not require that the objects be in contact.

● The sizes of the forces in each situation depend on the properties of the objects and their distances apart.

● For forces between two magnets, the size of the force

Students who understand the concepts are able to:

● Define a simple problem that can be solved through the development of a new or improved object or tool.

● Define a simple design problem that can be solved by applying scientific ideas about magnets (e.g., constructing a latch to keep a door shut or creating a device to keep two moving objects from touching each other).

● Define a simple design problem that can be solved through the development of an object, tool, process, or system, and include several criteria for success and constraints on

depends on their orientation relative to each other. ● Possible solutions to a problem are limited by available materials and resources (constraints). ● The success of a designed solution is determined by considering the desired features of a solution (criteria). ● Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	material, time, or cost. ● Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

What It Looks Like in the Classroom

After investigating electrical and magnetic forces, students will engage in a portion of the engineering design process in order to define a simple design problem that can be solved by applying scientific ideas about magnets. This process should include the following steps:

- ✓ As a class, create a list of the properties of magnets. (See content descriptions above)
- ✓ Brainstorm a list of everyday objects that use magnets, and discuss the function of the magnet(s) in each object. For example, electric can openers have a strong magnet that attaches a can to the device as it cuts through (opens) the top of the can.
- ✓ In small groups or pairs, students discuss possible everyday problems that might be solved using magnets. For example, they could construct a latch to keep a door shut.
- ✓ As a class, determine possible criteria that might be used to determine how successful the devices might be, and discuss possible constraints (on materials, time, or cost) that might affect each group's design solution.
- ✓ Small groups or pairs should have the opportunity to create a presentation (poster, PowerPoint, drawings, or actual physical model, if time permits) to share both the design problem and solution with the class.

In this unit, students are not expected to build and test their design solutions or to optimize their designs; however, they can compare different proposals for solutions on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. The overall goal is for students to understand that engaging in engineering design

will help them understand that scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process, and that as people's needs and wants change over time, so do their demands for new and improved technologies.

Engineering design is an important part of this unit of study. Students are expected to define a simple design problem that can be solved by applying scientific ideas and determine possible success criteria and constraints on time, materials, and cost. They should also compare different proposals for solutions based on how well the proposed solutions meet the criteria for success or how well each takes the constraints into account.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

Students should be given opportunities to conduct short research projects that build knowledge about electric and magnetic forces. They should be given multiple opportunities to recall and gather information from their investigations as well as from print and digital sources. Students should use that information to answer questions, describe cause-and-effect relationships, make comparisons, and explain interactions between objects when electrical or magnetic forces are involved.

Teachers should provide a variety of texts for students to explore in order to develop students' note-taking skills. As students take notes, they should use graphic organizers, such as Venn diagrams and T-charts, to sort supporting evidence into provided categories. For example, as students read a variety of texts about forces, they can take notes and then sort the evidence they collect into categories, such as electrical and magnetic forces.

Mathematics

Students should use measurement tools in a variety of ways as they conduct investigations. They could find the mass of an object in order to understand that the more mass an object has, the greater the force needed to attract, repel, or move it. Students then reason mathematically as they analyze their data to determine patterns of change that can be used to support explanations of cause-and-effect relationships. Students might also use algebraic reasoning during investigations. For example, when measuring magnetic strength by increasing the number of magnets, students can use multiplication to make predictions about possible outcomes. So, if a paper clip moves toward a single magnet when it is 2 centimeters away, then

students might predict that the paper clip will move toward a double magnet when it is 4 centimeters away. Or, if the paper clip moved towards a set of four magnets at a distance of 8 centimeters, then students might predict that the paper clip will move toward a single magnet when it is 2 centimeters away.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among

various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning

Elementary-school students are usually aware of the behavior of magnets but may not explain the behavior in terms of forces

(i.e., they may think of a magnet sticking to or moving towards another magnet but may not recognize this as the effect of a pull or force). Students of all ages may think of gravity and magnetism interchangeably. They may refer to magnetism as a "type of gravity," but they may also explain gravity in terms of the earth acting like a magnet on objects. Students may think that magnets do not work in a place where there is no air, just like they think about gravity. Students of all ages may also

confuse electrostatic and magnetic effects. For example, they may predict that north magnetic poles repel positively charged objects.

Students do not readily recognize the magnetic effect of an electric current. Some think of the wire, rather than the electric current as being the cause of the magnetic effect. Students may think that insulation around the wire prevents the existence of magnetic forces when current flows (NSDL, 2015).

Prior Learning

Kindergarten Unit 1: Pushes and Pulls

● Pushes and pulls can have different strengths and directions.

● Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. ● When objects touch or collide, they push on one another and can change motion.

● A bigger push or pull makes things speed up or slow down more quickly.

● A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary)*

Grade 1 Unit 1: Patterns of Change in the Sky

● Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.

Future Learning

Grade 4 Unit 7: Using Engineering Design with Force and Motion Systems

● Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary)*

Grade 6 Unit 5: Types of Interactions

● Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.

● Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.

● Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).

Connections to Other Units

In **Unit 2, Force and Motion**, students planned and conducted investigations to determine the effects of balanced and unbalanced forces on the motion of an object. As they made observations, they identified patterns of change in order to describe cause-and-effect relationships in simple force-and-motion systems.

Sample of Open Education Resources

Investigating the Magnetic Force Field: Calculating the Magnetic Pull of a Magnet by Varying Distances: Students will investigate the magnetic pull of a bar magnet at varying distances with the use of paper clips. Students will hypothesize, conduct the experiment, collect the data, and draw conclusions. As a class, students will then compare each team's data and their interpretation of the results.

Teacher Professional Learning Resources

Connections Between Practices in *NGSS*, Common Core Math, and Common Core ELA

The presenter was Sarah Michaels from Clark University. In this seminar Dr. Michaels talked about connecting the scientific and engineering practices described in A Framework for K–12 Science Education with the Common Core State Standards in Mathematics and English Language Arts.

Engineering Design as a Core Idea

The presenter was Cary Sneider, Associate Research Professor at Portland State University in Portland, Oregon. The seminar focused on the Core Idea of Engineering, led by Cary Sneider, Associate Research Professor at Portland State University. Cary explained the overall *NGSS* engineering components for K-2, MS and HS, and went through a number of practical

examples of how teachers could develop modules and investigations for their students to learn them. Cary also spoke about the ways in which teachers could include cross-cutting engineering concepts to a number of classroom subjects. The seminar concluded with an overview of NSTA resources about *NGSS* available to teachers by Ted, and a Q & A session with Cary.

Visit the resource collection.

Continue discussing this topic in the community forums.

NGSS Core Ideas: Motion and Stability: Forces and Interactions

The presenters were Alicia Alonzo from Michigan State University and Alex Robinson, a teacher at Thornapple Kellogg High School in Middleville, Michigan. The program featured strategies for teaching about physical science concepts that answer questions such as "How can one explain and predict interactions between objects and within systems of objects?"

Dr. Alonzo began the presentation by providing an overview of how disciplinary core ideas fit into the overall structure of NGSS. Then she and Mr. Robinson discussed common student preconceptions related to Motion and Stability: Forces and Interactions. They also showed how this disciplinary core idea progresses across grade bands. Participants had the opportunity to ask questions and discuss ideas for classroom application with other participating teachers.

View the resource collection.

Continue discussing this topic in the community forums.

Appendix A: NGSS and Foundations for the Unit

Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. *[Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a*

magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.] **(3-PS2-3)**

Define a simple design problem that can be solved by applying scientific ideas about magnets.* *[Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]* **(3-PS2-4)**

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices **Disciplinary Core Ideas**

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-3)

- -

Connections to Engineering,

Analyzing and Interpreting Data

- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1)

Asking Questions and Defining Problems

between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their

PS2.B: Types of Interactions

- Electric and magnetic forces
- Ask questions that can be investigated based on patterns such as cause and effect relationships. (3- PS2-3)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (3-PS2-4)
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

orientation relative to each other. (3- PS2-3),(3-PS2-4)

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and

resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5- ETS1-1)

Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-4)

English Language Arts

Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-PS2-3) **RI.3.1**

Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in
technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-PS2-3) **RI.3.3**

first/second/third in a sequence). (3-PS2-3) **RI.3.8**

Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3) **SL.3.3**

Mathematics

N/A

Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect,

Recommended Instructional Days: 15 days

Grade 3 Unit 4: Traits

NGSS:

Students who demonstrate understanding can:

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]

3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

Unit Summary

What kinds of traits are passed on from parent to offspring?

What environmental factors might influence the traits of a specific organism?

In this unit of study, students acquire an understanding that organisms have different inherited traits and that the environment canalso affect the traits that an organism develops. The crosscutting concepts of *patterns* and *cause and effec*t are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency *inanalyzing and interpreting data, constructing explanations*, and *designing solutions*. Students are also expected to use thesepractices to demonstrate understanding of the core ideas.

This unit is based on 3-LS3-1 and 3-LS3-2.

Student Learning Objectives

Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. *[Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non human examples.]* **(3-LS3-1)**

Use evidence to support the explanation that traits can be influenced by the environment. *[Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]* **(3-LS3-2)**

Unit Sequence
Part A: *What kinds of traits are passed on from parent to offspring?*

Concepts Formative Assessment

● Similarities and differences in patterns can be used to sort and classify natural phenomena (e.g., inherited traits that occur naturally). ● Many characteristics of organisms are inherited from their parents.	*Students who understand the concepts are able to:* ● Sort and classify natural phenomena using similarities and differences. *(Clarification: Patterns are the similarities and differences in traits shared between offspring and their parents or among siblings, with an emphasis on organisms*

● Different organisms vary in how they look and function because they have different inherited information.	*other than humans)*. ● Analyze and interpret data to make sense of phenomena using logical reasoning. ● Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. *(Assessment does not include genetic mechanisms of inheritance and prediction of traits, and is limited to nonhumans.)*

Unit Sequence	
Part B: *What environmental factors might influence the traits of a specific organism?*	
Concepts	**Formative Assessment**

● Cause-and-effect relationships are routinely identified and used to explain change. ● Other characteristics, which can range from diet to learning, result from individuals' interaction with the environment. ● Many characteristics involve both inheritance and environment. ● The environment also affects the traits that an organism develops.	*Students who understand the concepts are able to:* ● Identify cause-and-effect relationships in order to explain change. ● Use evidence (e.g., observations, patterns) to support an explanation. ● Use evidence to support the explanation that traits can be influenced by the environment. Examples of the environment's affect on traits could include: ✓ Normally tall plants that grow with insufficient water are stunted. ✓ A pet dog that is given too much food and little exercise may become overweight.

What It Looks Like in the Classroom

Scientists sort and classify organisms based on similarities and differences in characteristics or traits. Students can easily observe external traits of animals such as body coverings; type, shape, and number of external features; and type, shape, and color of eyes. Similarly, they can observe external traits of plants such as the type of root system or the shape, color, and average size of leaves. The characteristics that organisms inherit influence how they look and how they function within their environment. As students observe parents and their offspring, they will notice that parents and offspring share many traits. As they observe a larger number of organisms from the same group, they will notice similarities and differences in the traits of individuals within a group. Students can observe similarities and differences in the traits of organisms and use these observations as evidence to support the idea that offspring inherit traits from parents, but these traits do vary within a group of similar organisms.

Sometimes, variations among organisms within a group are due to fact that individuals inherit traits from different parents. However, traits can also be influenced by an individuals' interaction with the environment. For example, all lions have the necessary inherited traits that allow them to hunt, such as sharp claws, sharp teeth, muscular body type, and speed. However, being a successful hunter also depends on the interaction that individual lions have with their parents and their environment. A lion cub raised in captivity without parents will have the same type of claws, teeth, and muscular body as all other lions, but it may never have the opportunity to learn to use its traits to hunt. Additionally, the environment can affect an organism's physical development. For example, any plant that lacks sufficient nutrients or water will not thrive and grow as it should. It will most likely be smaller in size, have fewer leaves, and may even look sickly. Likewise, too much food and lack of exercise can result in an overweight dog.

To investigate how the environment influences traits, students can plant the same type of seedling in different locations, which will provide variations of light, water, or soil. Data can be collected about rates of growth, height, and heartiness of the plant. The information gathered can be analyzed to provide evidence as to how the environment influenced the traits of the plant. As students read about, observe, and discuss these ideas, they learn that even though every organism inherits particular traits from its parents, the environment can have a marked effect on those traits and the development of others.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

In order to integrate the CCSS for English language arts, students will need opportunities to read about inherited traits of animals and plants in a variety of texts and resources. During discussions, teachers might pose questions such as “What kinds of traits are passed on from parent to offspring?” or “What environmental factors might influence the traits of a specific organism?” Students should be able to refer specifically to the text when answering questions, articulate the main idea, and describe the key ideas using supporting details in their explanations. Additionally, they should describe the relationship between scientific ideas or concepts, using language that pertains to time, sequence, and cause and effect.

During this unit, students also need opportunities to write informative/explanatory texts to convey ideas and information gathered through investigations and from other resources. For example, after reading texts about a given organism, students should be expected to use key details and appropriate facts about that organism to compose an informative piece of writing. This piece should list some of the organism’s traits that were passed on from its parents, describe how those traits enable the organism to interact in its environment to meet its needs, and describe any influence the environment has on the organism’s traits. Students should also have the opportunity to report orally on a given topic related to traits and the way they are influenced by the environment. They should share relevant facts, details, and information while speaking clearly and at an understandable pace.

Mathematics

This unit also has connections to the CCSS for mathematics. Students can use rulers to measure the growth of organisms, then generate and plot the data they collected on line plots, making sure the horizontal scale is marked off in appropriate units (whole numbers, halves, or quarters). For example, students might chart out data in line plots to document the growth (over time) of each of a number of plants grown from a single parent. As students analyze their data, they will observe that the offspring are not the same exact height as each other or as the parent, but that the height of all plants is very similar when the plants are grown under the same conditions. Students might also make similar line plots to compare the same type of plants grown with varying amounts of water or sunlight, then compare these data to the growth data of the parent plant. Analyzing this data will help students understand that environmental factors influence/affect the traits of organisms. As students collect, organize, and

analyze their data, they have opportunities to reason abstractly and model with mathematics.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Research on Student Learning

N/A (NSDL, 2015).

Prior Learning

By the end of Grade 1, students understand that:

- Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents.
- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

Future Learning

By the end of middle school, students will understand that:

- Animals engage in characteristic behaviors that increase the odds of reproduction.
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features

for reproduction. ● Genetic factors as well as local conditions affect the growth of the adult plant.

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others are harmful, and some are neutral to the organism.

Connections to Other Units

N/A

Sample of Open Education Resources

Guppies Galore: Groups of students set up a small freshwater aquarium (made from gallon jars) that feature a male guppy, a female guppy, and a green plant. After the female guppy goes through her pregnancy and gives birth, the students will then observe, over time, the development of the fry into male and female guppies with characteristics similar to the parents.

Teacher Professional Learning Resources

NSTA Web Seminar: *Teaching* NGSS *in Elementary School—Third Grade*

The web seminar began with explaining how to unpack the performance expectations in third grade. It continued with a focus on scientific practices in relation to the specific standard and performance expectations. Science Talk - what it looks like and sounds like, and how to use it in the classroom, as well as claims, evidence and reasoning strategies were discussed. The web seminar concluded with an overview of NSTA resources on the *NGSS* available to teachers by Ted, and a Q & A with Carla, Mary, Kathy and Kimber.

Teaching *NGSS* in K-5: Constructing Explanations from Evidence

Carla Zembal-Saul, Mary Starr, and Kathy Renfrew, provided an overview of the NGSS for K-5th grade. The web seminar

focused on the three dimensional learning of the *NGSS*, while introducing CLAIMS-EVIDENCE-REASONING (CER) as a framework for introducing explanations from evidence. The presenters highlighted and discussed the importance of engaging learners with phenomena, and included a demonstration on using a KLEWS chart to map the development of scientific explanations of those phenomena.

Continue discussing this topic in the community forums.

NGSS Core Ideas: Heredity: Inheritance and Variation of Traits

The presenter was Ravit Golan Duncan of Rutgers University. The program featured strategies for teaching about life science concepts that answer questions such as "How are the characteristics of one generation related to the previous generation?" and "Why do individuals of the same species vary in how they look, function, and behave?"

Dr. Duncan began the presentation by discussing the importance of heredity as a disciplinary core idea. She then described how student learning should progress across grade levels and showed examples of common preconceptions. Dr. Duncan also shared strategies and resources for teaching about heredity. Participants had the opportunity to submit their questions and comments in the chat.

Visit the resource collection. Continue discussing this topic in the community forums.

Appendix A: NGSS and Foundations for the Unit

Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. *[Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.]* **(3-LS3-1)**

Use evidence to support the explanation that traits can be influenced by the environment. *[Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]* **(3-LS3-2)**

The performance expectations above were developed using the following elements from the NRC document *A Framework*

for K-12 Science Education:

Science and Engineering Practices **Disciplinary Core Ideas** **Crosscutting Concepts** **Analyzing and Interpreting Data LS3.A: Inheritance of Traits Patterns**

- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1)

Constructing Explanations and Designing Solutions

- Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)

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- Many characteristics of organisms are inherited from their parents. (3- LS3-1)
- Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)

LS3.B: Variation of Traits

- Different organisms vary in how they look and function because they have different inherited information. (3- LS3-1)
- The environment also affects the traits that an organism develops. (3- LS3-2)

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3- 1)

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2)

English Language Arts

Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS3-1),(3-LS3-2) **RI.3.1**

Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS3-1),(3-LS3-2) **RI.3.2**

Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical

procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1),(3-LS3-2) **RI.3.3**

Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-1),(3-LS3-2),(3- LS4-2) **W.3.2**

Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS3-1),(3- LS3-2) **SL.3.4**

Mathematics

Reason abstractly and quantitatively. (3-LS3-1),(3-LS3-2) **MP.2**

Model with mathematics. (3-LS3-1),(3-LS3-2) **MP.4**

Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS3-1),(3-LS3-2) **3.MD.B.4**

Recommended Instructional Days: 10 days

Grade 3 Unit 5: Continuing the Cycle

NGSS:

Students who demonstrate understanding can:

3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. [Clarification Statement: Changes organisms go through during their life form a pattern.] [Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.]

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.] **3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.** [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]
3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]

Unit Summary

Do all living things have the same life cycle?

Are there advantages to being different?

In this unit of study, students develop an understanding of the similarities and differences in organisms' life cycles. In addition, studentsuse evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provideadvantages in surviving, finding mates, and reproducing. The crosscutting concepts of *patterns* and *cause and effect* are called out asorganizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in *developing and usingmodels and constructing explanations and designing solutions*. Students are also expected to use these practices to demonstrateunderstanding of the core ideas.

This unit is based on 3-LS1-1 and 3-LS4-2.

Student Learning Objectives

Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. *[Clarification Statement: Changes organisms go through during their life form a pattern.]* *[*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human

reproduction.*]* **(3-LS1-1)**
Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species mayprovide advantages in surviving, finding mates, and reproducing. *[Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that havebetter camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]* **(3-LS4-2)**

Unit Sequence	
Part A: *Do all living things have the same life cycle?*	
Concepts	**Formative Assessment**

- Science findings are based on recognizing patterns.
- Similarities and differences in patterns can be used to sort and classify natural phenomena.
- Patterns of change can be used to make predictions.
- Reproduction is essential to the continued existence of every kind of organism.
- Plants and animals have unique and diverse life cycles.

Students who understand the concepts are able to:

- Sort and organisms (inherited traits) using similarities and differences in patterns.
- Make predictions using patterns of change.
- Develop models to describe phenomena.
- Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. (I.e., Changes organisms go through during their life form a pattern.) *(Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.)*

Unit Sequence
Part B: *Are there advantages to being different?*

Concepts Formative Assessment

- Cause-and-effect relationships are routinely identified and used to explain change.
- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.

Students who understand the concepts are able to:

- Identify cause-and-effect relationships in order to explain change.
- Use evidence (e.g., observations, patterns) to construct an explanation.
- Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. Examples of cause-and-effect relationships could include:
  - ✓ Plants that have larger thorns than other plants may be less likely to be eaten by predators.
  - ✓ Animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.

What It Looks Like in the Classroom

In third grade, students learn that the changes an organism goes through during its life form an observable pattern. Although different types of organisms have unique and diverse life cycles, they follow a pattern of birth, growth, reproduction, and death. While observing and studying life cycles, students should look closely for patterns of change and use these observed patterns to make predictions. They should also sort and classify a variety of organisms using the similarities and differences they observe. For example, flowering plants begin as seeds. With the right conditions, the seeds germinate and grow, from small seedlings to adult plants. Adult plants then produce flowers that, once pollinated, will produce seeds from which the next generation will grow.

Animals, likewise, go through observable patterns of change, which allow students to sort and classify them based on the stages of their life cycles. Some animals, for example, undergo complete metamorphosis; others go through incomplete metamorphosis; while others do not undergo metamorphosis at all. Some animals begin their life cycles with a live birth, while others hatch from eggs. Students should develop models to describe the unique and diverse life cycles of organisms. They can draw diagrams, build physical models, or create

presentations to show the patterns of change that make up the life cycles of given organisms. As students become familiar with the stages in the life cycles of different types of plant and animals, they will come to understand that reproduction is essential to the continued existence of every kind of organism.

In **Unit 4: Traits**, students learned that organisms have traits that are inherited from their parents. This process occurs during reproduction. While observing and identifying traits of a specific species or type of organism, students also learned that there are differences in characteristics within the same species. In this unit, students learn that these differences in characteristics among individuals of the same species sometimes provide advantages in survival, finding mates, and reproducing. For example, when comparing plants from the same species, those with larger or more abundant thorns may be less likely to be eaten by a predator. Likewise, animals with better camouflage coloration may be more likely to survive and therefore more likely to leave offspring. As students read about, observe, and discuss variations in organisms' characteristics, they should identify cause-and-effect relationships that help explain why any variation might give an advantage in surviving or reproducing to some members of a species over others.

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

Students need opportunities to read about the life cycles and inherited traits of organisms in a variety of texts and resources. During discussions, teachers might pose questions such as

- ✓ What are the stages of an organism's life cycle?
- ✓ How do the life cycles of organisms compare?
- ✓ What makes an organism's life cycle unique?
- ✓ How do organisms use their characteristics to survive, find mates, and reproduce?

Students need access to a variety of books, pictures, and maps. They should be able to refer to these resources specifically when answering questions, articulating the main idea, and describing the key ideas using supporting details in their explanations. Additionally, they should describe the relationship between scientific ideas or concepts and using language that pertains to time, sequence, and cause and effect.

Students also need opportunities to write informative/explanatory texts to convey ideas and information gathered through investigations and from other resources. For example, after reading texts about a given organism, students should be expected to use key details and appropriate facts about that organism to compose an informative piece of writing that lists some of the organism's traits that might give it
an advantage in survival, growth, or reproduction over others of its kind. Students can also use Venn diagrams or T-charts to compare traits among individuals from a common species. These data can be used to explain how variations in characteristics can give an advantage to one or another individual in reproduction, growth, or survival. Students should also have the opportunity to report on how one or more traits of an organism give it an advantage in survival, growth, and/or reproduction in its environment. As students speak, they should share relevant facts, details, and information while speaking clearly and at an understandable pace.

Mathematics

Students can draw scaled picture graphs or bar graphs to represent a data set with several categories, such as the average length of the life span of a variety of organisms, which could range from days to hundreds of years, or the varying reproductive capacity of organisms, which could range from a single offspring to thousands. As students analyze their data, they may observe similarities within a category of organisms (e.g., mammals, reptiles, or insects) or marked differences across these same categories. Analyzing data will help students
understand that organisms have unique and diverse life cycles, but all have in common birth, growth, reproduction, and death. As students collect, organize, and analyze their data, they have opportunities to reason abstractly and model with mathematics.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Research on Student Learning

N/A

Prior Learning

Grade 1 Unit 2: Characteristics of Living Things

- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

Future Learning

Grade 6 Unit 1: Growth, Development, and Reproduction of Organisms

- Animals engage in characteristic behaviors that increase the odds of reproduction.
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. ● Genetic factors as well as local conditions affect the growth of the adult plant.

Grade 6 Unit 2: Matter and Energy in Organisms and Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- Growth of organisms and population increases are limited by access to resources.
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

Grade 7 Unit 6: Inheritance and Variation of Traits

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Grade 8 Unit 2: Selection and Adaptation

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others.
- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.

Connections to Other Units

Grade 3 Unit 4: Traits

- Students used patterns and cause-and-effect relationships to understand that organisms have different inherited traits, and that the environment can also affect the traits that an organism develops.

Grade 3 Unit 6: Organisms and Environment

- Students use evidence to construct explanations for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
- They also use cause-and-effect relationships to understand that when the environment changes, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.

Sample of Open Education Resources

Let's Hear It For Ladybugs!

This article describes a ladybug life cycle unit that incorporates language arts and science concepts. Students build on their prior knowledge of butterflies as they explore the metamorphosis of ladybugs. To create their final project, clay life cycle models, students synthesize what they learned from live observation and nonfiction texts.

Simply Butterflies!

This article gives suggestions for building a simple walk-in classroom butterfly observatory and using the observatory to hatch out Painted Lady butterflies as part of a four-week unit on life cycle stages.

Teacher Professional Learning Resources

Assessment for the Next Generation Science Standards

The presenters were Joan Herman, Co-Director Emeritus of the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at UCLA; and Nancy Butler Songer, Professor of Science Education and Learning Technologies, University of Michigan.

Dr. Herman began the presentation by summarizing a report by the National Research Council on assessment for the Next Generation Science Standards (NGSS). She talked about the development of the report and shared key findings. Next, Dr. Songer discussed challenges for classroom implementation and provided examples of tasks that can be used with students to assess their proficiency on the NGSS performance expectations. Participants had the opportunity to submit questions and share their feedback in the chat.

View the resource collection.

Continue discussing this topic in the community forums.

NGSS Crosscutting Concepts: Patterns

The presenter was Kristin Gunckel from the University of Arizona. Dr. Gunckel began the presentation by discussing how patterns fit in with experiences and explanations to make up scientific inquiry. Then she talked about the role of patterns in NGSS and showed how the crosscutting concept of patterns progresses across grade bands. After participants shared their ideas about using patterns in their own classrooms, Dr. Gunckel shared instructional examples from the elementary, middle school, and high school levels.

NGSS Crosscutting Concepts: Structure and Function

The presenters were Cindy Hmelo-Silver and Rebecca Jordan from Rutgers University. Dr. Hmelo-Silver and Dr. Jordan began the presentation by discussing the role of the crosscutting concept of structure and function within NGSS. They then asked participants to think about the example of a sponge and discuss in the chat how a sponge's structure relates to its function. The presenters introduced the Structure-Behavior-Function (SBF) theory and talked about the importance of examining the relationships between mechanisms and structures. They also discussed the use of models to explore these concepts. Participants drew their own models for one example and shared their thoughts about using this strategy in the classroom.

NGSS Core Ideas: Heredity: Inheritance and Variation of Traits

The presenter was Ravit Golan Duncan of Rutgers University. The program featured strategies for teaching about life science concepts that answer questions such as "How are the characteristics of one generation related to the previous generation?" and "Why do individuals of the same species vary in how they look, function, and behave?"

Dr. Duncan began the presentation by discussing the importance of heredity as a disciplinary core idea. She then described how student learning should progress across grade levels and showed examples of common preconceptions. Dr. Duncan also shared strategies and resources for teaching about heredity.

Visit the resource collection.

Continue discussing this topic in the community forums.

Appendix A: NGSS and Foundations for the Unit

Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. *[Clarification Statement: Changes organisms go through during their life form a pattern.]* *[*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]* **(3-LS1-1)**

Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. *[Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]* **(3-LS4-2)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices **Disciplinary Core Ideas** **Crosscutting Concepts**

Developing and Using Models

- Develop models to describe phenomena. (3-LS1-1)

Constructing Explanations and Designing Solutions

- Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS4-2)

LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3- LS1-1)

LS4.B: Natural Selection

- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding

Patterns

- Patterns of change can be used to make predictions. (3-LS1-1)

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change. (3-LS4- 2),(3-LS4-3)

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- - - - ***Connections to Nature of Science***

Scientific Knowledge is Based on

	mates, and reproducing. (3-LS4-2)	**Empirical Evidence**

		● Science findings are based on recognizing patterns. (3-LS1-1)

English Language Arts	**Mathematics**

Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS4-2) **RI.3.1** Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS4-2) **RI.3.2** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS4-2) **RI.3.3** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). (3-LS1-1) **RI.3.7** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS4-2) **SL.3.4** Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details. (3-LS1-1) **SL.3.5**	Reason abstractly and quantitatively. (3-LS4-2) **MP.2** Model with mathematics. (3-LS1-1), (3-LS4-2) **MP.4** Number and Operations in Base Ten (3-LS1-1) **3.NBT** Number and Operations—Fractions (3-LS1-1) **3.NF** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs. (3-LS4-2) **3.MD.B.3** Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS4-1) **3.MD.B.4**

Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS4-2)
W.3.2

Recommended Instructional Days: 15 days

Grade 3 Unit 6: Organisms and the Environment

NGSS:

Students who demonstrate understanding can:

3-LS2-1.

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they livedlong ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [*Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.*]

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some

survive less well, and some cannot survive at all. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [*Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.*]

Unit Summary

Why don't we see alligators in the arctic?

In this unit of study, students develop an understanding of the idea that when the environment changes, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. The crosscutting concepts of *cause and effect* and the *interdependence of science, engineering, and technology* are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in *engaging in argument from evidence*. Students are also expected to use this practice to demonstrate understanding of the core ideas.

This unit is based on 3-LS2-1 and 3-LS4-3.

Student Learning Objectives

Construct an argument that some animals form groups that help members survive. (3-LS2-1)

Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. *[Clarification Statement: Examples of evidence could include needs and characteristics of the organisms*

and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.] **(3-LS4-3)**

Unit Sequence	
Part A: *In a particular habitat, why do some organisms survive well, some survive less well, and some not survive at all?*	
Concepts	**Formative Assessment**
● Cause-and-effect relationships are routinely identified and used to explain change. ● Knowledge of relevant scientific concepts and research findings is important in engineering. ● For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. ● Organisms and their habitat make up a system in which the parts depend on each other.	*Students who understand the concepts are able to:* ● Identify cause-and-effect relationships in order to explain change. ● Construct an argument with evidence. ● Construct an argument with evidence (e.g., needs and characteristics of the organisms and habitats involved) that in a particular habitat, some organisms can survive well, some can survive less well, and some cannot survive at all.

What It Looks Like in the Classroom

Organisms and their habitats make up a system in which they are interdependent. Environmental factors affect the growth and survival of every type of organism, and organisms in turn affect the environment. The focus of this unit of study is identifying cause and-effect relationships between the environment and organisms' ability to survive and reproduce.

In this unit, students first learn that all organisms have a variety of behaviors and traits that enable them to survive. One of these behaviors includes forming groups. Groups serve different functions and can vary dramatically in size. Animals may form groups to obtain food, to defend themselves, and/or to cope with changes in their environment. Students should have opportunities to conduct research on animals that form groups in order to understand how being part of a group is beneficial to survival and reproduction. Students might begin with studying animals that are indigenous to the local environment (e.g., squirrels, coyotes, deer, birds, or fish),