INTRODUCTION TO PERFORMANCE EXPECTATIONS

"The NGSS are standards or goals, that reflect what a student should know and be able to do; they do not dictate the manner or methods by which the standards are taught. . . . Curriculum and assessment must be developed in a way that builds students' knowledge and ability toward the PEs [performance expectations]" (*Next Generation Science Standards*, 2013, page xiv).

This chapter shows how the NGSS Performance Expectations were bundled in the **Plants and Animals Module** to provide a coherent set of instructional materials for teaching and learning.

This chapter also provides details about how this FOSS module fits into the matrix of the FOSS Program (page 37). Each FOSS module K–5 and middle school course 6–8 has a functional role in the FOSS conceptual frameworks that were developed based on a decade of research on science education and the influence of *A Framework for K–12 Science Education* (2012) and *Next Generation Science Standards* (NGSS, 2013).

The FOSS curriculum provides a coherent vision of science teaching and learning in the three ways described by the NRC *Framework*. First, FOSS is designed around learning as a developmental progression, providing experiences that allow students to continually build on their initial notions and develop more complex science and engineering knowledge. Students develop functional understanding over time by building on foundational elements (intermediate knowledge). That progression is detailed in the conceptual frameworks.

Second, FOSS limits the number of core ideas, choosing depth of knowledge over broad shallow coverage. Those core ideas are addressed at multiple grade levels in ever greater complexity. FOSS investigations at each grade level focus on elements of core ideas that are teachable and learnable at that grade level.

Third, FOSS investigations integrate engagement with scientific ideas (content) and the practices of science and engineering by providing firsthand experiences.

Teach the module with the confidence that the developers have carefully considered the latest research and have integrated into each investigation the three dimensions of the *Framework* and NGSS, and have designed powerful connections to to the Common Core State Standards for English Language Arts.

Contents

The NGSS Performance Expectations bundled in this module include:

Life Sciences
1-LS1-1
1-LS1-2
1-LS3-1

Engineering, Technology, and Applications of Science
K–2-ETS1-2

Disciplinary Core Ideas Addressed

The **Plants and Animals Module** connects with the NRC *Framework* for the grades K–2 grade band and the NGSS performance expectations for grade 1. The module focuses on core ideas for life sciences and engineering design.

Life Sciences

Framework core idea LS1: From molecules to organisms: structures and processes—How do organisms live, grow, respond to their environment, and reproduce?

- **LS1.A: Structure and function**
  How do the structures of organisms enable life's functions? [All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and see, find, and take in food, water, and air. Plants also have different parts that help them survive, grow, and produce more plants.]
- **LS1.B: Growth and development of organisms**
  How do organisms grow and develop? [Plants and animals have predictable characteristics at different stages of development. Plants and animals grow and change. Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.]
- **LS1.D: Information processing**
  How do organisms detect, process, and use information about the environment? [Animals have body parts that capture and convey different kinds of information needed for growth and survival—for example, eyes for light, ears for sounds, and skin for temperature or touch. Animals respond to these inputs with behaviors that help them survive (e.g., find food, run from a predator). Plants also respond to some external inputs (e.g., turn leaves toward the Sun).]

The following NGSS Grade 1 Performance Expectations for LS1 is derived from the Framework disciplinary core ideas above.

- **1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle

DISCIPLINARY CORE IDEAS

A Framework for K–12 Science Education has four core ideas in life sciences.

LS1: From molecules to organisms: Structures and processes

LS2: Ecosystems: Interactions, energy, and dynamics

LS3: Heredity: Inheritance and variation of traits

LS4: Biological evolution: Unity and diversity

NOTE: The questions and descriptions of the core ideas in the text on these pages are taken from the NRC *Framework* for the grades K–2 grade band to keep the core ideas in a rich and useful context.

The performance expectations related to each core idea are taken from the NGSS for grade 1.

NOTE

Disciplinary Core Idea LS1.D: Information processing is also addressed in the grade 1 **Sound and Light Module** where students study animal ears and eyes.

shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

- **1-LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. [Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

Framework core idea LS3: Heredity: Inheritance and Variation of Traits—How are characteristics of one generation passed to the next? How can individuals of the same species and even siblings have different characteristics?

- **LS3.A: Inheritance of traits**
  How are the characteristics of one generation related to the previous generations? [Organisms have characteristics that can be similar or different. Young animals are very much, but not exactly, like their parents and also resemble other animals of the same kind. Plants also are very much, but not exactly, like their parents and resemble other plants of the same kind.]

- **LS3.B: Variation of traits**
  Why do individuals of the same species vary in how they look, function, and behave? [Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.]

The following NGSS Grade 1 Performance Expectation for LS3 is derived from the Framework disciplinary core ideas above.

- **1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly, like their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]

REFERENCES

National Research Council. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press, 2012.

NGSS Lead States. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press, 2013.

DISCIPLINARY CORE IDEAS

A Framework for K–12 Science Education has two core ideas in engineering, technology, and applications of science.

ETS1: Engineering design

ETS2: Links among engineering, technology, science, and society

NOTE: Only one of these core ideas, ETS1, is represented in the NGSS performance expectations for grade 1.

The questions and descriptions of the core ideas in the text on these pages are taken from the NRC *Framework* for the grades K–2 grade band to keep the core ideas in a rich and useful context.

The performance expectations related to each core idea are taken from the NGSS for grade K–2.

Engineering, Technology, and Applications of Science

Framework core idea ETS1: Engineering design—How do engineers solve problems?

- **ETS1.A: Defining and delimiting an engineering problem**
  What is a design for? What are the criteria and constraints of a successful solution? [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. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.]
- **ETS1.B: Developing possible solutions**
  What is the process for developing potential design solutions? [Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. To design something complicated, one may need to break the problem into parts and attend to each part separately but must then bring the parts together to test the overall plan.]
- **ETS1.C: Optimizing the design solution**
  How can the various proposed design solutions be compared and improved? [Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weakness.]

The following NGSS Grades K–2 Performance Expectations for ETS1 are derived from the Framework disciplinary core ideas above.

- **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2.** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Framework core idea ETS2: Links among engineering, technology, science, and society—How are engineering, technology, science, and society interconnected?

- **ETS2.A: Interdependence of science, engineering, and technology**
  What are the relationships among science, engineering, and technology? [People encounter questions about the natural world every day. There are many types of tools produced by engineering that can be used in science to help answer these questions through observation or measurement. Observations and measurements are also used in engineering to help test and refine design ideas.]
- **ETS2.B: Influence of engineering, technology, and science on society and the natural world**
  How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world? [People depend on various technologies in their lives; human life would be very different without technology. Every human-made product is designed by applying some knowledge of the natural world and is built by using materials derived from the natural world, even when the materials are not themselves natural—for example, spoons made from refined metals. Thus, developing and using technology has impacts on the natural world.]

Note: There are no separate performance expectations described for core idea ETS2 (see volume 2, appendix J, for an explanation and elaboration).

SCIENCE AND ENGINEERING PRACTICES

A Framework for K–12 Science Education (National Research Council, 2012) describes eight science and engineering practices as essential elements of a K–12 science and engineering curriculum. Seven practices are incorporated into the learning experiences in the **Plants and Animals Module**.

The learning progression for this dimension of the framework is addressed in *Next Generation Science Standards* 2013, volume 2, appendix F. Elements of the learning progression for practices recommended for grade 1 as described in the performance expectations appear in bullets below each practice.

Science and Engineering Practices Addressed

1. ***Asking questions and defining problems***
   - Ask questions based on observations to find more information about the natural and/or designed world(s).
2. ***Developing and using models***
   - Develop and/or use a model to represent amounts, relationships, relative scales, and/or patterns in the natural world.
3. ***Planning and carrying out investigations***
   - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
   - Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
   - Make predictions based on prior experiences.
4. ***Analyzing and interpreting data***
   - Record information (observations, thoughts, and ideas).
   - Use and share pictures, drawings, and/or writings of observations.
   - Use observations (firsthand or from media) to describe patterns and/or use relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
   - Compare predictions (based on prior experiences) to what occurred (observable events).
5. ***Using mathematics and computational thinking***
   - Use counting and numbers to identify and describe patterns in the natural and designed world(s).
   - Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
6. ***Constructing explanations and designing solutions***
   - Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
7. ***Engaging in argument from evidence***
   - Construct an argument with evidence to support a claim.
8. ***Obtaining, evaluating, and communicating information***
   - Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).
   - Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Crosscutting Concepts Addressed

Patterns

- Patterns in the natural and human-designed world can be observed, used to describe phenomena, and used as evidence.

Cause and effect

- Events have causes that generate observable patterns.

Systems and system models

- Systems in the natural and designed world have parts that work together.

Structure and function

- The shape and stability of structures of natural and designed objects are related to their function(s).

Connections: Understandings about the Nature of Science

Scientific knowledge is based on empirical evidence.

- Scientists look for patterns and order when making observations about the world.

Science addresses questions about the natural and material worlds.

- Scientists study the natural and material worlds.

Scientific investigations use a variety of methods.

- Scientists use different ways to study the world.

Connections: Science, Technology, Society, and the Environment

Influence of engineering, technology, and science on society and the natural world

- Every human-made product is designed by applying some knowledge of the natural world, and is built by using natural materials.

CROSSCUTTING CONCEPTS

A Framework for K–12 Science Education describes seven crosscutting concepts as essential elements of a K–12 science and engineering curriculum. The crosscutting concepts listed here are those recommended for grade 1 in the NGSS, and are incorporated into the learning opportunities in the **Plants and Animals Module**.

The learning progression for this dimension of the framework is addressed in Next Generation Science Standards, 2013, volume 2, appendix G, in the NGSS. Elements of the learning progression for crosscutting concepts recommended for grade 1, as described in the performance expectations, appear after bullets below each concept.

CONNECTIONS

See Next Generation Science Standards, 2013, volume 2, appendix H and appendix J, for more on these connections.

For details on learning connections to Common Core State Standards for English Language Arts and Math, see the chapters FOSS and Common Core ELA—Grade 1 and FOSS and Common Core Math—Grade 1 in *Teacher Resources*.

FOSS CONCEPTUAL FRAMEWORK

In the last half decade, teaching and learning research has focused on learning progressions. The idea behind a learning progression is that **core ideas** in science are complex and wide-reaching, requiring years to develop fully—ideas such as the structure of matter or the relationship between the structure and function of organisms. From the age of awareness throughout life, matter and organisms are important to us. There are things students can and should understand about these core ideas in primary school years, and progressively more complex and sophisticated things they should know as they gain experience and develop cognitive abilities. When we as educators can determine those logical progressions, we can develop meaningful and effective curricula for students.

FOSS has elaborated learning progressions for core ideas in science for kindergarten through grade 8. Developing a learning progression involves identifying successively more sophisticated ways of thinking about a core idea over multiple years.

If mastery of a core idea in a science discipline is the ultimate educational destination, then well-designed learning progressions provide a map of the routes that can be taken to reach that destination. . . . Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning. (National Research Council, *A Framework for K–12 Science Education*, 2012, page 26)

TEACHING NOTE

FOSS has conceptual structure at the module and strand levels. The concepts are carefully selected and organized in a sequence that makes sense to students when presented as intended.

The FOSS modules are organized into three domains: physical science, earth science, and life science. Each domain is divided into two strands, as shown in the table "FOSS Next Generation—K–8 Sequence." Each strand represents a core idea in science and has a conceptual framework

- Physical Science: matter; energy and change
- Earth and Space Science: dynamic atmosphere; rocks and landforms
- Life Science: structure and function; complex systems

The sequence in each strand relates to the core ideas described in the NRC *Framework*. Modules at the bottom of the table form the foundation in the primary grades. The core ideas develop in complexity as you proceed up the columns.

Information about the FOSS learning progression appears in the **conceptual frameworks** (page 39 and 43), which shows the structure of scientific knowledge taught and assessed in this module, and the **content sequence** (pages 44–45), a graphic and narrative description that puts this single module into a K–8 strand progression.

FOSS Next Generation—K–8 Sequence

	PHYSICAL SCIENCE		EARTH SCIENCE		LIFE SCIENCE	
	MATTER	ENERGY AND CHANGE	ATMOSPHERE AND EARTH	ROCKS AND LANDFORMS	STRUCTURE/ FUNCTION	COMPLEX SYSTEMS
6–8	Waves; Gravity and Kinetic Energy Chemical Interactions Electromagnetic Force		Planetary Science Earth History Weather and Water		Heredity and Adaptation Populations and Ecosystems Diversity of Life; Human Systems Interactions	
5	Mixtures and Solutions		Earth and Sun		Living Systems	
4		Energy		Soils, Rocks, and Landforms	Environments	
3	Motion and Matter		Water and Climate		Structures of Life	
2	Solids and Liquids			Pebbles, Sand, and Silt	Insects and Plants	
1		Sound and Light	Air and Weather		Plants and Animals	
K	Materials and Motion		Trees and Weather		Animals Two by Two	

FOSS is a research-based curriculum designed around the core ideas described in the NRC *Framework*. The FOSS module sequence provides opportunities for students to develop understanding over time by building on foundational elements or intermediate knowledge leading to the understanding of core ideas. Students develop this understanding by engaging in appropriate science and engineering practices and exposure to crosscutting concepts. The FOSS conceptual frameworks therefore are *more detailed* and *finer grained* than the set of goals described by the NGSS performance expectations (PEs). The following statement reinforces the difference between the standards as a blueprint for assessment and a curriculum, such as FOSS.

Some reviewers of both public drafts [of NGSS] *requested that the standards specify the intermediate knowledge necessary for scaffolding toward eventual student outcomes. However, the NGSS are a set of goals. They are PEs for the end of instruction—not a curriculum. Many different methods and examples could be used to help support student understanding of the DCIs and science and engineering practices, and the writers did not want to prescribe any curriculum or constrain any instruction. It is therefore outside the scope of the standards to specify intermediate knowledge and instructional steps.* (*Next Generation Science Standards*, 2013, volume 2, p. 342)

BACKGROUND FOR THE CONCEPTUAL FRAMEWORK *in Plants and Animals*

There are two conceptual frameworks for the disciplinary core ideas in this module for grade 1—one with a focus on life science and one on engineering design.

A Closer Look at Plants

This module introduces young students to a few members of the plant kingdom. To the botanist, a plant is a multicellular organism that has cellulose-reinforced cell walls and one or more pigments, such as chlorophyll, that convert energy from the Sun into energy-rich substances that can be used as food at a later time. Most plants also have more familiar structures and characteristics—they have roots that anchor them to the soil, they are green, at least in part, and they have leaves of some kind. These are the characteristics that primary students will use as evidence that the organism is a plant.

The similarities among all the members of the plant kingdom are evidence for plants having evolved from a common ancestor, a green algae. Some of the most ancient plants are the mosses, liverworts, and hornworts. As time passed, some plants developed internal plumbing for moving water and nutrients up and down their stems. This derived characteristic, vascular tissue, marks a major division in the plant kingdom. Plants with specialized tissues for moving fluids are vascular plants, and plants without continuous well-developed channels inside are nonvascular plants.

Later in evolutionary history, some vascular plants derived the ability to produce seeds as a means of propagating new plants. Other vascular plants, such as ferns and horsetails, produce spores, which can develop into new plants. Unlike seeds, spores have no protective coat and carry no energy-rich food supply to nourish the new plant.

Still later in evolutionary history, some seed plants developed flowers. Those that did not evolve this characteristic are the nonflowering plants, or gymnosperms. Conifers—pines, junipers, spruces, hemlocks, redwoods—are examples of nonflowering plants. The seeds form in female cones after they are fertilized by pollen from the male cones, but no flower is ever present. The gingko tree (although not a conifer) is another example of a nonflowering plant.

Flowering plants, or angiosperms, are the largest division of plants, with about 235,000 species. Flowering plants arrived on the scene perhaps 150 million years ago. They are either monocots or dicots. *Cot* is short for *cotyledon* (cot•eh•LEE•dun), which is the structure within the seed that stores the food for the developing seedling. If the seed has a single cotyledon, it is a monocot; if it has two cotyledons, it is a dicot. Grasses and most other flowering plants with parallel veins in the leaves (lilies, palm trees, orchids) are monocots. All others are dicots.

All organisms have a few characteristics in common, and some of these will be explored in this module. No individual organism lives forever. All organisms come into being as a result of one of several reproductive processes, progress through their life span, and perish, to be decomposed and possibly incorporated into the next generation of living organisms. The life span of a plant may be as brief as a few weeks as in the case of some grasses, or as long as many centuries as in the case of the bristlecone pine trees, which can live more than 4000 years. Because all plants eventually die, it is imperative that plants reproduce if their kind is to survive. Those individuals that are best suited to survive the rigors of the particular environment surrounding them are the ones that will reproduce. The term "survival of the fittest" is familiar to many as a way to explain how one individual is selected to carry the germ of life to the next generation. This term is somewhat misleading because it implies that the most robust, powerful, massive, aggressive individual will be the one to succeed, but this is not necessarily the case. The term might better be stated as the "survival of the fittingest." The individual best adapted to fit into the environment is the one most likely to survive and consequently to reproduce.

CONCEPTUAL FRAMEWORK
Life Science, Structure and Function:
Plants and Animals

Structure and Function

Concept A All living things need food, water, a way to dispose of waste, and an environment in which they can live.

- Plants depend on air, water, nutrients (in the soil), and light to grow. Animals need air (oxygen), water, food, and shelter.
- Animals and plants have structures that serve various functions in growth, survival, and reproduction.

Concept B Reproduction is essential to the continued existence of every kind of organism. Organisms have diverse life cycles.

- Plants and animals grow and change and have predictable characteristics at different stages of development. Adult plants and animals can produce offspring.
- In many kinds of animals, parents and the offspring engage in behavior that helps the offspring to survive.

Concept C Animals detect, process, and use information about their environment to survive.

- Animals have sensory structures that provide the animals with information about their surroundings to help them find food and protect themselves from danger.

Complex Systems

Concept C Heredity involves passing information from one generation to the next and introducing variation in traits between individuals in a population.

- Plants and animals are very much, but not exactly, like their parents and resemble other organisms of the same kind.

Plant Reproduction

Most animals, including humans, reproduce by one process only, the production of an embryo that results from the fusion of genetic material from two individuals, usually a male and a female. Plants, on the other hand, are much more versatile. In addition to sexual reproduction that produces an embryo in a seed, many plants can also reproduce by spores or vegetatively. Some plants have developed special structures that produce new plants. Lilies form little bulbs around the base of the parent bulb, each of which can form a new plant, and strawberries send out specialized stems, stolons, from which new plants sprout. In addition, many plants can develop new offspring from a piece of the parent plant, such as a stem or leaf. African violets propagate by rooting a single leaf, and ivy grows from a little piece of stem. If humans could reproduce in this manner, you could cut off a finger, place it in a suitable supportive environment, and in due course grow a new person from it. Not only would it be a new person, it would be an exact copy of you.

This module explores reproduction of plants—producing new plants from old. In the first investigation, students plant seeds, one of nature's crowning achievements. A seed results when the male germ in the pollen grain fuses with the female germ in the ovule. The resulting embryo is packaged in a protective wrapper with a food supply and cast in one way or another into the world. A seed is in many ways analogous to an egg, except that most eggs must develop into a new individual immediately or perish. Seeds can wait. Most seeds can remain viable for years, waiting for the right combination of conditions to initiate growth and development.

Vascular plants have three main vegetative structures: roots, stems, and leaves. Roots serve mostly as the subterranean anchor for the plant and the plumbing structure that takes up essential moisture and nutrients from the soil and transports them to the aerial structures of the plant. However, many plants can produce a new plant from the root structure if the plant is burned, broken, or eaten. Chaparral plants that are frequently burned, like coyote bush and sage, have this capacity, as do many trees, including redwoods, acacias, aspens, and willows. Some herbaceous plants (with nonwoody stems) have specialized roots that readily produce new plants if the aboveground part is lost. The large taproots of dandelions and rutabagas regenerate new plants when necessary.

Stems are perhaps the most varied structures in the plant kingdom. The trunks, branches, and twigs that support the leaves on plants are the most frequently encountered kinds of stems, so from our human point of view, the most typical. However, the knobby rootlike underground part of the iris is a modified stem called a rhizome, and the bulblike structure of the gladiolus is a modified stem called a corm. White potatoes are actually stems called tubers, and the wiry connectors that run between clumps of Bermuda grass are stems called stolons. These modified stems are adapted for reproduction of the plants that produce them, but the regular stems of many plants can produce new plants as well. Many herbaceous plants will produce new plants if a portion of stem is placed in water. Coleus, ivy, mint, geranium, and begonia will readily form roots in a matter of days; the rooted cutting can be placed in soil, and a new plant is on its way.

Plants, unlike animals, make their own food through the complex process of photosynthesis. Leaves function primarily as the factories that intercept solar energy and store it in the chemical bonds between carbon and hydrogen atoms in substances known as sugars. The leaves of some plants are endowed with the ability to develop roots and reproduce an exact copy of the parent plant if the leaf falls on the moist ground or is placed in a container of water. African violets, jade plants, and begonias have this ability.

Plants provide food and much more for people. Trees provide wood for construction and paper. Cotton, flax, and hemp provide fiber for cloth and rope. Innumerable plants provide oils for lubrication, cooking, and finishes. And the value provided to humans by living plants is immeasurable. How can the value of a beautiful flower be judged? Or the majesty of a sequoia, the comfort of shade under a cottonwood on a hot day, the crimson fall foliage of the durable eastern hardwood forest, or the refreshing smell of piney woods? These are a minute sampling of the multitudes of ways plants enrich not only our chances for survival but also our aesthetic appreciation of the planet.

Basic Needs of Plants and Animals

All organisms, including plants and animals, have specific requirements for successful growth, development, and reproduction. One of the requirements is a supportive environment. The sum of the external conditions that affect reproduction and survival is an organism's environment. The external conditions, called environmental factors, include nonliving, or abiotic, factors such as water, light, air, chemicals, and temperature, as well as living, or biotic, factors such as the influence of other organisms.

Animals look the way they do and live where they do because it helps them survive. Caribou have dense fur for insulation from cold. Hawks have long, sharp talons for capturing prey. Frogs have webbed feet for efficient swimming. Fox have sharp teeth for biting. Robins use trees for shelter and grass for nesting. Cacti have extensive root systems to acquire water. Maple trees drop their leaves in autumn to overwinter.

An organism's external structures are the result of ages of selective processes. If a feature helps an organism live, it is reinforced through genetic inheritance, and subsequent generations of the organism will have the advantage of that feature. Another word for structures (and behaviors) that help an organism survive and thrive is *adaptation*. The concept of adaptation will be introduced into the curriculum in a few years, but for now students should observe and compare external features of organisms, and start to think about the role of those features in the struggle for survival.

Many of the external structures of organisms that interest young students are associated with getting food and water, and defending themselves and their offpspring from danger. Young students know that people eat, as do pets and other familiar animals. People and other animals need to eat to stay healthy. Drinking is also recognized as something people and animals do. Throughout the investigations and readings, take advantage of opportunities to discuss how plants get the water they need via roots, and how animals get the water they need by drinking or extracting it from their food. By bringing out the need for food and water for each kind of plant and animal you discuss, the larger concept of the universal nature of these imperatives will build in a natural manner.

The important message is that all organisms need food. Students in the early stages of grappling with the notion of photosynthesis will incorrectly think that plants don't need food. The story that plants need only sunshine, carbon dioxide, water, and nutrients to live is true, but leaves out a critically important fact. Plants use these resources to produce food. They in turn use that food to conduct the metabolic processes of life. Every living organism uses food. For early learners, this concept should be introduced simply and accurately by stating that plants don't eat, but rather make their own food from air, water, and sunlight, and that this food making happens in green parts of plants, primarily leaves.

All animals lack the ability to synthesize food. Animals eat plants in order to benefit from the food produced by the plants. Other animals eat the plant eaters to acquire the food originally produced by plants. It doesn't matter how far an animal is removed from a vegetarian diet—its food originated in a plant.

Animals have a variety of sensory structures to gather information about their surroundings to help them survive. And parents and their offspring engage in behaviors to ensure the survival of the young animals.

Engineering Design

Engineering is the systematic approach to finding solutions to problems identified by people in societies. The fields of science and engineering are mutually supportive and scientists and engineers collaborate in their work. The practices that engineers use are very similar to science practices but also involve defining problems and designing solutions.

The process of engineering design, while it involves engineering practices, is considered a separate set of disciplinary core ideas in the *Framework* and in the NGSS. For grade 1, these are the core ideas.

Defining the problem involves asking questions and making observations to obtain information about designing a specific structure. In this module, students explore through readings how engineers define human problems to solve.

Developing possible solutions involves making decisions about the materials available and thoughtfully making a design to solve a specific problem, such as how to move in water, how to climb wooden poles, or how to protect human bodies from cold weather. Students learn through words and illustrations how engineers learn from nature to solve human problems.

Comparing different solutions to improve the design solution involves testing several designs to see how well each one meets the challenge. First graders are not expected to conduct tests with controlled variables, but they should be able to determine if the structure meets the challenge and if not, how it might be improved. Identifying the differences between design solutions is important. Collaboration is an important aspect of engineering design; learning from the successes and failures of other design groups can be very productive. Students can engage in engineering practices without fully engaging in the iterative process of design.

CONCEPTUAL FRAMEWORK
Engineering Design: Plants and Animals

Concept A Defining and delimiting engineering problems.

Asking questions, making observations, and gathering information are helpful in thinking about a problem. Before beginning to design a solution, it is important to clearly understand the problem.

Concept B Developing possible solutions.

Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

Concept C Optimizing the design solution.

Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Life Science Content Sequence

This table shows the FOSS modules that inform the structure and function and complex systems strands. The supporting elements in these modules (somewhat abbreviated) are listed. The elements for the **Plants and Animals Module** are expanded to show how they fit into the sequence.

	LIFE SCIENCE	
Module or course	**Structure and Function**	**Complex Systems**
Diversity of Life (middle school)	• All living things are made of cells • Cells have the same needs and perform the same functions as more complex organisms. • All living things need food, water, a way to dispose of waste, and an environment in which they can live (macro and microlevel). • Plants reproduce in a variety of ways.	• Adaptations are structures or behaviors of organisms that enhance their chances to survive and reproduce in their environment. • Biodiversity is the wide range of existing life-forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems.
Living Systems (grade 5)	• Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need. • Reproduction is essential to the continued existence of every kind of organism. • Humans and other animals have systems made up of organs that are specialized for particular body functions. • Animals detect, process, and use information about their environment to survive.	• Organisms obtain gases, water, and minerals from the environment and release waste matter back into the environment. • Matter cycles between air and soil, and among plants, animals, and microbes as these organisms live and die. • Organisms are related in food webs. • Some organisms, such as fungi and bacteria, break down dead organisms, operating as decomposers.
Environments (grade 4)	• Plants and animals have structures and behaviors that function in growth, survival, and reproduction. • Producers make their own food. • Animals obtain food from eating plants or eating other animals.	• Organisms have ranges of tolerance for environmental factors as a result of their internal and external structures. • Organisms interact in feeding relationships in ecosystems (food chains and food webs). • Difference in individual characteristics may give individuals an advantage in surviving.
Structures of Life (grade 3)	• A seed is a living organism. • Plants and animals have structures that function in growth and survival. • Reproduction is essential to the continued existence of every kind of organism. • Organisms have diverse life cycles. • Behavior of animals is influenced by internal and external cues.	• Organisms are related in food chains. • Different organisms can live in different environments; adaptations allow them to survive in that environment. • Changes in an organism's habitat are sometimes beneficial, sometimes harmful. • Many characteristics of organisms are inherited from parents.
Insects and Plants (grade 2)	• Insects need air, food, water, and space. • Plants and insects have structures that function in growth, and reproduction. • Organisms have diverse life cycles. • Plants and insects grow and change and have predictable stages of development.	• Animals interact with plants using them as food. They also assist in plant reproduction through seed dispersal and pollination. • Plants depend on the environment for water and light to grow. • There are many different kinds of living things and they exist in different places.
Plants and Animals (grade 1)		
Animals Two by Two **Trees and Weather (grade K)**	• Animals have identifiable structures and behaviors. • Animals and plants have basic needs. • Trees are living plants and have structures. • Trees go through predictable stages.	• Living things can survive only when their needs are met. • Individuals of the same kind (plants or animals) are recognizable as similar but can also vary in many ways.

Plants and Animals	Structure and Function	Complex Systems
	• Plants and animals have structures and behaviors that function in growth, survival, and reproduction. • Animals have sensory structures that provide the animals with information about their surroundings. • Reproduction is essential to the continued existence of every kind of organism. New plants can grow from seeds, stems, bulbs, and roots. • Plants and animals grow and change and have predictable characteristics at different stages of development. • Adult plants and animals can have offspring. Animal parents and their young engage in survival behaviors.	• Plants make their own food. Plants depend on air, water, nutrients in the soil, and light to grow. • Plants and animals are very much, but not exactly, like their parents and resemble other plants and animals of the same kind. • A habitat is a place where animals live and their needs are met. There are many different kinds of habitats.

NOTE

See the Assessment chapter at the end of this *Investigations Guide* for more details on how the FOSS embedded and benchmark assessment opportunities align to the conceptual frameworks and the learning progressions. In addition, the Assessment chapter describes specific connections between the FOSS assessments and the NGSS performance expectations.

The NGSS Performance Expectations addressed in this module include:

Life Sciences
1-LS1-1
1-LS1-2
1-LS3-1

Engineering, Technology, and Applications of Science
K–2 ETS1-2

See pages 30–33 in this chapter for more details on the Grade 1 NGSS Performance Expectations.

CONNECTIONS TO NGSS BY INVESTIGATION

	Science and Engineering Practices	Connections to Common Core State Standards for ELA
Inv. 1: Grass and Grain Seeds	Asking questions Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations Engaging in argument from evidence Obtaining, evaluating, and communicating information	RI 1: Ask and answer questions about key details in a text. RI 2: Identify the main topic and retell key details of a text. RI 3: Describe the connection between pieces of information in a text. RI 4: Ask and answer questions to help determine or clarify the meaning of words and phrases in a text. RI 5: Know and use text features. RI 6: Distinguish between information provided by illustrations and by words. RI 7: Use illustrations and details to describe its key ideas. RI 8: Identify the reasons an author gives to support points. RI 9: Identify similarities in and differences between texts on the same topic. RI 10: Read informational complex texts. W 5: Strengthen writing by revising and editing. SL 1: Participate in collaborative conversations. SL 2: Ask and answer questions about information presented orally and through other media. L 5a: Sort words into categories to gain a sense of the concepts the categories represent.
Inv. 2: Stems	Asking questions Planning and carrying out investigations Analyzing and interpreting data Constructing explanations Obtaining, evaluating, and communicating information	W 5: Strengthen writing by revising and editing. SL 1: Participate in collaborative conversations.

Disciplinary Core Ideas		Crosscutting Concepts
LS1.A: Structure and function • All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in good water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **(1-LS1-1)**	**LS1.B: Growth and development of organisms** • Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. **LS3.B: Variation of traits** • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. **(1-LS3-1**)	Patterns Cause and effect Structure and function
LS1.A: Structure and function • All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in good water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **(1-LS1-1)**	**LS1.B: Growth and development of organisms** • Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. **LS3.B: Variation of traits** • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. **(1-LS3-1**)	Patterns Cause and effect Structure and function

	Science and Engineering Practices	Connections to Common Core State Standards for ELA
Inv. 3: Terrariums	Asking questions Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using mathematics and computational thinking Constructing explanations and designing solutions Obtaining, evaluating, and communicating information	RI 1: Ask and answer questions about key details in a text. RI 2: Identify the main topic and retell key details of a text. RI 3: Describe the connection between pieces of information in a text. RI 4: Ask and answer questions to help determine or clarify the meaning of words and phrases in a text. RI 5: Know and use text features. RI 6: Distinguish between information provided by illustrations and by words. RI 7: Use illustrations and details to describe its key ideas. RI 8: Identify the reasons an author gives to support points. W 2: Write informative/explanatory text. W 5: Strengthen writing by revising and editing. SL 1: Participate in collaborative conversations. SL 2: Ask and answer questions about information presented orally and through other media. SL 4: Describe events with relevant details.
Inv. 4: Growth and Change	Asking questions Planning and carrying out investigations Analyzing and interpreting data Constructing explanations Obtaining, evaluating, and communicating information	RI 1: Ask and answer questions about key details in a text. RI 4: Ask and answer questions to help determine or clarify the meaning of words and phrases in a text. RI 5: Know and use text features. RI 6: Distinguish between information provided by illustrations and by words. RI 7: Use illustrations and details to describe its key ideas. RI 8: Identify the reasons an author gives to support points. RI 10: Read informational complex texts. W 5: Strengthen writing by revising and editing.

Disciplinary Core Ideas		Crosscutting Concepts
LS1.A: Structure and function • All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in good water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **(1-LS1-1)** **LS1.D: Information processing** • Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. **(1-LS1-1)**	**LS3.B: Variation of traits** • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. **(1-LS3-1)** **ETS1.B: Developing possible solutions** • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. **(K-2-ETS1-2**)	Systems and system models Structure and function
LS1.A: Structure and function • All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in good water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **(1-LS1-1)** **LS1.B: Growth and development of organisms** • Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. **(1-LS1-2)**	**LS3.A: Inheritance of traits** • Young animals are very much, but not exactly, like their parents. Plants also are very much, but not exactly, like their parents. **(1-LS3-1)** **LS3.B: Variation of traits** • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. **(1-LS3-1)**	Patterns Cause and effect Structure and function

RECOMMENDED FOSS NEXT GENERATION K–8 SCOPE AND SEQUENCE

Grade	Integrated Middle Grades				
6–8	Heredity and Adaptation*	Electromagnetic Force*	Gravity and Kinetic Energy*	Waves*	Planetary Science
	Chemical Interactions	Earth History	Populations and Ecosystems		
	Weather and Water	Diversity of Life	Human Systems Interactions*		

**Half-length courses* *Physical Science content* *Earth Science content* *Life Science content* *Engineering content*

Grade	Physical Science	Earth Science	Life Science
5	Mixtures and Solutions	Earth and Sun	Living Systems
4	Energy	Soils, Rocks, and Landforms	Environments
3	Motion and Matter	Water and Climate	Structures of Life
2	Solids and Liquids	Pebbles, Sand, and Silt	Insects and Plants
1	Sound and Light	Air and Weather	Plants and Animals
K	Materials and Motion	Trees and Weather	Animals Two by Two