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 Living Systems 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 41). 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 the Common Core State Standards for English Language Arts.
Disciplinary Core Ideas Addressed

The Living Systems Module connects with the NRC Framework 3–5 grade band and the NGSS performance expectations for grade 5. The module focuses on core ideas for Life, Physical, and Earth Sciences.

**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.C:** Organization for matter and energy flow in organisms  
  How do organisms obtain and use the matter and energy they need to live and grow? [Animals and plants alike generally need to take in air and water, animals must take in food, and plants need light and minerals; anaerobic life, such as bacteria in the gut, functions without air. Food provides animals with the materials they need for body repair and growth and is digested to release the energy they need to maintain body warmth and for motion. Plants acquire their material for growth chiefly from air and water and process matter they have formed to maintain their internal conditions (e.g., at night).]

- **LS1.D:** Information processing  
  How do organisms detect, process, and use information about the environment? [Different sense receptors are specialized for particular kinds of information, which may then be processed and integrated by an animal’s brain, with some information stored as memories. Animals are able to use their perceptions and memories to guide their actions. Some responses to information are instinctive—that is, animals’ brains are organized so that they do not have to think about how to respond to certain stimuli.]

**The following NGSS Grade 4–5 Performance Expectation for LS1 are derived from the Framework disciplinary core ideas above.**

- **5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

- **4-LS1-2.** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. [Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]
Framework core idea LS2: Ecosystems: Interactions, Energy, and Dynamics—How and why do organisms interact with their environment and what are the effects of those interactions?

• LS2.A: Interdependent relationships in ecosystems
  How do organisms interact with the living and nonliving environments to obtain matter and energy? [The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Either way, they are “consumers.” Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil for plants to use. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.]

• LS2.B: Cycles of matter and energy transfer in ecosystems
  How do matter and energy move through an ecosystem? [Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, water, and minerals from the environment and release waste matter (gas, liquid, or solid) back into the environment.]

The following NGSS Grade 5 Performance Expectation for LS2 is derived from the Framework disciplinary core ideas above.

• 5-LS2-1. Use a model to describe the movement of matter among plants, animals, decomposers, and the environment.
  [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]
**Physical Sciences**

**Framework core idea PS3: Energy—How is energy transferred and conserved?**

- **PS3.D: Energy in chemical processes and everyday life**
  
  How do food and fuel provide energy? If energy is conserved, why do people say it is produced or used? [The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use—for example, the stored energy of water behind a dam is released so that it flows downhill and drives a turbine generator to produce electricity. Food and fuel also release energy when they are burned or digested. When machines or animals “use” energy, most often the energy ends up transferred to heat in the surrounding environment. The energy released by burning fuel or digested food was once energy from the Sun that was captured by plants.] [Assessment Boundary: The fact that plants capture energy from sunlight is introduced at this level, but details of photosynthesis are not.]

The following NGSS Grade 5 Performance Expectation for PS3 is derived from the Framework disciplinary core ideas above.

- **5-PS3-1. Use models to describe that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the Sun.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]
Earth Sciences

Framework core idea ESS2: Earth’s systems—How and why is Earth constantly changing?

• ESS2.A: Earth materials and systems
  *How do the major Earth systems interact?* [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.]

The following NGSS Grade 5 Performance Expectation for ESS2 is derived from the Framework disciplinary core ideas above.

• 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]

Framework core idea ESS3: Earth and human activity—How do Earth’s surface processes and human activities affect each other?

• ESS3.C: Human impact on Earth systems
  *How do humans change the planet?* [Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments.]

The following NGSS Grade 5 Performance Expectation for ESS3 is derived from the Framework disciplinary core ideas above.

• 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.
Science and Engineering Practices Addressed

1. **Asking questions**
   - Ask questions that can be investigated based on patterns such as cause-and-effect relationships.

2. **Developing and using models**
   - Identify limitations of models.
   - Collaboratively develop and revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
   - Develop and/or use models to describe phenomena.
   - Use a model to test cause-and-effect relationships or interactions concerning the functioning of a natural system.

3. **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.
   - 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.
   - Make predictions about what would happen if a variable changes.

4. **Analyzing and interpreting data**
   - Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships.
   - Analyze and interpret data to make sense of phenomena using logical reasoning.
   - Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

5. **Using mathematics and computational thinking**
   - Describe, measure, estimate, and/or graph quantities such as weight to address scientific and engineering questions.
6. **Constructing explanations**
   - Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
   - Identify the evidence that supports particular points in an explanation.

7. **Engaging in argument from evidence**
   - Construct an argument with evidence, data, and/or models.

8. **Obtaining, evaluating, and communicating information**
   - Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.
   - Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
   - Communicate scientific and/or technical information orally and/or in written formats, including various forms of media, such as tables, diagrams, and charts.
Crosscutting Concepts Addressed

Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. Patterns of change can be used to make predictions and as evidence to support an explanation.

Scale, proportion, and quantity

- Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Systems and system models

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- A system can be described in terms of its components and their interactions.

Energy and matter

- Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. That is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
- Energy can be transferred in various ways and between objects.
- Energy is transported into, out of, and within systems.

Structure and function

- Substructures have shapes and parts that serve function.

Stability and change

- Change is measured in terms of difference over time and may occur at different rates.
- Some systems appear stable, but over long periods of time will eventually change.
Connections: Understandings about the Nature of Science

Scientific investigations use a variety of methods.
  • Scientific methods are determined by questions. Scientific investigations use a variety of methods, tools, and techniques.

Scientific knowledge is based on empirical evidence.
  • Science findings are based on recognizing patterns.
  • Scientists use tools and technologies to make accurate measurements and observations.

Scientific knowledge is open to revision in light of new evidence.
  • Scientific knowledge can change based on new evidence.

Science is a way of knowing.
  • Science is both a body of knowledge and processes that add new knowledge. Science is a way of knowing that is used by many people.

Science assumes an order and consistency in natural systems.
  • Science assumes consistent patterns in natural systems. Basic laws of nature are the same everywhere in the universe.

CONNECTIONS
See volume 2, appendix H and appendix J, in the NGSS for more on these connections.

For details on learning connections to Common Core State Standards English Language Arts and Math, see the chapters FOSS and Common Core ELA—Grade 5 and FOSS and Common Core Math—Grade 5 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, p. 26)

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 framework (page 43), which shows the structure of scientific knowledge taught and assessed in this module, and the content sequence (pages 46–47), a graphic and narrative description that puts this single module into a K–8 strand progression.

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 Living Systems

**Systems**

Virtually everything is a system or part of a system, or both. What does that mean? A system is an association of objects, processes, or concepts that together constitute an entity, institution, or social convention. It’s fairly easy to understand a kitchen range as a system. Close scrutiny allows a critical observer to compile a complete inventory of parts of the system—burners, oven door, oven racks, heat-regulating dials, gas or electric service lines, hood, and so on—and to understand how each part contributes a function to the association of parts that defines a kitchen range. When parts interact in a functional way, those parts assume a higher, more compelling meaning—the whole becomes more than the sum of the parts.

It can be more difficult to discern the system in something as diverse and difficult to define as a social institution. Democracy, for instance, is a political system of governance. A political system is an association of principles, laws, social behaviors, and procedures. This kind of system is not a physical entity that you can hold or stand next to with pride, but an intellectual and psychological space that surrounds your consciousness of your place, rights, and responsibilities in the universe.

We all associate with lots of social institutions that are systems. You are doubtless a player in an educational system, maybe a church or a health club, and possibly an organized sports team. These social institutions are all systems. Professional baseball is a system of young athletes with an array of skills that qualify them to fill the nine positions on the defensive field, plus a host of managers and sundry support professionals. The system includes a collection of physical objects: baseballs, wooden bats, an assortment of gloves, and protective equipment. A subsystem of people coordinate the team’s financial activities: pay for the athletes, food, travel, housing, and in the event of a championship, champagne and outlandish award rings. And there is the official ballpark in which to play the games, with all the attendant features and services that interact to construct and maintain the ballpark infrastructure subsystem. Baseball is a complex system, and every team hires a gaggle of competent managers to attend to all the subsystems that have to be integrated to deliver a season of entertainment and frustration.
**Biological Systems**

Some of the most interesting and important systems on Earth are those associated with life. The largest life system on Earth is the biosphere, which includes every living organism on Earth. You are a player in that system. The biosphere is conceptually parsed out into thousands (perhaps millions) of subsystems called ecosystems. An ecosystem is all the interacting organisms in a defined geographic space and all the abiotic factors with which the organisms interact. And of course every ecosystem is itself composed of thousands of subsystems. Every kind of organism is part of a population (all the individuals of one species that interact and reproduce in an ecosystem). A population is a system, and every individual organism is a complex system.

An ecosystem is a community of living things, all the nonliving things that surround it, and the relationships among them. Ecology is the study of the interactions between a community of organisms and the environment in which the community lives.

One of the major ideas presented in this context is the mechanisms by which organisms acquire the material resources (chemicals in the form of minerals, gases, and carbohydrates) and energy to conduct their lives. In most ecosystems on Earth, energy enters the ecosystem as light from the Sun and is converted to chemical energy through the complex process of photosynthesis performed by plants, algae, some bacteria, and some protists. Once plants (producers) have synthesized carbon dioxide and water into energy-rich carbohydrates, the energy and material in those carbohydrates is available to the consumers (the animals, fungi, bacteria, and protists) in the ecosystem, which cannot make their own food through

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**Complex Systems**

**Concept A** Organisms and populations of organisms depend on their environmental interactions both with other living things and with nonliving factors.
- An ecosystem is the interaction of organisms with one another and the abiotic environment.
- Organisms interact in feeding relationships (food chains and food webs).

**Concept C** Heredity involves passing information from one generation to the next and introducing variation in traits between individuals in a population.
- Many characteristics of organisms are inherited from parents; other characteristics result from interaction with the environment.
photosynthesis. Energy captured by plants is the energy used to run the whole ecosystem. The consumers can acquire energy they need only by consuming other organisms.

The feeding relationships between a series of organisms is called a food chain. Grass plants synthesize food, rabbits eat grass, foxes eat rabbits, and mountain lions eat foxes. The waste and uneaten bodies of dead organisms fall to the base of the ecosystem, where they are reduced to basic elements—minerals, gases, and water—by decomposers like bacteria and fungi. The last of the chemical energy is wrung out of the organic materials, and the raw materials are again available for the next generations of producer organisms in the ecosystem.

Food chains describe a simple linear relationship between a few organisms in an ecosystem. Food webs describe all the feeding interactions and represent the flow of energy through the food chains. They also illustrate competition for food resources among organisms.

**Systems of the Human Body**

To appreciate the wonder of being human requires a deep, dedicated systemic point of view. First it is necessary to understand that life happens in cells. You are the result of a mass of several trillion individual cells all working in concert. Whipping those cells into shape to produce you is a masterpiece of coordination. Every one of those trillions of cells has a demanding set of support criteria that must be attended to continuously. No mean feat!

Cells need a steady supply of food, water, and oxygen. Full service at all times. The human system is replete with dozens of subsystems dedicated to servicing cells. Cells “eat” a very limited menu of simple chemical foods (nutrients). Leading the list is glucose, a cell’s favorite source of energy. Cell nutrients are extracted from food that we eat. The digestive system is dedicated to the process of extracting nutrient chemicals from the complex mess of organic substances we ingest. Once the nutrients are separated from the other stuff, they diffuse from the digestive system into the blood.

Nutrients move along in the blood as it flows through the circulatory system. The signature feature of the circulatory system is an extensive network of blood vessels. A critically important fixture in the network of vessels is a heart, the durable muscle that pumps the blood to the lungs and then throughout the entire body.

The vessel network includes arteries, large vessels that divide and divide, branching out and getting smaller and smaller as they reach toward every cell in your body. When the arteries near their destinations, they divide one final time into tiny capillaries.
Capillaries are so numerous, small, and delicate that they come into contact with every cell in your body. The thin walls of the capillaries allow cell nutrients to pass from the bloodstream into the cells. The blood then continues on its way. The capillaries converge with one another into larger and larger vessels. These vessels—veins—carry the spent blood back to the heart.

The veins all converge on the right atrium. From there, blood enters the right ventricle, which pumps it to the lungs, where the circulatory system merges with the respiratory system. The blood releases its load of waste carbon dioxide into the lungs and picks up a fresh charge of oxygen. The refreshed blood collects in the left atrium and then moves into the left ventricle, which pumps it out through the aorta into the body.

Round and round the blood goes, pushing several thousand trillion red blood cells on their way. Red blood cells live about 4 months, and then they die and are replaced. Your body manufactures red blood cells at the rate of 3 million per second. That’s another subsystem that is tightly coordinated to ensure that the blood always has enough red blood cells to provide oxygen and remove carbon dioxide for all your trillions of cells on a continuous basis.

The circulatory system interacts with other systems to maintain the health of your cells. It works with the respiratory system to exchange gases, and with the digestive system to acquire nutrient chemicals that cells use for energy generation, growth, and structural repair. It also works with the hepatic (liver) system and renal (kidney) system. These two systems act as selective filters for removing specific classes of waste materials from the blood. These wastes are dumped into blood as it passes through the capillaries.

The nervous system is the complex electric system that coordinates and manages all the other systems in a human. It is managed by the central nervous system, which comprises the three parts of the brain (cerebrum, cerebellum, brain stem) and the spinal cord. The peripheral nervous system includes all the millions of receptor neurons that gather information from the environment, which is sent to the brain, and the network of motor neurons that convey action instructions from the brain to muscles and other tissues.

Everything that you do (behaviors) is managed by your nervous system. You can breathe and maintain a constant heart function even while sound asleep. You have neurons distributed throughout your body that monitor these and other functions, sending instructions to the proper places to keep your heart beating and your diaphragm pulling air into your lungs.
Life Science Content Sequence

This table shows some of the modules and courses in the FOSS content sequence for life science that emphasize and inform the complex systems strand. The elements for the Living Systems Module are expanded to show how they fit into the sequence.

<table>
<thead>
<tr>
<th>Module or course</th>
<th>Structure and Function</th>
<th>Complex Systems</th>
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<tbody>
<tr>
<td><strong>LIFE SCIENCE</strong></td>
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<tr>
<td><strong>Populations and Ecosystems</strong></td>
<td>- Plants, algae, and many microorganisms use energy from light to make sugars from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. - Animals obtain food from eating plants or eating other animals.</td>
<td>- An ecosystem is a web of interactions and relationships among the organisms and abiotic factors in an area. - Food webs are models that demonstrate how matter and energy are transferred among producers, consumers, and decomposers.</td>
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<td>(middle school)</td>
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<tr>
<td><strong>Human Systems Interactions</strong></td>
<td>- Aerobic cellular respiration is the process by which energy stored in food molecules is converted into usable energy for cells. - The human body is a system of interacting subsystems. - The nervous system is a human subsystem that functions to gather and synthesize information from the environment.</td>
<td>- The Sun provides energy that plants use to produce food molecules from carbon dioxide and water. The energy in food molecules is processed in the cells of most organisms to drive life processes.</td>
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<tr>
<td>(middle school)</td>
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<tr>
<td><strong>Diversity of Life</strong></td>
<td>- All living things are made of cells (unicellular or multicellular). Special structures within cells are responsible for various functions. - 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 micro levels).</td>
<td>- 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.</td>
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<td>(middle school)</td>
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<tr>
<td><strong>Living Systems</strong></td>
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<tr>
<td><strong>Environments</strong></td>
<td>- Plants and animals have structures that function in growth, survival, and reproduction. - Producers make their own food. - Animals obtain food from eating plants or eating other animals. - Animals detect, process, and use information about their environment to survive.</td>
<td>- Organisms have ranges of tolerance for environmental factors. - Organisms interact in feeding relationships in ecosystems (food chains and food webs). - Individuals of the same kind differ in their characteristics; differences may give individuals an advantage in reproducing.</td>
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<td>(grade 4)</td>
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<tr>
<td><strong>Structures of Life</strong></td>
<td>- A seed is a living organism. - Plants and animals have structures that function in growth, survival, and reproduction. - Reproduction is essential to the continued existence of every kind of organism. - Plants and animals grow and change and have predictable characteristics at different stages.</td>
<td>- Organisms are related in food chains. - Animals exhibit different kinds of behaviors. - Different organisms can live in different environments. - Changes in an organism's habitat can be beneficial and sometimes harmful. - Fossils provide evidence of organisms that lived in ancient environments.</td>
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<tr>
<td>(grade 3)</td>
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<tr>
<td><strong>Insects and Plants</strong></td>
<td>- Insects need air, food, water, and space, including shelter; different insects meet these needs in different ways. - Plants and insects have structures that function in growth, survival, and reproduction. - Organisms have diverse life cycles.</td>
<td>- Bees and other insects help some plants by moving pollen from flower to flower. - There is variation in traits within one kind of organism. - Many characteristics of organisms are inherited from parents; others result from interaction with the environment.</td>
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<td>(grade 2)</td>
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FOSS Conceptual Framework

<table>
<thead>
<tr>
<th>Structure and Function</th>
<th>Complex Systems</th>
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<tbody>
<tr>
<td>• Food provides animals with the materials they need for body repair and growth and</td>
<td>• Organisms obtain gases, water, and minerals from the environment and</td>
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<tr>
<td>is digested to release the energy they need to maintain body warmth and to move.</td>
<td>release waste matter back into the environment.</td>
</tr>
<tr>
<td>• Humans and other animals have systems made up of organs that are specialized for</td>
<td>• Matter cycles between air and soil, and among plants, animals, and microbes</td>
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<tr>
<td>particular body functions.</td>
<td>as these organisms live and die.</td>
</tr>
<tr>
<td>• Animals detect, process, and use information about their environment to survive.</td>
<td>• Organisms are related in food webs.</td>
</tr>
<tr>
<td></td>
<td>• Some organisms, such as fungi and bacteria, break down dead organisms,</td>
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<td></td>
<td>operating as decomposers.</td>
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<tr>
<td></td>
<td>• Animals exhibit instinctive behaviors and learned behaviors.</td>
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</table>

**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:

<table>
<thead>
<tr>
<th>Physical Sciences</th>
<th>Life Sciences</th>
<th>Earth Sciences</th>
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<tbody>
<tr>
<td>5-PS3-1</td>
<td>5-LS1-1</td>
<td>5-ESS2-1</td>
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<tr>
<td></td>
<td>5-LS2-1</td>
<td>5-ESS3-1</td>
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<tr>
<td></td>
<td>4-LS1-2</td>
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</tbody>
</table>

See pages 32–35 in this chapter for more details on the Grade 5 NGSS Performance Expectations.
CONNECTIONS TO NGSS BY INVESTIGATION

**Science and Engineering Practices**
- Asking questions
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Constructing explanations
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**Connections to Common Core State Standards—ELA**
- **RF 4:** Read with sufficient accuracy and fluency to support comprehension.
- **RI 1:** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences.
- **RI 2:** Determine main ideas of a text and explain how they are supported by key details; summarize the text.
- **RI 4:** Determine the meaning of general academic and domain-specific words and phrases in a text.
- **RI 7:** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
- **RI 8:** Explain how an author uses reasons and evidence to support particular points in a text.
- **RI 9:** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.
- **W 8:** Recall relevant information from experiences or gather relevant information; take notes.
- **SL 1:** Engage in collaborative discussions.
- **SL 2:** Summarize information presented visually.
- **L 4:** Determine or clarify the meaning of unknown and multiple-meaning words and phrases.
- **L 5:** Demonstrate understanding of word relationships.
Disciplinary Core Ideas

**PS3.D: Energy in chemical processes and everyday life**
- The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water). (5-PS3-1)

**LS1.C: Organization for matter and energy flow in organisms**
- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (5-PS3-1)

**LS2.A: Interdependent relationships in ecosystems**
- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)

**LS2.B: Cycles of matter and energy transfer in ecosystems**
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments. (5-LS2-1)

**ESS2.A: Earth materials and systems**
- Earth’s major systems are the geosphere, the hydrosphere, the atmosphere, and the biosphere. 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. (5-ESS2-1)

Crosscutting Concepts

- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Stability and change
Science and Engineering Practices

- 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

Connections to Common Core State Standards—ELA

- RI 1: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences.
- RI 2: Determine main ideas of a text and explain how they are supported by key details; summarize the text.
- RI 3: Explain the relationships or interactions between two or more concepts in a scientific text based on specific information in the text.
- RI 4: Determine the meaning of general academic and domain-specific words and phrases in a text.
- RI 8: Explain how an author uses reasons and evidence to support particular points in a text.
- RI 10: By the end of the year, read and comprehend informational science texts.
- W 6: Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others.
- W 8: Recall relevant information from experiences or gather relevant information; take notes.
- SL 1: Engage in collaborative discussions.
- SL 2: Summarize information presented visually.
- SL 4: Report on a topic or text or present an opinion, using appropriate facts and relevant information.
- SL 5: Include multimedia components and visual displays in presentations.
- SL 6: Adapt speech to a variety of contexts and tasks.
- L 4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases.
- L 5: Demonstrate understanding of word relationships.

Invite 2: Nutrient Systems

PS3.D: Energy in chemical processes and everyday life
• The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water).

LS1.C: Organization for matter and energy flow in organisms
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
• Plants acquire their material for growth chiefly from air and water.

LS2.B: Cycles of matter and energy transfer in ecosystems
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments.
### Disciplinary Core Ideas

**PS3.D: Energy in chemical processes and everyday life**
- The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water). (5-PS3-1)

**LS1.C: Organization for matter and energy flow in organisms**
- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (5-PS3-1)
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

**LS2.B: Cycles of matter and energy transfer in ecosystems**
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments. (5-LS2-1)

### Crosscutting Concepts

- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
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<td>RI 10: By the end of the year, read and comprehend informational science texts.</td>
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<td>W 5: Develop and strengthen writing.</td>
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<td>W 7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.</td>
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<td>W 8: Recall relevant information from experiences or gather relevant information; take notes.</td>
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**Inv. 3: Transport Systems**

**LS3.D: Energy in chemical processes and everyday life**
- The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water). (5-PS3-1)

**LS1.C: Organization for matter and energy flow in organisms**
- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (5-PS3-1)
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

**LS2.B: Cycles of matter and energy transfer in ecosystems**
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments. (5-LS2-1)
### Disciplinary Core Ideas

**PS3.D: Energy in chemical processes and everyday life**
- The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water). (5-PS3-1)

**LS1.C: Organization for matter and energy flow in organisms**
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**LS2.B: Cycles of matter and energy transfer in ecosystems**
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments. (5-LS2-1)

### Crosscutting Concepts

- Patterns
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
Science and Engineering Practices

- Asking questions
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations
- Obtaining, evaluating, and communicating information

Connections to Common Core State Standards—ELA

- **RF 4:** Read with sufficient accuracy and fluency to support comprehension.
- **RI 1:** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences.
- **RI 2:** Determine main ideas of a text and explain how they are supported by key details; summarize the text.
- **RI 3:** Explain the relationships or interactions between two or more concepts in a scientific text based on specific information in the text.
- **RI 9:** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.
- **W 5:** Develop and strengthen writing.
- **W 8:** Recall relevant information from experiences or gather relevant information; take notes.
- **SL 1:** Engage in collaborative discussions.
- **SL 2:** Summarize information presented visually.
- **SL 4:** Report on a topic or text or present an opinion, using appropriate facts and relevant information.
- **SL 5:** Include multimedia components and visual displays in presentations.
- **SL 6:** Adapt speech to a variety of contexts and tasks.
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PS3.D: Energy in chemical processes and everyday life
- The energy released from food was once energy from the Sun that was captured by plants in the chemical processes that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for matter and energy flow in organisms
- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (5-PS3-1)

LS1.D: Information processing
- Different sense receptors are specialized for particular kinds of information, which may then be processed by an animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)

LS2.B: Cycles of matter and energy transfer in ecosystems
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environments, and release waste, matter (gas, liquid, or solid) back into the environments. (5-LS2-1)

ESS2.A: Earth materials and systems
- Earth's major systems are the geosphere, the hydrosphere, the atmosphere, and the biosphere. 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. (5-ESS2-1)

ESS3.C: Human impacts on Earth systems
- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)
## RECOMMENDED FOSS NEXT GENERATION K–8
### SCOPE AND SEQUENCE

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*Half-length courses

### Grade Integrated Middle Grades

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