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 Structures of Life 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 39). 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.

The NGSS Performance Expectations bundled in this module include:

- Life Sciences
  - 3-LS1-1
  - 3-LS2-1
  - 3-LS3-1
  - 3-LS3-2
  - 3-LS4-1
  - 3-LS4-2
  - 3-LS4-3
  - 3-LS4-4
Disciplinary Core Ideas Addressed

The Structures of Life Module connects with the NRC Framework for the grades 3–5 grade band and the NGSS performance expectations for grade 3. The module focuses on core ideas for life 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.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. (By end of grade 2.) Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (By end of grade 5. Boundary: Stress at this grade level is on understanding the macroscale systems and their function, not microscopic processes.)]

- LS1.B: Growth and development of organisms
  How do organisms grow and develop? [Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles that include being born (sprouting in plants), growing, developing into adults, reproducing, and eventually dying.]

The following NGSS Grade 3 Performance Expectation for LS1 is derived from the Framework disciplinary core ideas above.

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

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.C: Ecosystem dynamics, functioning, and resilience
  What happens to ecosystems when the environment changes? [When
the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

• LS2.D: Social interactions and group behavior
  How do organisms interact in groups so as to benefit individuals? [Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (By the end of grade 2.) Groups can be collections of equal individuals, hierarchies with dominant members, small families, groups of single or mixed gender, or groups composed of individuals similar in age. Some groups are stable over long periods of time; others are fluid, with members moving in and out. Some groups assign specialized tasks to each member; in others, all members perform the same or a similar range of functions. (By the end of grade 5.)]

The following NGSS Grade 3 Performance Expectations for LS2 is derived from the Framework disciplinary core ideas above.

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

 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: Heredity: Inheritance and variation of traits
  How are the characteristics of one generation related to the previous generation? [Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.]

• LS3.B: Variation of traits
  Why do individuals of the same species vary in how they look, function, and behave? [Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information. In each kind of organism there is variation in the traits themselves, and different kinds of organisms may have different versions of the traits. The environment also affects the traits that an organism develops—differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently.]

REFERENCES


The following NGSS Grade 3 Performance Expectations for LS3 are derived from the Framework disciplinary core ideas above.

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

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

Framework core idea LS4: Biological evolution: Unity and diversity—How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms? How does biodiversity affect humans?

• LS4.A: Evidence of common ancestry and diversity
  What evidence shows that different species are related? [Some kinds of plants and animals that once lived on Earth (e.g., dinosaurs) are no longer found anywhere, although others now living (e.g., lizards) resemble them in some ways. (By the end of grade 2.) Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences. (By the end of grade 5.)]

• LS4.B Natural selection
  How does genetic variation among organisms affect survival and reproduction? [Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.]

• LS4.C: Adaptation
  How does the environment influence populations of organisms over multiple generations? [Changes in an organism’s habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.]
Introduction to Performance Expectations

- LS4.D: Biodiversity and humans

What is biodiversity, how do humans affect it, and how does it affect humans? [Scientists have identified and classified many plants and animals. Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. Humans, like all other organisms, obtain living and nonliving resources from their environment.]

The following NGSS Grade 3 Performance Expectations for LS4 are derived from the Framework disciplinary core ideas above.

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

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

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

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

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

2. **Developing and using models**
   - Develop models to describe phenomena.

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.

4. **Analyzing and interpreting data**
   - Represent data in tables and various graphical displays to reveal patterns that indicate relationships.
   - Analyze and interpret data to make sense of phenomena using logical reasoning.

5. **Using mathematics and computational thinking**
   - Organize simple data sets to reveal patterns that suggest relationships.

6. **Constructing explanations and designing solutions**
   - Use evidence (e.g., observations, patterns) to construct or support an explanation or design a solution to a problem.

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

8. **Obtaining, evaluating, and communicating information**
   - Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
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.

Cause and effect

• Cause-and-effect relationships are routinely identified and used to explain change.

Scale, proportion, and quantity

• Observable phenomena exist from very short to very long time periods.

Systems and system models

• A system can be described in terms of its components and their interactions.

Structure and function

• Substructures have shapes and parts that serve functions.

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. Scientific findings are based on recognizing patterns. Scientists use tools and technologies to make accurate measurements and observations.

• Scientific knowledge 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.

• Science is a human endeavor. Men and women from all cultures and backgrounds choose careers as scientists and engineers. Most scientists and engineers work in teams. Science affects everyday life. Creativity and imagination are important to science.
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 curriculum 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.

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.
Information about the FOSS learning progression appears in the **conceptual framework** (page 41), 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](https://www.nextgenscience.org/))*
The Variety of Life

Even in their most primitive and simplest forms, organisms are marvelous things. Some 1.4 million living species have been described and are known to exist on Earth. Of these, 750,000 are insects, 42,000 are vertebrates, and 250,000 are plants. The remainder include invertebrates, fungi, algae, and microorganisms. New species of organisms are being discovered every day. It has been estimated that there might be 5 to 30 million species on this planet. There might be as many as 10 million species of land-dwelling animals alone.

As we learn more and more about the universe, we continue to find the same chemicals everywhere we look. However, no convincing evidence has yet been found to indicate that life exists anywhere except on Earth. Is it possible that life is unique to our water planet? The life on Earth is a complex, exciting, beautiful, enigmatic subject for human inquiry, and everyone should have the opportunity to develop a deep and personal appreciation for the wonder of life.

What Is Life?

We all know what it is to be living, but a completely satisfactory definition of life is hard to find. We have, however, identified four characteristics common to all living organisms.

Living organisms metabolize. Life requires a steady stream of raw materials and energy. The raw materials originate in the earth and atmosphere, and the energy that drives the life process is usually solar energy, trapped in the form of carbohydrates manufactured by plants. Living organisms also generate a steady stream of by-products. All organisms require this constant maintenance and resupply activity.

Another characteristic of life is growth, a process of getting bigger and more complex. This implies that living things change. As organisms mature, they get bigger and develop new structures and functions.

Living organisms respond to stimuli. This characteristic allows them to react to things happening in their environment. Organisms can enhance their ability to continue life by avoiding unfavorable situations or seeking favorable situations. Response implies a high level of organization, as there must be sensory systems, message-transmission
CONCEPTUAL FRAMEWORK

Life Science, Focus on Structure and Function:
Structures of Life

**Structures and Function**

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

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

**Complex Systems**

**Concept A**  Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving factors.
- Organisms are related in food chains.
- Animals exhibit different kinds of behaviors. Being part of a social group may help individuals in that group survive.

**Concept B**  Ecosystems are dynamic and change over time.
- When the environment changes, some organisms and populations of organisms survive, thrive, and reproduce; others move, decline, or die.

**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.
- Sometimes the difference in characteristics between individuals of the same species provides advantage in surviving and reproducing.

**Concept D**  Biological evolution, the process by which all living things have evolved over many generations from common ancestors, explains both the unity and diversity of species.
- Different organisms can live in different environments; organisms have adaptations that allow them to survive in that environment.
- Changes in an organism’s habitat are sometimes beneficial to it and sometimes harmful.
- Fossils provide evidence of organisms that lived long ago and the nature of their environments.
systems, and mechanisms for response actions. Responses can be as primitive as recoiling from a hot object or as complex as a blush following an unexpected compliment.

The most incredible characteristic of life is that it reproduces itself. Organisms reproduce themselves, using myriad different strategies and mechanisms to accomplish the feat. Some simply break into two parts, each part able to live independently and function as a free individual. Others can reproduce by breaking a little piece loose to develop into a free-living individual. Still others reproduce by having a new host of individuals grow right out of the parent organism’s tissue. But far and away the most frequently seen method of reproduction requires that two individuals of a kind contribute to the creation of the new generation and in doing so, pass characteristics from parents to offspring. The contribution is the splendid substance DNA, the carrier of the message for the construction and operation of the new living organism, the phenomenon of inheritance. The message is embedded in a complex chemical code. The code dictates whether the new organism will be a salmon, a mosquito, a geranium, or a human. The code carries the very essence of life and orchestrates the fantastic diversity of form and function seen the planet over. And yet, there is some variation of traits in offspring.

How Life Goes On

Life goes in circles. Often, life starts as a tiny, vulnerable system called an embryo, usually in an egg or a seed. In the proper life-supporting environment the embryo will grow and become a free-living organism, able to sustain itself and go about its business independently. When the organism is mature, it develops the ability to provide the germs of life, ova and sperm, which, after mating or pollination, form the embryo for a new generation of organisms. This is called the life cycle, and it rolls on and on and on.

One thing that all living organisms have in common is the antithesis of life—death. The process of living taxes the organism to such a degree that even the most durable living things will one day fail and fall to pieces. Some single-celled organisms may live only a few hours, some insects a few days or weeks, small birds and mammals a few years, larger mammals and reptiles a few decades, and the longest-lived trees maybe 4,000 years or more. Ultimately all organic material in an organism will be disintegrated by the action of other organisms and physical forces, rendering the once-living organism into elemental parts ready for recycling in the process of life. Some of our atoms may have passed through this arena called life many times during the history of Earth.
Environment

Everything that surrounds an organism is part of its environment. This includes the land, water, air, energy, weather, other organisms, and everything else. The environment provides resources for organisms. But at the same time, the environment puts pressure on organisms. The balance between resources and pressures determines how successful an organism will be. Environments tend to be dynamic. An organism that thrives in an environment might be pushed to the limits of survival by a change in the environment. The rate of survival rests in the match between the environment and the structural and behavioral adaptations of an organism. Organisms with adaptations that promote survival in a specific environment will thrive; when the environment changes, those adaptations may no longer serve the organism, so it will decline or fail.

The big idea of organism adaptations and their functional relationship to environments is complex. It will take many years for the majesty and universal application of these ideas to form fully in students’ minds. This module starts students on the path, looking at structures, behaviors, and functions that help organisms survive.

Organisms and Biomes

Large regions of Earth can be defined by the physical environment and the indicator (predominant) species that live there. They are known as biomes, but students will know them as unique environments. This is fine. Examples of the characteristic environments include the ocean, desert, tundra, forest, wetlands, and grasslands. Each environment imposes a set of challenges for organisms. Coral reef organisms must be saltwater tolerant, heat tolerant, and adapted for holding onto or swimming around the coral structures. Desert organisms are as different from coral reef organisms as can be imagined. Desert organisms have adaptations for living with very little water, are heat adapted, and breathe air.

All the differences in organisms seen from one environment to the next present a picture of the diversity of life on Earth. Different environments encourage different kinds of organisms, and within environments, different kinds of organisms compete for resources needed for survival. FOSS Science Resources provides a snapshot of the diversity in each of several environments. Call on students to share other organisms they know of that live in each of the environments, and direct them to books and video resources that may extend this introduction to diversity.
When Environments Change

Fires scorch environments; earthquakes, volcanoes, huge storms, and floods destroy ecosystems; droughts deprive organisms of water; global climate change imposes radical pressures on all life. And there is evidence that infrequent, but significant, disruptions caused by extraterrestrial objects, like asteroids, can change life on Earth dramatically. Arguably, the most imposing changes to environments are those imposed by human beings. Environments are raided for their resources, spoiled by waste, or destroyed and replaced by constructions of value to people.

Some organisms benefit when the environment is disrupted. For example, range fires destroy shrubs and trees, but the grasses that reemerge from hearty roots thrive as a result of reduced competition and the redistribution of minerals in the ashes. The animals that depend on grass for food, such as insects, rodents, and bison, benefit from the success of the grasslands.

Many other organisms change the environments in which they live. Ants build anthills, termites build galleries in wood, ground squirrels and prairie dogs make complex underground tunnels, and woodpeckers drill chambers in trees. Two of nature’s master builders are the corals in tropical seas and the beaver in temperate fresh water. Tiny coral polyps secrete calcium carbonate cups in which they live. Over time, billions of the cups create massive solid structures that radically change the ocean environment. Organisms that require a structure on which to attach or creep can live on the reef. In the absence of the structure provided by the reef, they cannot survive. If something happens to the reef, the reef organisms have to relocate or perish.

A single beaver striking out on his own to establish a territory and start a family can dam a creek in a few weeks, impounding millions of gallons of water in a pond. What was a riparian, terrestrial habitat is transformed into an aquatic habitat. This change benefits the aquatic organisms in the neighborhood, such as fish, frogs, water insects, water lilies, and algae. But the trees, grasses, ground squirrels, worms, soil insects, and others will be displaced.

The Human Body

The human body may be the most complex and versatile object in the world. Dozens of integrated systems coordinate to perform the myriad operations that we require of it at all times. The last investigation in this module addresses the human skeletal system as an inherited characteristic, its articulations, and the muscles that power the body.
Humans take their shape from the basic framework called the skeleton, a system. It is made of a hard, resilient tissue called bone. To the novice, the skeletons of male and female appear the same, but the experienced observer can readily note the subtle differences, primarily in the size of the pelvic opening, that distinguish one from the other. There are about 206 individual bones in our skeletons. Each has evolved to perform a specific function, and together these bones allow us to do things that are distinctly human, such as stand, walk, and run on two legs; grip, lift, and rotate objects with our hands and arms; and tilt our heads up and down and pivot them from side to side. The human thumb, which works in opposition to the fingers, has provided us with dexterity without equal in the animal world. Some would argue that this one feature has promoted humans to their preeminent position on the pyramid of life.

Bone is living material and remains so even after it has stopped growing in the late teens or early twenties. Having an internal skeleton is a convenience because bones can grow continuously by enlarging and lengthening as the person matures. Compare this characteristic to a crayfish or an insect, which has an exoskeleton, or shell. In order to grow, it must discard its skeleton completely, expand rapidly, and regrow a new skeleton. It is a most precarious position to be in, without protection and structure, while the new skeleton hardens. The ability of the skeleton to grow and harden is key to human development. Humans can be born small and then grow over time. The newborn’s cranium (skull) plates grow together over time to form a continuous hard protective case, filling in the soft spot, or fontanel, in the process. The cranium plates will continue to calcify for 30 or 40 years, providing evidence of the age of a skull’s owner. The newborn has about 90 more bones than the adult, but a year or so later, it has the adult number of bones. As bones grow and harden, a number of them fuse together, essentially becoming one.

Hard, rigid bones are great for structure and protection (safeguarding the brain, eyes, ear, and organs in the chest), but not for mobility. To accommodate movement, the human skeleton is articulated, or jointed. Joints are where two bones come together, and there are several classifications of joints in the human skeletal system. Bones don’t move themselves; they must be pulled by a source of power. The power is provided by muscle. Every joint has a pairing of antagonistic flexors and extensors to ensure that joints can be moved powerfully in several directions.
### Life Science Content Sequence

This table shows the modules in the FOSS content sequence for Life Science from grades 1-8. The supporting elements in these modules (somewhat abbreviated) are listed. The elements for the Structures of Life 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>
</tr>
</thead>
<tbody>
<tr>
<td>Heredity and Adaptation (middle school)</td>
<td>• Structural similarities between ancient and modern organisms are one piece of evidence from which we can infer relatedness. • Genes on DNA code for proteins that are responsible for an organism's traits. Alleles are different versions of the same gene, one of each pair inherited from each parent.</td>
<td>• Natural selection is a process by which individuals best adapted to their environment tend to survive and pass their traits to subsequent generations. • Change in populations by means of natural selection is the basis for the theory of evolution.</td>
</tr>
<tr>
<td>Diversity of Life (middle school)</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 level). • Plants reproduce in a variety of ways, sometimes depending on animal behaviors and specialized features for reproduction.</td>
<td>• Adaptations are structures or behaviors of organisms that enhance their chances to survive and reproduce in their environment. • Sexual reproduction results in offspring with genetic variation, similar to parents but not identical. Asexual reproduction results in offspring with identical genetic information. • 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>
</tr>
<tr>
<td>Living Systems (grade 5)</td>
<td>• 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. • Reproduction is essential to the continued existence of every kind of organism. • Humans and other animals have systems specialized for particular body functions. • Animals detect, process, and use information about their environment to survive.</td>
<td>• 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.</td>
</tr>
<tr>
<td>Environments (grade 4)</td>
<td>• 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.</td>
<td>• 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). • Differences in individual characteristics may give individuals an advantage in surviving.</td>
</tr>
<tr>
<td>Structures of Life (grade 3)</td>
<td></td>
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</tr>
<tr>
<td>Insects and Plants (grade 2)</td>
<td>• Insects need air, food, water, and space, including shelter, and different insects meet these needs in different ways. • Plants depend on the environment for water and light to grow. • Reproduction is essential to the continued existence of every kind of organism.</td>
<td>• Bees and other insects help some plants by moving pollen from flower to flower. • Animals interact with plants, using them as food. They also assist in plant reproduction. • There are many different kinds of living things and they exist in different habitats on land and in water.</td>
</tr>
<tr>
<td>Plants and Animals (grade 1)</td>
<td>• Animals and plants have structures that serve functions in growth and survival. • Plants can produce new plants in many ways. • Adult animals can have offspring. Parents and the offspring engage in behavior that helps the offspring to survive.</td>
<td>• Plants and animals are very much, but not exactly, like their parents and resemble other organisms of the same kind.</td>
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</tbody>
</table>
**FOSS Conceptual Framework**

**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.

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**Structure and Function**
- A seed is a living organism, containing the embryo of a plant.
- Plants and animals have structures that function in growth, survival, and reproduction.
- 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.
- Behavior of animals is influenced by internal and external cues.
- Bones have several functions: support, protection, and movement.

**Complex Systems**
- Organisms are related in food chains.
- Animals exhibit different kinds of behaviors. Being part of a social group may help individuals in that group survive.
- Different organisms can live in different environments; organisms have adaptations that allow them to survive in that environment.
- Changes in an organism’s habitat are sometimes beneficial to it and sometimes harmful.
- Many characteristics of organisms are inherited from parents; other characteristics result from interaction with the environment.
- A skeleton is a system of interacting bones. The skeletons of humans and other mammals have many similarities.
- Differences in characteristics between individuals of the same species may give individuals an advantage in surviving.
- Fossils provide evidence of organisms that lived in ancient environments.

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The NGSS Performance Expectations addressed in this module include:

- **Life Sciences**
  - 3-LS1-1
  - 3-LS2-1
  - 3-LS3-1
  - 3-LS3-2
  - 3-LS4-1
  - 3-LS4-2
  - 3-LS4-3
  - 3-LS4-4

See pages 32–35 in this chapter for more details on the Grade 3 NGSS Performance Expectations.
## CONNECTIONS TO NGSS BY INVESTIGATION

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<td>SL 2: Determine the main idea from information presented orally.</td>
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<td>SL 3: Ask and answer questions, offering appropriate elaboration and detail.</td>
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<td>L 4: Determine the meaning of unknown words.</td>
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<td>L 6: Acquire and use domain-specific words.</td>
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</tbody>
</table>

**Inv. 1: Origin of Seeds**

- 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

**Inv. 2: Growing Further**

- 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 NGSS by Investigation

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<td><strong>LS1.B:</strong> Growth and development of organisms</td>
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<tr>
<td>• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)</td>
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</tr>
<tr>
<td><strong>LS3A:</strong> Inheritance of traits</td>
<td>Structure and function</td>
</tr>
<tr>
<td>• Many characteristics of organisms are inherited from their parents. (3-LS3-1)</td>
<td></td>
</tr>
<tr>
<td><strong>LS1.A:</strong> Structure and function</td>
<td>Other characteristics result from individuals' interactions with the environment. Many characteristics involve both inheritance and environment. (3-LS3-2)</td>
</tr>
<tr>
<td>• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (foundational)**</td>
<td></td>
</tr>
<tr>
<td><strong>LS1.B:</strong> Growth and development of organisms</td>
<td>Patterns</td>
</tr>
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## Science and Engineering Practices

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<td>Constructing explanations and designing solutions</td>
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<td>Engaging in argument from evidence</td>
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<th>Inv. 3: Meet the Crayfish</th>
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<tr>
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## Connections to Common Core State Standards—ELA

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<tr>
<td>RI 2: Determine the main idea of a text.</td>
<td>RI 2: Determine the main idea of a text; recount the key details.</td>
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<tr>
<td>RI 3: Describe the relationship between scientific ideas, using cause and effect.</td>
<td>RI 3: Describe the relationship between scientific ideas.</td>
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<tr>
<td>RI 4: Determine the meaning of domain-specific words and phrases in a text.</td>
<td>RI 5: Use text features to locate information.</td>
</tr>
<tr>
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<td>RI 6: Distinguish your own point of view from that of the author of a text.</td>
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<tr>
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<td>RI 7: Use information gained from illustrations and words to demonstrate understanding of the text.</td>
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<tr>
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<td>RI 8: Describe the logical connection in a text (cause and effect).</td>
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<td>RI 9: Compare and contrast two texts on the same topic.</td>
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<tr>
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<td>RI 10: Read and comprehend informational text.</td>
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<td>RF 3: Apply word analysis skills in decoding words.</td>
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<td>W 1: Write opinion pieces.</td>
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<tr>
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<td>W 7: Conduct short research projects.</td>
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<td>W 8: Recall from experience and gather information from print; take brief notes and sort evidence into provided categories.</td>
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<td>SL 2: Determine the main ideas of information presented orally.</td>
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<td>L 4: Determine the meaning of unknown words.</td>
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<tr>
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<td>L 4c: Use a known root word as a clue to the meaning of an unknown word.</td>
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<td>L 6: Use domain-specific words.</td>
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## Disciplinary Core Ideas

### LS2.C: Ecosystem dynamics, functioning, and resilience
- When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (3-LS4-4)

### LS2.D: Social interactions and group behavior
- Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (3-LS2-1)

### LS3.A: Inheritance of traits
- Many characteristics of organisms are inherited from their parents. (3-LS3-1)
- Other characteristics result from individuals’ interactions with the environment. Many characteristics involve both inheritance and environment. (3-LS3-2)

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

### LS4.C: Adaptation
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

### LS4.B: Natural selection
- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)

### LS4.A: Evidence of common ancestry and diversity
- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)

## Crosscutting Concepts
- Patterns
- Cause and effect
- Systems and system models
- Structure and function
- Stability and change

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**Structures of Life Module—FOSS Next Generation**

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# RECOMMENDED FOSS NEXT GENERATION K–8

## SCOPE AND SEQUENCE

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