INTRODUCTION

The study of the structures and behaviors of organisms and the relationships between one organism and its environment builds knowledge of all organisms. With this knowledge comes an awareness of limits. Such knowledge is important because humans can change environments.

The Environments Module has four investigations that focus on the anchor phenomenon that animals and plants interact with their environment and with each other. The driving question for the module deals with structure and function—How do the structures of an organism allow it to survive in its environment? Students design investigations to study preferred environments, range of tolerance, and optimum conditions for growth and survival of specific organisms, both terrestrial and aquatic. Students conduct controlled experiments by incrementally changing specific environmental conditions to determine the range of tolerance for early growth of seeds and hatching of brine shrimp, and use these data to develop and use models to understand the impact of changes to the environment. Students explore how animals use their sense of hearing and develop models for detecting and interpreting sound. They graph and interpret data from multiple trials of experiments and build explanations from evidence. Students gain experiences that will contribute to the understanding of crosscutting concepts of patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change.
## Module Summary

### Inv. 1: Environmental Factors

Students observe terrestrial organisms as a phenomenon—mealworms and isopods in the classroom and leaf-litter critters on the schoolyard. They set up a mealworm environment at two temperatures and observe the life cycle over time. Students investigate how isopods respond to environmental factors such as water and light, and design an isopod environment. Students investigate small animals that live in leaf litter and study their structures.

Students observe and describe the living and nonliving components (biotic and abiotic factors) in terrestrial environments and are introduced to the diverse environments of deserts and rain forests. Students organize information they gather about organisms through first-hand investigations, readings, and videos to understand how structures function to meet the needs of organisms in terrestrial environments.

### Inv. 2: Ecosystems

Students investigate the phenomenon of life in water and how organisms’ needs are the same and different from life on land. Students set up a freshwater aquarium with different kinds of fish, plants, and other organisms. They monitor the environmental factors in the system and look for feeding interactions among the populations. They learn about the role of producers, consumers, and decomposers in food chains and food webs in terrestrial and aquatic systems. Through an outdoor simulation, students learn about how food affects a population’s home range.

Students compare the structures of land and water organisms and the ways structures function to meet the organisms’ needs. Students gather and compare information on how different animals obtain one basic need—oxygen.

Students explore how animals receive information from their environment through their sensory system and use the information to guide their actions. Through simulations and research, students model how animals use their sense of hearing.

### Guiding and Focus Questions for Phenomena

**How do the structures of terrestrial organisms function to support the survival of the organisms in that environment?**

**How do mealworm structures and behaviors help them grow and survive?**

**What moisture conditions do isopods prefer?**

**What light conditions do isopods prefer?**

**What are the characteristics of animals living in the leaf-litter environment?**

**How are the structures of aquatic organisms similar and different from land animals?**

**How do organisms sense and interact with their environment?**

**What are the environmental factors in an aquatic system?**

**What are the roles of organisms in a food chain?**

**How does food affect a population in its home range?**

**How do animals use their sense of hearing?**
<table>
<thead>
<tr>
<th>Content Related to Disciplinary Core Ideas</th>
<th>Reading/Technology</th>
<th>Assessment</th>
</tr>
</thead>
</table>
| • An environment is everything living and nonliving that surrounds and influences an organism. | **Science Resources Book**  
“Two Terrestrial Environments”  
“Darkling Beetles”  
“Setting Up a Terrarium”  
“Isopods”  
“Amazon Rain Forest Journal” | **Embedded Assessment**  
Science notebook entry  
Performance assessment  
Response sheet |
| • A relationship exists between environmental factors and how well organisms grow. | **Videos**  
**Deserts**  
**Animals of the Rain Forest Animal Needs** | **Benchmark Assessment**  
Survey  
**Investigation 1 I-Check** |
| • Animals have structures and behaviors that function to support survival, growth, and reproduction. | **Science Resources Book**  
“Freshwater Environments”  
“What Is an Ecosystem?”  
“Food Chains and Food Webs”  
“Human Activities and Aquatic Ecosystems”  
“Comparing Aquatic and Terrestrial Ecosystems”  
“Animal Sensory Sysems”  
“Saving Murrelets through Mimicry” | **NGSS Performance Expectations**  
4-LS1-1  
4-LS1-2 |
| • Every organism has a set of preferred environmental conditions. | **Videos**  
Animal Language and Communication  
All about the Senses | **Online Activities**  
“Virtual Aquarium”  
“Virtual Terrarium” |
| • Aquatic environments include living and nonliving factors (water and temperature). | **Online Activities**  
“Amazon Rain Forest Journal”  
“Comparing Aquatic and Terrestrial Ecosystems” |
| • Organisms that live in water have structures that function to meet their needs. Terrestrial and aquatic organisms have similar needs; while their structures are different, the functions are similar. | **Online Activities**  
“Amazon Rain Forest Journal” |
| • An ecosystem is the interactions of organisms with one another and with the nonliving environment. | **Online Activities**  
“Amazon Rain Forest Journal” |
| • Organisms have structures that allow them to interact in feeding relationships in ecosystems (food chains and food webs). | **Online Activities**  
“Amazon Rain Forest Journal” |
| • Producers make their own food, which is also used by animals (consumers); decomposers eat dead plant and animal materials and recycle the nutrients in the system; organisms may compete for resources in an ecosystem. | **Online Activities**  
“Amazon Rain Forest Journal” |
| • Decomposers recycle the nutrients in the ecosystem. | **Online Activities**  
“Amazon Rain Forest Journal” |
| • Animals communicate to warn others of danger, scare predators away, or locate others of their kind. Animals detect and interpret sounds, and act on them. | **Online Activities**  
“Amazon Rain Forest Journal” |
**Module Summary**

**Inv. 3: Brine Shrimp Hatching**

Students are presented with an ecological problem related to water level fluctuations in an important migratory bird environment—Mono Lake. Brine shrimp are a critical factor in the food web of the lake ecosystem and the salinity of the lake may change due to human activities. Students conduct a controlled experiment to determine which of four salt concentrations allow brine shrimp eggs to hatch. Students determine range of tolerance and optimum conditions for brine shrimp hatching. They use the data to make a recommendation about managing the environment. Students, through an outdoor simulation, look at variation in a population, and consider how variation among individuals contributes to survival of a population.

**Inv. 4: Range of Tolerance**

Students return to the desert and rain forest environments they studied in Investigation 1 and engage with the phenomenon that different plants survive in each environment. Students set up and monitor controlled experiments to determine the range of tolerance of water for germination of four kinds of seeds: corn, pea, barley, and radish. In a second experiment, students test the effect of salinity on these seeds. Students study local plants by mapping schoolyard plants and relate plant distribution to environmental factors. Students look at plant adaptations that allow the organisms to thrive in dry desert environments and wet tropical environments.

**Guiding and Focus Questions for Phenomena**

**Inv. 3: Brine Shrimp Hatching**

- *How is optimum environment related to organism and population survival?*
- *How can we find out if salinity affects brine shrimp hatching?*
- *How does salinity affect the hatching of brine shrimp eggs?*
- *Does changing the salt environment allow the brine shrimp eggs to hatch?*
- *What are some benefits of having variation within a population?*

**Inv. 4: Range of Tolerance**

- *What environmental conditions result in the best growth and survival of different plants?*
- *How do the structures of plants function to support the survival of the organisms in a particular environment?*
- *How much water is needed for early growth of different kinds of plants?*
- *What is the salt tolerance of several common farm crops?*
- *How does mapping the plants in the schoolyard help us to investigate environmental factors?*
- *What are some examples of plant adaptations?*
## Module Matrix

### Content Related to Disciplinary Core Ideas

- Organisms have ranges of tolerance for environmental factors; there are optimum conditions that produce maximum growth.
- Brine shrimp eggs can hatch in a range of salt concentrations, but more hatch in environments with optimum salt concentration.
- When environments change, some organisms survive and reproduce; others move; some die.
- Individuals of the same kind differ in their characteristics; differences may give individuals an advantage in surviving and reproducing.
- Human activities impact environments. Communities are using science to help protect Earth's resources and environments.

### Reading/Technology

- **Science Resources Book**
  - “Brine Shrimp”
  - “The Mono Lake Story”
  - “What Happens When Ecosystems Change?”
  - “The Shrimp Club”
  - “Variation and Selection”

- **Online Activities**
  - “Food Webs”
  - “Virtual Investigation: Trout Range of Tolerance”

### Assessment

- **Embedded Assessment**
  - Performance assessment
  - Science notebook entry
  - Response sheet

- **Benchmark Assessment**
  - Investigation 3 I-Check

- **NGSS Performance Expectations**
  - 4-LS1-1
  - 3-LS4-2
  - 3-LS4-4
  - 5-ESS3-1

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### Additional Content

- Organisms have ranges of tolerance for environmental factors; there are optimum conditions that produce maximum growth.
- Adaptations are structures and behaviors of an organism that help it survive and reproduce.
- A relationship exists between environmental factors and how well organisms grow.

- **Science Resources Book**
  - “Environmental Scientists”
  - “Range of Tolerance”
  - “How Organisms Depend on One Another”
  - “Animals from the Past” (optional)

- **Video**
  - All about Plant Adaptations

- **Online Activity**
  - “Tutorial: Analyzing Environmental Experiments”

- **Embedded Assessment**
  - Performance assessment
  - Response sheet

- **Benchmark Assessment**
  - Posttest

- **NGSS Performance Expectations**
  - 4-LS1-1
  - 3-LS4-4
FOSS COMPONENTS

Teacher Toolkit for Each Module

The FOSS Next Generation Program has three modules for grade 4—Energy, Environments, and Soils, Rocks, and Landforms.

Each module comes with a Teacher Toolkit for that module. The Teacher Toolkit is the most important part of the FOSS Program. It is here that all the wisdom and experience contributed by hundreds of educators has been assembled. Everything we know about the content of the module, how to teach the subject, and the resources that will assist the effort are presented here. Each toolkit has three parts.

Investigations Guide. This spiral-bound document contains these chapters.

- Overview
- Framework and NGSS
- Materials
- Technology
- Investigations (four in this module)
- Assessment

Investigation 2: Ecosystems

13. Introduce new ranges for year 5. All students write their predicted deer ranges in their notebooks. Keep track of the highest and lowest range for deer. Have students compare their predicted range with the range in their group. Keep track of the highest and lowest range for deer.

14. Simulate year 5. Begin year 5 by double the surviving deer from year 4 and adding any deer that moved out of their home range the previous year. Now, do the same for the surviving deer from the previous year. Add any deer that moved into the new home range. Keep track of the number of deer in each range. Have students compare the predicted range with the actual range.

15. Return to class. Have students collect all of the food markers, bags, and any other materials. Then head back to the classroom.

16. Organize the data. Display the data on the chart paper with the recorded data and have students fill in the data in their table at the top of notebook sheet 11. Have students glue the sheet into their notebooks.

17. Have a sense-making discussion. Tell students, “Our deer population was greatly impacted by the amount of available food. They might have moved in or out of the feeding area, our deer might have been killed by predators, and the carrying capacity for deer is only the greatest number of deer the food plants can support for a long period of time. The carrying capacity can be changed by the food plants or in some cases, damaging the food source.

Ask:

➤ How many deer move into new feeding areas? Why? What factors could lead to a decrease in the food plants?

➤ Can our sense-making activity be used to predict the carrying capacity for deer? How would we do that?

➤ In our sense-making activity, which factors influenced the carrying capacity of the deer? What factors could influence the carrying capacity of other organisms, such as mealworms or fish?

➤ What happens to the deer population when they exceed the carrying capacity? Do the populations change in a way that helps them survive? How does this activity help you think about new food sources?

➤ What happens to the deer population when the plants don’t reach the carrying capacity? (Population remains stable.)

➤ What does this tell students about a potential problem that might happen to populations in other organisms, such as mealworms or fish? What actions can communities or individuals take to try to help maintain healthy populations of deer?

18. Return vocabulary. Extend key vocabulary introduced in this part, and refer to these words on the word wall.

19. Answer the focus question. These questions appear on the final page in this module.

➤ How does the climate affect the population of deer in your area?

➤ How does the climate affect the population of other organisms, such as mealworms or fish?

Have students understand and communicate the causes and effects of changes in food source and population size and their environments.

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Investigations Guide. This spiral-bound document contains these chapters.

- Overview
- Framework and NGSS
- Materials
- Technology
- Investigations (four in this module)
- Assessment
**FOSS Science Resources book.** One copy of the student book of readings is included in the *Teacher Toolkit.*

**Teacher Resources.** These chapters can be downloaded from FOSSweb and are also in the bound *Teacher Resources* book.

- FOSS Program Goals
- Planning Guide—Grade 4
- Science and Engineering Practices—Grade 4
- Crosscutting Concepts—Grade 4
- Sense-Making Discussions for Three-Dimensional Learning—Grade 4
- Access and Equity
- Science Notebooks in Grades 3–5
- Science-Centered Language Development
- FOSS and Common Core ELA—Grade 4
- FOSS and Common Core Math—Grade 4
- Taking FOSS Outdoors
- Science Notebook Masters
- Teacher Masters
- Assessment Masters

### Equipment Kit for Each Module or Grade Level

The FOSS Program provides the materials needed for the investigations, in sturdy, front-opening drawer-and-sleeve cabinets. Inside, you will find high-quality materials packaged for a class of 32 students. Consumable materials are supplied for three uses before you need to resupply. Teachers may be asked to supply small quantities of common classroom materials.

Delta Education can assist you with materials management strategies for schools, districts, and regional consortia.
FOSS Science Resources Books

*FOSS Science Resources: Environments* is a book of original readings developed to accompany this module. The readings are referred to as articles in *Investigations Guide*. Students read the articles in the book as they progress through the module. The articles cover specific concepts, usually after the concepts have been introduced in the active investigation.

The articles in *FOSS Science Resources* and the discussion questions provided in *Investigations Guide* help students make connections to the science concepts introduced and explored during the active investigations. Concept development is most effective when students are allowed to experience organisms, objects, and phenomena firsthand before engaging the concepts in text. The text and illustrations help make connections between what students experience concretely and the ideas that explain their observations.

Rattlesnakes are members of a family of snakes called pitvipers. Pitvipers have a sensory receptor on their face that detects heat. With this structure, rattlesnakes locate prey such as mice and rats. These small animals give off body heat. The snakes can sense the heat. Put a blindfold on a rattlesnake, and it can still sense and capture prey. A rattlesnake can find a meal even in complete darkness.

American pitvipers include 16 kinds of rattlesnake, the copperhead, and the cottonmouth. Other kinds of pitvipers live in Central and South America.

Animal Sensory Systems

How do you get the information you need to survive in your environment? You get information through your five senses. You use your sense of hearing, touch or feel, sight, smell, and taste. Your senses make you aware of things far away through sight and hearing. And they help you sense things that are close, through smell and touch or feel. The sense of touch or feel has many dimensions. Through touch, you can detect many kinds of input to your skin. Human touch can detect pressure, heat, cold, pain, tickle, itch, and textures such as smooth, rough, slippery, and sharp.

Sensory receptors on your body get information from the environment. Some of this information travels to your brain, which processes it. Then it sends information to your body to take action. Animals use these same senses, or variations of these senses, to get the information they need to survive in their environments. Some animals use senses that are beyond the reach of humans.
Technology

The FOSS website opens new horizons for educators, students, and families, in the classroom or at home. Each module has digital resources for students and families—interactive simulations, virtual investigations, and online activities. For teachers, FOSSweb provides online teacher Investigations Guides; grade-level planning guides (with connections to ELA and math); materials management strategies; science teaching and professional development tools; contact information for the FOSS Program developers; and technical support. In addition, FOSSweb provides digital access to PDF versions of the Teacher Resources component of the Teacher Toolkit, digital-only instructional resources that supplement the print and kit materials, and access to FOSSmap, the online assessment and reporting system for grades 3–8.

With an educator account, you can customize your homepage, set up easy access to the digital components of the modules you teach, and create class pages for your students with access to tutorials and online assessments.

Ongoing Professional Learning

The Lawrence Hall of Science and Delta Education strive to develop long-term partnerships with districts and teachers through thoughtful planning, effective implementation, and ongoing teacher support. FOSS has a strong network of consultants who have rich and experienced backgrounds in diverse educational settings using FOSS.

NOTE

To access all the teacher resources and to set up customized pages for using FOSS, log in to FOSSweb through an educator account. See the Technology chapter in this guide for more specifics.

NOTE

Look for professional development opportunities and online teaching resources on www.FOSSweb.com.
FOSS INSTRUCTIONAL DESIGN

FOSS is designed around active investigation that provides engagement with science concepts and science and engineering practices. Surrounding and supporting those firsthand investigations are a wide range of experiences that help build student understanding of core science concepts and deepen scientific habits of mind.

The Elements of the FOSS Instructional Design

- Using Formative Assessment
- Integrating Science Notebooks
- Taking FOSS Outdoors
- Engaging in Science–Centered Language Development
- Accessing Technology
- Reading FOSS Science Resources Books
Each FOSS investigation follows a similar design to provide multiple exposures to science concepts. The design includes these pedagogies.

- Active investigation in collaborative groups: firsthand experiences with phenomena in the natural and designed worlds
- Recording in science notebooks to answer a focus question dealing with the scientific phenomenon under investigation
- Reading informational text in FOSS Science Resources books
- Online activities to acquire data or information or to elaborate and extend the investigation
- Outdoor experiences to collect data from the local environment or to apply knowledge
- Assessment to monitor progress and inform student learning

In practice, these components are seamlessly integrated into a curriculum designed to maximize every student’s opportunity to learn.

A learning cycle employs an instructional model based on a constructivist perspective that calls on students to be actively involved in their own learning. The model systematically describes both teacher and learner behaviors in a coherent approach to science instruction.

A popular model describes a sequence of five phases of intellectual involvement known as the 5Es: engage, explore, explain, elaborate, and evaluate. The body of foundational knowledge that informs contemporary learning-cycle thinking has been incorporated seamlessly and invisibly into the FOSS curriculum design.

Engagement with real-world phenomena is at the heart of FOSS. In every part of every investigation, the investigative phenomenon is referenced implicitly in the focus question that guides instruction and frames the intellectual work. The focus question is a prominent part of each lesson and is called out for the teacher and student. The investigation Background for the Teacher section is organized by focus question—the teacher has the opportunity to read and reflect on the phenomenon in each part in preparing for the lesson. Students record the focus question in their science notebooks, and after exploring the phenomenon thoroughly, explain their thinking in words and drawings.

In science, a phenomenon is a natural occurrence, circumstance, or structure that is perceptible by the senses—an observable reality. Scientific phenomena are not necessarily phenomenal (although they may be)—most of the time they are pretty mundane and well within the everyday experience. What FOSS does to enact an effective engagement with the NGSS is thoughtful selection of scientific phenomena for students to investigate.

NOTE
The anchor phenomena establish the storyline for the module. The investigative phenomena guide each investigation part. Related examples of everyday phenomena are incorporated into the readings, videos, discussions, formative assessments, outdoor experiences, and extensions.
ENVIRONMENTS — Overview

Active Investigation

Active investigation is a master pedagogy. Embedded within active learning are a number of pedagogical elements and practices that keep active investigation vigorous and productive. The enterprise of active investigation includes

- context: sharing prior knowledge, questioning, and planning;
- activity: doing and observing;
- data management: recording, organizing, and processing;
- analysis: discussing and writing explanations.

**Context: sharing, questioning, and planning.** Active investigation requires focus. The context of an inquiry can be established with a focus question about a phenomenon or challenge from you or, in some cases, from students. (How can we find out if salinity affects the hatching of brine shrimp eggs?) At other times, students are asked to plan a method for investigation. This might start with a teacher demonstration or presentation. Then you challenge students to plan an investigation, such as to find out how much water is needed for early growth of plants. In either case, the field available for thought and interaction is limited. This clarification of context and purpose results in a more productive investigation.

**Activity: doing and observing.** In the practice of science, scientists put things together and take things apart, observe systems and interactions, and conduct experiments. This is the core of science—active, firsthand experience with objects, organisms, materials, and systems in the natural world. In FOSS, students engage in the same processes. Students often conduct investigations in collaborative groups of four, with each student taking a role to contribute to the effort.

The active investigations in FOSS are cohesive, and build on each other to lead students to a comprehensive understanding of concepts. Through investigations and readings, students gather meaningful data.

**Data management: recording, organizing, and processing.** Data accrue from observation, both direct (through the senses) and indirect (mediated by instrumentation). Data are the raw material from which scientific knowledge and meaning are synthesized. During and after work with materials, students record data in their science notebooks. Data recording is the first of several kinds of student writing.

Students then organize data so they will be easier to think about. Tables allow efficient comparison. Organizing data in a sequence (time) or series (size) can reveal patterns. Students process some data into graphs, providing visual display of numerical data. They also organize data and process them in the science notebook.
Analysis: discussing and writing explanations. The most important part of an active investigation is extracting its meaning. This constructive process involves logic, discourse, and prior knowledge. Students share their explanations for phenomena, using evidence generated during the investigation to support their ideas. They conclude the active investigation by writing a summary of their learning as well as questions raised during the activity in their science notebooks.

Science Notebooks

Research and best practice have led FOSS to place more emphasis on the student science notebook. Keeping a notebook helps students organize their observations and data, process their data, and maintain a record of their learning for future reference. The process of writing about their science experiences and communicating their thinking is a powerful learning device for students. The science-notebook entries stand as credible and useful expressions of learning. The artifacts in the notebooks form one of the core exhibitions of the assessment system.

You will find the duplication masters for grades 1–5 presented in notebook format. They are reduced in size (two copies to a standard sheet) for placement (glue or tape) into a bound composition book. Full-sized masters for grades 3–5 that can be filled in electronically and are suitable for display are available on FOSSweb. Student work is entered partly in spaces provided on the notebook sheets and partly on adjacent blank sheets in the composition book. Look to the chapter in Teacher Resources called Science Notebooks in Grades 3–5 for more details on how to use notebooks with FOSS.
Reading in FOSS Science Resources

The FOSS Science Resources books, available in print and interactive eBooks, are primarily devoted to expository articles and biographical sketches. FOSS suggests that the reading be completed during language-arts time to connect to the Common Core State Standards for ELA. When language-arts skills and methods are embedded in content material that relates to the authentic experience students have had during the FOSS active learning sessions, students are interested, and they get more meaning from the text material.

Recommended strategies to engage students in reading, writing, speaking, and listening around the articles in the FOSS Science Resources books are included in the flow of Guiding the Investigation. In addition, a library of resources is described in the Science-Centered Language Development chapter in Teacher Resources.

The FOSS and the Common Core ELA—Grade 4 chapter in Teacher Resources shows how FOSS provides opportunities to develop and exercise the Common Core ELA practices through science. A detailed table identifies these opportunities in the three FOSS modules for the fourth grade.

Engaging in Online Activities through FOSSweb

The simulations and online activities on FOSSweb are designed to support students’ learning at specific times during instruction. Digital resources include streaming videos that can be viewed by the class or small groups. Resources may also include virtual investigations and tutorials that students can use to review the active investigations and to support students who need more time with the concepts or who have been absent and missed the active investigations.

The Technology chapter provides details about the online activities for students and the tools and resources for teachers to support and enrich instruction. There are many ways for students to engage with the digital resources—in class as individuals, in small groups, or as a whole class, and at home with family and friends.
Assessing Progress

The FOSS assessment system includes both formative and summative assessments. Formative assessment monitors learning during the process of instruction. It measures progress, provides information about learning, and is predominantly diagnostic. Summative assessment looks at the learning after instruction is completed, and it measures achievement.

Formative assessment in FOSS, called embedded assessment, is an integral part of instruction, and occurs on a daily basis. You observe action during class in a performance assessment or review notebooks after class. Performance assessments look at students’ engagement in science and engineering practices or their recognition of crosscutting concepts, and are indicated with the second assessment icon. Embedded assessment provides continuous monitoring of students’ learning and helps you make decisions about whether to review, extend, or move on to the next idea to be covered.

The embedded assessments are based on authentic work produced by students during the course of participating in the FOSS activities. Students do their science, and you observe the actions and look at their notebook entries. Bullet points in the Guiding the Investigation tell you specifically what students should know and be able to communicate.

Benchmark assessments include the Survey, I-Checks, Posttest, and interim assessments. The Survey is given before instruction begins. It provides information about students’ prior knowledge. I-Checks are actually hybrid tools: they can provide summative information about students’ achievement, but more importantly, they can be used formatively as well to provide diagnostic information. Reviewing specific items on an I-Check with the class provides additional opportunities for students to clarify their thinking. The Posttest is a summative assessment given after instruction is complete.

Interim assessments give students practice with items specifically designed to measure three-dimensional learning described by NGSS performance expectations. Interim assessment tasks generally begin with a scenario, and ask students to apply practices and crosscutting concepts as well as disciplinary core ideas to respond to the item. Interim assessment tasks can be administered during a module, at the end of the module, or as an end-of-year grade-level assessment.

All benchmark items are carefully designed to be valid, reliable, and accessible to all students. They focus on assessment for learning, and when accompanied by thoughtful self-assessment activities and feedback, contribute to the development of a growth mindset.
Taking FOSS Outdoors

FOSS throws open the classroom door and proclaims the entire school campus to be the science classroom. The true value of science knowledge is its usefulness in the real world and not just in the classroom. Taking regular excursions into the immediate outdoor environment has many benefits. First of all, it provides opportunities for students to apply things they learned in the classroom to novel situations. When students are able to transfer knowledge of scientific principles to natural systems, they experience a sense of accomplishment.

In addition to transfer and application, students can learn things outdoors that they are not able to learn indoors. The most important object of inquiry outdoors is the outdoors itself. To today’s youth, the outdoors is something to pass through as quickly as possible to get to the next human-managed place. For many, engagement with the outdoors and natural systems must be intentional, at least at first. With repeated visits to familiar outdoor learning environments, students may first develop comfort in the outdoors, and then a desire to embrace and understand natural systems.

The last part of most investigations is an outdoor experience. Venturing out will require courage the first time or two you mount an outdoor expedition. It will confuse students as they struggle to find the right behavior that is a compromise between classroom rigor and diligence and the freedom of recreation. With persistence, you will reap rewards. You will be pleased to see students’ comportment develop into proper field-study habits, and you might be amazed by the transformation of students with behavior issues in the classroom who become your insightful observers and leaders in the schoolyard environment.

Teaching outdoors is the same as teaching indoors—except for the space. You need to manage the same four core elements of classroom teaching: time, space, materials, and students. Because of the different space, new management procedures are required. Students can get farther away. Materials have to be transported. The space has to be defined and honored. Time has to be budgeted for getting to, moving around in, and returning from the outdoor study site. All these and more issues and solutions are discussed in the Taking FOSS Outdoors chapter in Teacher Resources.
Science-Centered Language Development and Common Core State Standards for ELA

The FOSS active investigations, science notebooks, FOSS Science Resources articles, and formative assessments provide rich contexts in which students develop and exercise thinking and communication. These elements are essential for effective instruction in both science and language arts—students experience the natural world in real and authentic ways and use language to inquire, process information, and communicate their thinking about scientific phenomena. FOSS refers to this development of language process and skills within the context of science as science-centered language development.

In the Science-Centered Language Development chapter in Teacher Resources, we explore the intersection of science and language and the implications for effective science teaching and language development. Language plays two crucial roles in science learning: (1) it facilitates the communication of conceptual and procedural knowledge, questions, and propositions, and (2) it mediates thinking—a process necessary for understanding. For students, language development is intimately involved in their learning about the natural world. Science provides a real and engaging context for developing literacy and language-arts skills identified in contemporary standards for English language arts.

The most effective integration depends on the type of investigation, the experience of students, the language skills and needs of students, and the language objectives that you deem important at the time. The Science-Centered Language Development chapter is a library of resources and strategies for you to use. The chapter describes how literacy strategies are integrated purposefully into the FOSS investigations, gives suggestions for additional literacy strategies that both enhance students’ learning in science and develop or exercise English-language literacy skills, and develops science vocabulary with scaffolding strategies for supporting all learners. We identify effective practices in language-arts instruction that support science learning and examine how learning science content and engaging in science and engineering practices support language development.

Specific methods to make connections to the Common Core State Standards for English Language Arts are included in the flow of Guiding the Investigation. These recommended methods are linked to the CCSS ELA through ELA Connection notes. In addition, the FOSS and the Common Core ELA chapter in Teacher Resources summarizes all of the connections to each standard at the given grade level.
Learning from Experience

The roots of FOSS extend back to the mid-1970s and the Science Activities for the Visually Impaired and Science Enrichment for Learners with Physical Handicaps projects (SAVI/SELPH Program). As this special-education science program expanded into fully integrated (mainstreamed) settings in the 1980s, hands-on science proved to be a powerful medium for bringing all students together. The subject matter is universally interesting, and the joy and satisfaction of discovery are shared by everyone. Active science by itself provides part of the solution to full inclusion and provides many opportunities at the same time for differentiated instruction.

Many years later, FOSS began a collaboration with educators and researchers at the Center for Applied Special Technology (CAST), where principles of Universal Design for Learning (UDL) had been developed and applied. FOSS continues to learn from our colleagues about ways to use new media and technologies to improve instruction. Here are the UDL guiding principles.

**Principle 1.** Provide multiple means of representation. Give learners various ways to acquire information and demonstrate knowledge.

**Principle 2.** Provide multiple means of action and expression. Offer students alternatives for communicating what they know.

**Principle 3.** Provide multiple means of engagement. Help learners get interested, be challenged, and stay motivated.
FOSS for All Students

The FOSS Program has been designed to maximize the science learning opportunities for all students, including those who have traditionally not had access to or have not benefited from equitable science experiences—students with special needs, ethnically diverse learners, English learners, students living in poverty, girls, and advanced and gifted learners. FOSS is rooted in a 30-year tradition of multisensory science education and informed by recent research on UDL and culturally and linguistically responsive teaching and learning. Procedures found effective with students with special needs and students who are learning English are incorporated into the materials and strategies used with all students during the initial instruction phase. In addition, the Access and Equity chapter in Teacher Resources (or go to FOSSweb to download this chapter) provides strategies and suggestions for enhancing the science and engineering experiences for each of the specific groups noted above.

Throughout the FOSS investigations, students experience multiple ways of interacting with phenomena and expressing their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate his or her strengths and needs, thoughts, and aspirations.

The challenge is then to provide appropriate follow-up experiences or enhancements appropriate for each student. For some students, this might mean more time with the active investigations or online activities. For other students, it might mean more experience and/or scaffolds for developing models, building explanations, or engaging in argument from evidence.

For some students, it might mean making vocabulary and language structures more explicit through new concrete experiences or through reading to students. It may help them identify and understand relationships and connections through graphic organizers.

For other students, it might be designing individual projects or small-group investigations. It might be more opportunities for experiencing science outside the classroom in more natural, outdoor environments or defining problems and designing solutions in their communities.
Assessment and Extensions

The next-step strategies suggested during the self-assessment sessions following I-Checks provide opportunities for differentiated instruction. These strategies can also be used to provide targeted and strategic instruction for students who need additional specific support. For more on next-step strategies, see the Assessment chapter.

There are additional approaches and strategies for ensuring access and equity by providing appropriate differentiated instruction. The FOSS Program provides tools and strategies so that you know what students are thinking throughout the module. Based on that knowledge and what you know about your students’ cultural and linguistic background, as well as their individual strengths and needs, read through the extension activities for additional ways to enhance the learning experience for your students. Interdisciplinary extensions in the arts, social studies, math, and language arts, as well as more advanced projects are listed at the end of each investigation. Use these ideas to meet the individual needs and interests of your students. In addition, online activities including tutorials and virtual investigations are effective tools to provide differentiated levels of instruction.

English Learners

The FOSS Program provides a rich laboratory for language development for English learners. A variety of techniques are provided to make science concepts clear and concrete, including modeling, visuals, and active investigations in small groups. Instruction is guided and scaffolded through carefully designed lesson plans, and students are supported throughout.

Science vocabulary and language structures are introduced in authentic contexts while students engage in hands-on learning and collaborative discussion. Strategies for helping all students read, write, speak, and listen are described in the Science-Centered Language Development chapter. A specific section on English learners provides suggestions for both integrating English language development (ELD) approaches during the investigation and for developing designated (targeted and strategic) ELD-focused lessons that support science learning.
FOSS INVESTIGATION ORGANIZATION

Modules are subdivided into investigations (four in this module). Investigations are further subdivided into three to five parts. Each investigation has a general guiding question for the phenomenon students investigate, and each part of each investigation is driven by a focus question. The focus question, usually presented as the part begins, engages the student with the phenomenon and signals the challenge to be met, mystery to be solved, or principle to be uncovered. The focus question guides students’ actions and thinking and makes the learning goal of each part explicit for teachers. Each part concludes with students recording an answer to the focus question in their notebooks.

The investigation is summarized for the teacher in the At-a-Glance chart at the beginning of each investigation.

Investigation-specific scientific background information for the teacher is presented in each investigation chapter organized by the focus questions.

The Teaching Children about section makes direct connections to the NGSS foundation boxes for the grade level—Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts. This information is later presented in color-coded sidebar notes to identify specific places in the flow of the investigation where connections to the three dimensions of science learning appear. The Teaching Children about section ends with information about teaching and learning and a conceptual-flow graphic of the content.

The Materials and Getting Ready sections provide scheduling information and detail exactly how to prepare the materials and resources for conducting the investigation.

Teaching notes and ELA Connections appear in blue boxes in the sidebars. These notes comprise a second voice in the curriculum—an educative element. The first (traditional) voice is the message you deliver to students. The second (educative) voice, shared as a teaching note, is designed to help you understand the science content and pedagogical rationale at work behind the instructional scene. ELA Connection boxes provide connections to the Common Core State Standards for English Language Arts.

FOSS Investigation Organization

FOCUS QUESTION

How do animals use their sense of hearing?

SCIENCE AND ENGINEERING PRACTICES

Developing and using models

DISCIPLINARY CORE IDEAS

LS1.A: Structure and function

CROSSCUTTING CONCEPTS

Systems and system models

TEACHING NOTE

This focus question can be answered with a simple yes or no, but the question has power when students support their answers with evidence. Their answers should take the form “Yes, because ____.”
The **Getting Ready** and **Guiding the Investigation** sections have several features that are flagged in the sidebars. These include several icons to remind you when a particular pedagogical method is suggested, as well as concise bits of information in several categories.

The **safety** icon alerts you to potential safety issues related to chemicals, allergic reactions, and the use of safety goggles.

The small-group **discussion** icon asks you to pause while students discuss data or construct explanations in their groups.

The **new-word** icon alerts you to a new vocabulary word or phrase that should be introduced thoughtfully.

The **vocabulary** icon indicates where students should review recently introduced vocabulary.

The **recording** icon points out where students should make a science-notebook entry.

The **reading** icon signals when the class should read a specific article in the *FOSS Science Resources* book.

The **technology** icon signals when the class should use a digital resource on FOSSweb.
The **assessment** icons appear when there is an opportunity to assess student progress by using embedded or benchmark assessments. Some are performance assessments—observations of science and engineering practices, indicated by a second icon which includes a beaker and ruler.

The **outdoor** icon signals when to move the science learning experience into the schoolyard.

The **engineering** icon indicates opportunities for an experience incorporating engineering practices.

The **math** icon indicates an opportunity to engage in numerical data analysis and mathematics practice.

The **crosscutting concepts** icon indicates an opportunity to expand on the concept by going to *Teacher Resources*, Crosscutting Concepts chapter. This chapter provides details on how to engage students with that concept in the context of the investigation.

The **EL note** provides a specific strategy to use to assist English learners in developing science concepts.

To help with pacing, you will see icons for **breakpoints**. Some breakpoints are essential, and others are optional.
ESTABLISHING A CLASSROOM CULTURE

Working in Collaborative Groups

Collaboration is important in science. Scientists usually collaborate on research enterprises. Groups of researchers often contribute to the collection of data, the analysis of findings, and the preparation of the results for publication.

Collaboration is expected in the science classroom too. Some tasks call for everyone to have the same experience, either taking turns or doing the same things simultaneously. At other times, group members may have different experiences that they later bring together.

Research has shown that students learn better and are more successful when they collaborate. Working together promotes student interest, participation, learning, language development, and self-confidence. FOSS investigations use collaborative groups extensively. Here are a few general guidelines for collaborative learning that have proven successful over the years.

For most activities in upper-elementary grades, collaborative groups of four in which students take turns assuming specific responsibilities work best. Groups can be identified completely randomly (first four names drawn from a hat constitute group 1), or you can assemble groups to ensure diversity and inclusion. Thoughtfully constituted groups tend to work better.

Groups can be maintained for extended periods of time, or they can be reconfigured frequently. Six to nine weeks seems about optimum, so students might stay together throughout an entire module.

Functional roles within groups can be determined by the members themselves, or they can be assigned in one of several ways. Each member in a collaborative group can be assigned a number or a color. Then you need only announce which color or number will perform a certain task for the group at a certain time. Compass points can also be used: the person seated on the east side of the table will be the Reporter for this investigation.

The functional roles used in the investigations follow. If you already use other names for functional roles in your class, use them in place of those in the investigations.

The Getter is responsible for materials. One person from each group gets equipment from the materials station, and later returns the equipment.
One person is the **Starter** for each task. This person supervises setting up the equipment and makes sure that everyone gets a turn and that everyone has an opportunity to contribute ideas to the investigation.

The **Recorder** makes sure that everyone has recorded information in his or her science notebook and, as appropriate, records the group data and ideas.

The **Reporter** reports group data to the class or transcribes it to the board or class chart, and shares the main points of the group discussion during class discussion.

Getting started with collaborative groups requires patience, but the rewards are great. Once collaborative groups are in place, you will be able to engage students in more meaningful conversations about science content. You are free to “cruise” the groups, to observe and listen to students as they work, and to interact with individuals and small groups as needed.

**Norms for Sense-Making Discussions**

Setting up norms for discussion and holding yourself and your students accountable is the first step toward creating a culture of productive talk in the classroom that supports engagement in the science and engineering practices. Students need to feel free to express their ideas, and to provide and receive criticism from others as they work toward understanding of the disciplinary core ideas of science and methods of engineering.

Establish norms at the beginning of the school year. It is recommended that this be done together as a class activity. However, presenting a poster of norms to students and asking them to discuss why each one is important can also be effective. Before each sense-making discussion, review the norms. Review what it will look like, sound like, and feel like when everyone is following the agreements. You might have students work on one or two at a time as they are developing their oral discourse skills. After discussion, save a few minutes for reflection on how well the group or the class adhered to the norms and what they can do better next time. More strategies for supporting academic discourse can be found in the Sense-Making Discussions for Three-Dimensional Learning and Science-Centered Language Development chapters in *Teacher Resources* (also available as downloadable PDFs on FOSSweb).
Managing Materials

The Materials section lists the items in the equipment kit and any teacher-supplied materials. It also describes things to do to prepare a new kit and how to check and prepare the kit for your classroom. Classroom volunteers and helpful students can also assist in setting up and preparing the materials.

Individual photos of each piece of FOSS equipment are available for printing from FOSSweb, and can help students and you identify each item. They can be used to support emerging readers and English language learners to acquire and use new vocabulary words necessary to engage in the investigations. (Photo equipment cards are available in English and Spanish formats.)

The FOSS Program designers suggest using a central materials distribution system. You organize all the materials for an investigation at a single location called the materials station. As the investigation progresses, one member of each group gets materials as they are needed, and another returns the materials when the investigation is complete. You place the equipment and resources at the station, and students do the rest. Students can also be involved in cleaning and organizing the materials at the end of a session. Be sure to work with students to Reduce, Reuse, and Recycle the materials used in science.

When Students Are Absent

When a student is absent for a session, give him or her a chance to spend some time with the materials at a center. Another student might act as a peer tutor. Allow the student to bring home a FOSS Science Resources book to read with a family member. There are suggested interactive reading strategies for each article as well as embedded review items that the student can respond to verbally or in writing.

There is a set of two or three virtual investigations for each FOSS module for grades 3–5. Students who have been absent from certain investigations can access these simulations online through FOSSweb. The virtual investigations require students to record data and answer concluding questions in their science notebooks. Sometimes the notebook sheet that was used in the classroom investigation is also used for the virtual investigation.
Collaborative Teaching and Learning

Collaborative learning requires a collective as well as individual growth mindset. A growth mindset is when people believe that their most basic abilities can be developed through dedication and hard work (see the research of Carol Dweck and her book *Mindset: The Psychology of Success*). As students work together to make sense of phenomena and develop their inquiry and discourse skills, it’s important to recognize and value their efforts to try new approaches and their willingness to make their thinking visible. Remind students that everyone in the classroom, including you the teacher, will be learning new ideas and ways to think about the world. Where there is productive struggle, there is learning. Here are a few ways to help students develop a growth mindset for science and engineering.

- **Praise effort, not right answers.** When students are successful at a task, provide positive feedback about their level of engagement and effort in the practices, e.g., the efforts they put into careful observations, how well they organized and interpreted their data, the relevancy of their questions, how well they connected or applied new concepts, and their use of precise vocabulary, etc. Also, try to provide feedback that encourages students to continue to improve their learning and exploring, e.g., is there another way to approach this question? Have you thought about _____? What evidence is there to support _____?

- **Foster and validate divergent thinking.** During sense-making discussions, continually emphasize how important it is to share emerging ideas and to be open to the ideas of others in order to build understanding. Model for students how you refine and revise your thinking based on new information. Make it clear to students that the point is not for them to show they have the right answer, but rather to help each other arrive at new understandings. Point out positive examples of students expressing and revising their ideas.

Establishing a classroom culture that supports three-dimensional teaching and learning centers on collaboration. Collaborative groupings, materials management, and norms are structures you can put into place to foster collaboration. These structures along with the expectations that students will be negotiating meaning together as a community of learners, creates a learning environment where students are compelled to work, think, and communicate like scientists and engineers to help one another learn.
SAFETY IN THE CLASSROOM AND OUTDOORS

Following the procedures described in each investigation will make for a very safe experience in the classroom. You should also review your district safety guidelines and make sure that everything you do is consistent with those guidelines. Two posters are included in the kit: FOSS Science Safety for classroom use and FOSS Outdoor Safety for outdoor activities.

Look for the safety icon in the Getting Ready and Guiding the Investigation sections that will alert you to safety considerations throughout the module.

Safety Data Sheets (SDS) for materials used in the FOSS Program can be found on FOSSweb. If you have questions regarding any SDS, call Delta Education at 1-800-258-1302 (Monday–Friday, 8 a.m.–5 p.m. ET).

Science Safety in the Classroom

General classroom safety rules to share with students are listed here.

1. Listen carefully to your teacher’s instructions. Follow all directions. Ask questions if you don’t know what to do.
2. Tell your teacher if you have any allergies.
3. Never put any materials in your mouth. Do not taste anything unless your teacher tells you to do so.
4. Never smell any unknown material. If your teacher tells you to smell something, wave your hand over the material to bring the smell toward your nose.
5. Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.
6. Always protect your eyes. Wear safety goggles when necessary. Tell your teacher if you wear contact lenses.
7. Always wash your hands with soap and warm water after handling chemicals, plants, or animals.
8. Never mix any chemicals unless your teacher tells you to do so.
9. Report all spills, accidents, and injuries to your teacher.
10. Treat animals with respect, caution, and consideration.
11. Clean up your work space after each investigation.
12. Act responsibly during all science activities.
SCHEDULING THE MODULE

Below is a suggested teaching schedule for the module. The investigations are numbered and should be taught in order, as the concepts build upon each other from investigation to investigation. We suggest that a minimum of 9 weeks be devoted to this module.

Active-investigation (A) sessions include hands-on work with materials and organisms, active thinking about experiences, small-group discussion, writing in science notebooks, and learning new vocabulary in context.

Reading (R) sessions involve reading FOSS Science Resources articles. Reading can be completed during language-arts time to make connections to Common Core State Standards for ELA (CCSS ELA).

During Wrap-Up/Warm-Up (W) sessions, students share notebook entries and engage in connections to CCSS ELA. These sessions can also be completed during language-arts time.

I-Checks are short summative assessments at the end of each investigation. Students have a short notebook review session the day before and a self-assessment of selected items the following day. (See the Assessment chapter for the next-step strategies for self-assessment.)

<table>
<thead>
<tr>
<th>Week</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>START Inv. 1 Part 1</td>
<td>R/W</td>
<td>A/R</td>
<td>A/R</td>
<td>A/R</td>
</tr>
<tr>
<td></td>
<td>A (mealworms)</td>
<td>START Inv. 1 Part 2</td>
<td>R/W</td>
<td>A/R</td>
<td>A/R</td>
</tr>
<tr>
<td>2</td>
<td>A/W</td>
<td>START Inv. 1 Part 3</td>
<td>R</td>
<td>R/Review</td>
<td>(Start aging water)</td>
</tr>
<tr>
<td></td>
<td>A/R</td>
<td>START Inv. 2 Part 1</td>
<td>A/R/W</td>
<td>A</td>
<td>A/R</td>
</tr>
<tr>
<td>3</td>
<td>(Observe mealworms)</td>
<td>START Inv. 2 Part 2</td>
<td>START Inv. 2 Part 4</td>
<td>A</td>
<td>(Observe mealworms)</td>
</tr>
<tr>
<td></td>
<td>Self-assess</td>
<td>R</td>
<td>R/W</td>
<td>A/R</td>
<td>(Observe mealworms)</td>
</tr>
<tr>
<td>4</td>
<td>R</td>
<td>Review</td>
<td>I-Check 2</td>
<td>Self-assess</td>
<td>START Inv. 3 Part 3</td>
</tr>
<tr>
<td></td>
<td>(Test shrimp eggs)</td>
<td>START Inv. 3 Part 2</td>
<td>A/R</td>
<td>A/R/W</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>START Inv. 3 Part 4</td>
<td>A/R</td>
<td>Review</td>
<td>(Day 8 observe)</td>
</tr>
<tr>
<td></td>
<td>A/R/W</td>
<td>START Inv. 4 Part 1</td>
<td>A (planting)</td>
<td>I-Check 3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Self-assess 3</td>
<td>(Day 5 observe)</td>
<td>A/R</td>
<td>R/W</td>
<td>A/R/W</td>
</tr>
<tr>
<td></td>
<td>START Inv. 4 Part 2</td>
<td>A</td>
<td>Day 8 observe</td>
<td>A/R/W</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>START Inv. 4 Part 3</td>
<td>A</td>
<td>Day 13 observe</td>
<td>A/R/W</td>
<td>Posttest</td>
</tr>
</tbody>
</table>

NOTE

Read through Investigation 1, Part 1, so you know how to plan the schedule for observing the life cycle stages of the darkling beetle (mealworm). It will take about 6 weeks for the mealworms to become adult beetles. Students are introduced to the reading, “Darkling Beetles”, in week 9, day 2, after they have observed the entire life cycle.

It is important to start Investigation 3, Part 1, with brine shrimp eggs on a Monday, have students make observations each day, and set up Part 3 on Friday.

In Investigation 4, Part 1, students set up two plant experiments (half the class sets up the water tolerance experiment and the other half sets up the salt tolerance experiment). Students observe and record plant changes on days 5, 8, and 13. On day 13 or 14 the experiments come to an end; students make final observations and record. Plan to go on to Investigation 4, Part 2 and Part 3, before finishing Part 1 of that investigation.

Be prepared—read the Getting Ready section thoroughly and review the teacher preparation video on FOSSweb.
ENVIRONMENTS — Overview

FOSS CONTACTS

General FOSS Program information
www.FOSSweb.com
www.DeltaEducation.com/FOSS

Developers at the Lawrence Hall of Science
foss@berkeley.edu

Customer Service at Delta Education
www.DeltaEducation.com/contact.aspx
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET

FOSSmap (online component of FOSS assessment system)
http://FOSSmap.com/

FOSSweb account questions/access codes/help logging in
technicalsupport.science@schoolspecialty.com
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET

School Specialty online support
loginhelp@schoolspecialty.com
Phone: 1-800-513-2465, 8:30 a.m.–6:00 p.m. ET

FOSSweb tech support
support@fossweb.com

Professional development
www.FOSSweb.com/Professional-Development

Safety issues
www.DeltaEducation.com/SDS
Phone: 1-800-258-1302, 8:00 a.m.–5:00 p.m. ET
For chemical emergencies, contact Chemtrec 24 hours per day.
Phone: 1-800-424-9300

Sales and replacement parts
www.DeltaEducation.com/FOSS/buy
Phone: 1-800-338-5270, 8:00 a.m.–5:00 p.m. ET