AmplifyScience

Grade 5

Implementation and Planning Guide For NYC Department of Education

authored by THE LAWRENCE HALL OF SCIENCE UNIVERSITY OF CALIFORNIA, BERKELEY

Planning your year

Overview: Amplify Science K-5 Course Structure

PRIMARILY LIFE SCIENCE   PRIMARILY PHYSICAL SCIENCE   PRIMARILY EARTH SCIENCE

SEPT OCT NOV DEC JAN FEB MAR APR MAY JUN

Grade	Unit 1	Unit 2	Unit 3	Unit 4	Minutes per lesson
K	Needs of Plants and Animals	Pushes and Pulls	Sunlight and Weather		45
1	Animal and Plant Defenses	Light and Sound	Spinning Earth		45
2	Plant and Animal Relationships	Properties of Materials	Changing Landforms		60
3	Balancing Forces	Inheritance and Traits	Environments and Survival	Weather and Climate	60
4	Energy Conversions	Vision and Light	Earth's Features	Waves, Energy and Information	60
5	Patterns of Earth and Sky	Modeling Matter	The Earth System (26 lessons)	Ecosystem Restoration	60

All units have 22 lessons except Grade 5: The Earth System, which has 26 lessons.

Implementation considerations:

- The lesson and activity sequence needs to be followed within a unit.
- Pacing in this guide assumes 3 lessons taught each week.
- Lessons can be taught either by a classroom teacher or through a collaboration between cluster teacher and classroom teacher.

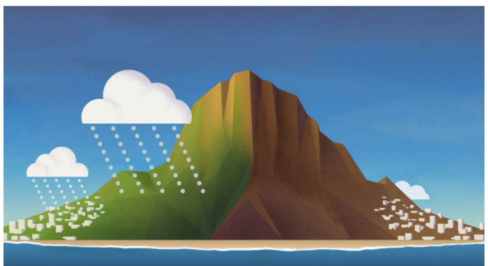
Course structure notes:

- The order of units in Kindergarten and Grade 1 takes early literacy development into consideration. Reading, writing, and discourse routines in K-1 units build on one another from the beginning to the end of the year.
- Particular activities that are best suited for fall, winter, or spring are reflected in the unit order.
- In various instances, students engage in specific science and engineering practices, crosscutting concepts or disciplinary core ideas in increasingly complex ways over the course of a year.

5th Grade units:

Patterns of Earth and Sky

Modeling Matter



The Earth System

Ecosystem Restoration

5th Grade Crosswalk: NYSSLS alignment to Amplify Science units

The NRC Framework for K-12 Science Education, the foundational document for both NGSS and the NYSSLS, lists standards in the form of student performance expectations (PEs). The PEs clarify the expectations of what students will know and be able to do by the end of the grade or grade band. Both the NYC DOE Units of Study and Amplify Science are examples of curriculum designed to create coherent instructional programs for achievement of these standards. *(reference: NGSS Appendix A, page 2)*

Amplify Science Units and associated PEs from NGSS	NYC DOE Units of Study and associated PEs from NYSSLS
Unit 1: Patterns of Earth and Sky 5-PS2-1 5-ESS1-1 5-ESS1-2	**Earth Systems Science** 5-PS2-1 **Stars and the Solar System** 5-ESS1-1 5-ESS1-2
Unit 2: Modeling Matter 5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4 *3-5-ETS1-2*	**Physical and Chemical Changes** 5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4 **Matter and Energy in Ecosystems** 5-PS1-1 5-PS1-3 **Earth Systems Science** 5-PS1-1 5-PS1-3
Unit 3: The Earth System 5-ESS1-1 5-ESS1-2 5-PS2-1 *3-5-ETS1-1* *3-5-ETS1-2* *3-5-ETS1-3*	**Physical and Chemical Changes** 5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4 **Matter and Energy in Ecosystems:** 5-PS1-1 5-PS1-3 5-LS2-1 **Earth Systems Science** 5-ESS2-1 5-ESS2-2 5-ESS3-1 **Stars and the Solar System** 5-ESS2-1 5-ESS2-2
Unit 4: Ecosystem Restoration 5-LS1-1 5-LS2-1 5-PS1-1 5-PS1-1 5-PS1-4 5-PS3-1 5-ESS3-1	**Physical and Chemical Changes** 5-PS1-1 5-PS1-4 5-PS3-1 **Matter and Energy in Ecosystems** 5-LS1-1 5-LS2-1 5-PS1-1 **Earth Systems Science** 5-ESS3-1

5th Grade Unit 1
Patterns of Earth and Sky
Recommended time frame: 8 weeks

This Implementation and Planning Guide includes text from one of the Unit Overview Documents, *Standards and Goals*.

Please see additional Unit Overview documents in the unit's Teacher's Guide for full reference and planning guidance.

Standards and Goals

Focal Performance Expectations

- 5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth. [Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).] Patterns of Earth and Sky Teacher References Standards and Goals © The Regents of the University of California 1
- 5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]
- 5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

Unit-level 3-D Statement:

- Students investigate why we see different stars at different times, using digital and kinesthetic models to figure out what causes (cause and effect) daily and yearly patterns (patterns) of Earth and sky.

Key
Practices
Disciplinary Core Ideas
Crosscutting Concepts

Standards & Goals

Science and Engineering Practices

The *Patterns of Earth and Sky* unit provides students with exposure to all of the eight science and engineering practices described in the NGSS. This unit emphasizes the following practices (listed in order of particular emphasis), providing students with explicit instruction and expectations for increasing independence over the course of the unit:

- **Practice 3: Planning and Carrying Out Investigations.** Students conduct various investigations using the Patterns of Earth and Sky Simulation in order to gather evidence about why different stars are visible at different times. They use this information as they work to understand and explain the daily and yearly patterns of stars that can be observed from Earth.
- **Practice 2: Developing and Using Models.** Students receive explicit instruction and opportunities to practice using and creating a variety of models throughout the unit, both physical models that represent phenomena as well as the use of a digital modeling tool with which students create and communicate their mental models. The use of models is key to students' understanding of scale, spatial relationships between objects in space, and the movements of Earth.
- **Practice 4: Analyzing and Interpreting Data.** Students have numerous opportunities to collect and analyze data from the Patterns of Earth and Sky Simulation. Students analyze data from their investigations of when different stars are visible from Earth in order to look for annual patterns and, ultimately, to understand what causes the patterns they have observed.
- **Practice 5: Using Mathematics and Computational Thinking.** Throughout their investigations in the Patterns of Earth and Sky Simulation, students collect and review data in order to reveal patterns. As students gather more data, they begin to develop an understanding of the relationships between Earth's movement and what we observe in the sky at different times.
- **Practice 6: Constructing Explanations.** Students learn about scientific explanations and have multiple opportunities to write increasingly complex explanations over the course of the unit, describing phenomena (e.g., Earth's spin and orbit) that are not easy to observe directly.
- **Practice 8: Obtaining, Evaluating, and Communicating Information.** Throughout the unit, students refer to informational texts and a reference book in order to gather evidence to support their developing ideas about the astronomical phenomena they observe in the Patterns of Earth and Sky Simulation.
- **Practice 7: Engaging in Argument from Evidence.** As students work to explain the significance of images on the artifact and figure out what images might have been on the missing piece, they engage in talk with their peers, discussing possible claims and supporting those claims with evidence. Standards and Goals Patterns of Earth and Sky Teacher References © The Regents of the University of California 2
- **Practice 1: Asking Questions and Defining Problems.** Students ask questions that can be investigated about which stars are visible at different times. They use daily and yearly patterns to make predictions about which stars would be visible at particular times.

In all Amplify Science units, practices from the NGSS, the CCSS-ELA, and the CCSS-Math are linked. For instance, when students use the *Patterns of Earth and Sky* Simulation to determine the months during which they can see particular constellations, they are also engaging in the CCSS-Math Practices 4 and 6 (Practice 4: Model with Mathematics, Practice 6: Attend to precision). When students analyze and interpret data, use that data to inform their explanations, and engage with science text, they are developing the foundational capacity to build knowledge about a phenomenon through research and to respond analytically to informational sources, as called for by the CCSS-ELA Standards.

Disciplinary Core Ideas

Focal Disciplinary Core Ideas

This unit addresses the following core ideas:

ESS1.A: The Universe and Its Stars:
- The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)

ESS1.B: Earth and the Solar System:
- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2))

PS2.B: Types of Interactions:
- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)

Standards & Goals

Crosscutting Concepts

The crosscutting concept emphasized in the Patterns of Earth and Sky unit is Patterns. In their role as astronomers, students work to investigate what causes the various patterns that can be observed in the sky over time. Throughout their investigations, students make observations using the Patterns of Earth and Sky Simulation, as well as physical and kinesthetic models and analyze and interpret data to identify and understand the underlying causes of the patterns they observe. Students return to the idea of patterns again and again throughout the unit, through a variety of modalities.

Do. Students utilize a simulation, digital modeling tools, and kinesthetic models to observe, investigate, and apply their growing ideas about the daily and yearly patterns of stars that can be observed from Earth. Throughout the unit, students collect data about which stars are visible at different times, revealing emergent patterns. Then, students turn to the Mount Nose kinesthetic model to look for patterns in Earth's motion to help them understand and explain the patterns they observe in the Patterns of Earth and Sky Simulation.

Talk. Students share their developing ideas about the daily or yearly patterns of stars they observe with peers through the various student-to-student talk opportunities, including the Think-Write-Pair-Share routine. These low-stakes discussion opportunities allow students to make sense of the patterns of stars over time that they are investigating.

Read. Students read two books that support them in investigating the pattern of when constellations are visible in the night sky. In addition, students read about a scientist who looks for patterns in star brightness data to discover new planets.

Write. With increasing independence, students write explanations describing the relationship between Earth's motion and the daily or yearly patterns of stars that can be observed.

Visualize. As they engage in the Mount Nose Model, students use visualization to develop an understanding of the daily and yearly patterns of stars that they observe. The strategy of visualization is central to students' ability to connect the patterns of stars that they observe over time and Earth's spin and orbit.

There are also opportunities to emphasize the crosscutting concepts of Systems and System Models (e.g., students have numerous opportunities to work with models of the solar system and parts of the Milky Way); Cause and Effect (e.g., students investigate what causes the patterns of sun and stars that they observe); and Scale, Proportion, and Quantity (e.g., students explore the relative sizes of objects and distances between objects in space).

Background Knowledge and Alternate Conceptions

Background Knowledge and Alternate Conceptions	
Patterns of Earth and Sky includes a pre-unit assessment in lesson 1.1 in which students make a scientific explanation. This pre-unit writing assessment is an opportunity for students to articulate their initial ideas about Earth and the sky as they answer questions about an ancient artifact. This provides students with an opportunity to connect their background knowledge and initial ideas to the concepts they will be learning about in the Patterns of Earth and Sky: Analyzing Stars on Ancient Artifacts unit. It can also provide insight into students' thinking as you begin this unit of instruction. This will allow you to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding. **Note:** For full details, see the assessment task and associated Assessment Guide in lesson 1.1.	
Connecting to students' experiences. Examples of students' experiences to which you can connect the content of specific lessons in the unit: • experience with looking at stars in the night sky • experience with common constellation names • experience observing the sky during the daytime	**Building on prior knowledge**. Ideas about animals and plants on which you and students can build throughout the unit: • It is nighttime when Earth is not facing the sun. • It is daytime when Earth is facing the sun. • Stars are visible at nighttime. • It is difficult to see stars other than the sun during the daytime. • Earth is round. • Earth moves
Gauging students' facility with science practices. Students write a scientific explanation for this task, it offers an entry-level assessment of this important science and engineering practice.	**Applying crosscutting concepts.** Alternate conceptions to address or watch out for as the unit unfolds: • The constellations change as the seasons change. (applying the idea that similarities and differences in patterns can be used to communicate and analyze changes in natural phenomena) • The pattern of daytime and nighttime repeats every day because the earth spins every day. (applying the idea that patterns can be used as evidence to support an explanation)

Standards & Goals

Preconceptions to watch out for over the course of the unit:

- All stars, except the sun, are very small: Students might think that stars' actual sizes are very small because the stars look so much smaller than the sun in the sky. This idea does not take into account the distance between Earth and the sun and Earth and other stars. The stars are much farther away from Earth than the sun, which makes them look smaller than the sun. In fact, many stars are as big or bigger than the sun.
- Sometimes Earth moves too far away from constellations for us to see them: Some students may attribute the fact that we cannot always see certain constellations to Earth being farther away from them. In contrast, the constellations we see in the sky at certain times depend on the relative positions of Earth, the sun, and other stars, not Earth's distance from them.
- Stars are only on one side of Earth, which is why we can only see them at night: Some students might think that the stars are on one side of Earth and the sun is on the other. As a result, Earth faces the sun during the day and the other stars at night, which explains what we see in the sky at those times. These students likely do not know that the stars actually surround Earth in all directions, and during the daytime, the sun's brightness prevents us from seeing other stars.
- Earth's rotation is related to seasonal change: Students might think that Earth's spin is largely tied to the seasons—Earth faces one way during winter and another way during summer. These students likely do not know that Earth is spinning all the time, and that this spinning causes the daily pattern of day and night.
- Gravity is a push: Students might believe that the force of gravity is a push or a push and a pull at different times. In fact, gravity is a pulling force that Earth exerts on people and objects. Earth pulls things toward its center. It is common for people to say that gravity pulls on an object, but it is better to say that Earth pulls on an object, and the name of that pulling force is gravity.

5th Grade Unit 1 Patterns of Earth and Sky

Grade 5 Unit 1 Pacing Guidance at-a-glance Patterns of Earth and Sky		
Guidance for cluster teachers and classroom teachers: All lessons can be taught by either teacher. The lessons in bold include activities with a particular literacy emphasis and the the lessons with * include activities with a particular hands-on emphasis. Keep in mind that all Amplify Science lessons engage students in reading, writing, and/or discourse, as well as in scientific inquiry, so refer to the lesson-by-lesson guidance for details as you plan to teach.		
Pacing assumes 1 lesson per day, 3 times per week. Lessons are each 60 minutes long. Occasional weeks with 2 lessons affords flex time, to make up instructional minutes and/or differentiate according to formative assessment.		
Recommended time frame: 8 weeks September through November	**Week 1**	1.1: Pre-Unit Assessment: Students' Initial Explanations 1.2: Earth and Stars in Space
	Week 2	1.3: **How Big Is Big? How Far Is Far?** 1.4: Distances to the Stars 1.5: Investigating Size and Distance*
	Week 3	1.6: **The Brightness of Starlight** 1.7: **Explaining When We See Stars**
	Week 4	2.1: Observing Patterns* 2.2: The Daily Pattern 2.3: What We See as We Spin*
	Week 5	2.4: **Which Way Is Up?** 2.5: How Does Up Change?* 2.6: **Explaining the Effects of Earth's Spin**
	Week 6	3.1: Stars Through the Year 3.2: Modeling Earth's Orbit* 3.3: Seeing Stars for a Year
	Week 7	3.4: **Dog Days of Summer** 3.5: Modeling Constellations over Time 3.6: **End-of-Unit Assessment: Students' Explanations**
	Week 8	4.1: **Star Scientist** 4.2: Planning Investigations 4.3: Students' Investigations of Constellations or Stars

Patterns of Earth and Sky Lesson Planning Guide Lesson 1.1: Pre-Unit Assessment: Students' Initial Explanations (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Students are introduced to the unit and to their role as well as *Handbook of Stars and Constellations*. In activity 3, students write their initial explanations as a pre-unit assessment.		
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars.	**Students learn:** • Reflecting on what you do and don't understand allows you to prepare for learning new things. • Astronomers are scientists who study stars, planets, and other objects in space. • Archaeologists are scientists who study people and cultures from long ago. • Scientists refer to reference books when they need to look for information	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 6, 8 **DCIs** PS2.B, ESS1.A, ESS1.B **CCCs** Patterns, Systems and System Models
3-D statement: Students write initial explanations about the patterns of the sun and stars (patterns) on an ancient artifact. **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Introducing the Unit (10 min)** Students reflect on prior knowledge about stars and are introduced to their role in this unit as astronomers. **2. Introducing the Artifact (10 min)** Students are introduced to the problem they will be solving in this unit: working out what the missing piece of the artifact might depict. Students learn where archaeologists found the mystery artifact and record initial observations in their Investigation Notebooks. **3. Pre-Unit Assessment (30 min)** Students record their initial ideas about why the three sections of the artifact are not the same. These explanations reveal students' initial understanding of the unit's core content, which can be assessed with Assessment Guide: Interpreting Students' Pre-Unit Explanations About the Discovered Artifact (in Digital Resources). In addition to providing insight for the teacher, asking students to take stock of their initial knowledge helps them prepare to make connections to new knowledge. **4. Previewing the Reference Book (10 min)** Students engage in a free exploration of the reference book in order to briefly familiarize themselves with its layout and contents.		

5th Grade Unit 1 Patterns of Earth and Sky

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<td>
Materials
For the Classroom Wall
• Unit Question: Why do we see different stars at different times?
• section headers: Key Concepts, Vocabulary
• Vocabulary: astronomer, star
For the Class
• Pre-Unit Writing: Explaining the Discovered Artifact copymaster
• 1 sheet of chart paper*
• marker, wide tip*
• masking tape*
• stapler*
For Each Pair of Students
• 1 copy of Handbook of Stars and Constellations
For Each Student
• 1 copy of Pre-Unit Writing: Explaining the Discovered Artifact student sheet
• Patterns of Earth and Sky Investigation Notebook (page 3)
*supplied by teacher
</td>
<td>
Digital Resources
• Pre-Unit Writing: Explaining the Discovered Artifact copymaster
• Assessment Guide: Interpreting Students' Pre-Unit Explanations About the Discovered Artifact
• Projections: Lesson 1.1
• Partner Reading Guidelines
• Patterns of Earth and Sky Investigation Notebook
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<td>
Vocabulary
• astronomer
• star
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Patterns of Earth and Sky: Lesson 1.1

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS2.B: Types of Interactions:** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1) **ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 1.2: Earth and Stars in Space (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students look at models and photographs and explore in the *Patterns of Earth and Sky* Simulation.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** During daytime, we see the sun, but no other stars.	• Earth is a sphere. • Scientists use models to explore their ideas about the real world. • Models need to be like the things they represent in some ways, but models are different from what they represent in other ways. • Different models can be useful for different purposes	**SEPs** 2, 4, 5, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Systems and System Models; Scale, Proportion, and Quantity

3-D statement: Students explore physical and digital models to begin understanding the shape and scale (scale, proportion, and quantity) of objects in space and communicate their initial ideas about where the stars are in space.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Modeling the Shape of Earth (20 min)
Students initiate the study of the Chapter 1 Question: Why don't we see a lot of stars during the daytime? by exploring two models of Earth. They discuss which is more accurate in terms of the planet's overall shape and confirm that Earth is a sphere. This activity includes an On-the-Fly Assessment to informally assess students' understanding that the shape of Earth is a sphere.

2. Exploring a Simulation of Earth and Sky (20 min)
Students explore the Patterns of Earth and Sky Simulation. In this activity, students focus on how the Sim works and aspects of space that it represents. Providing this introductory time for exploring the Sim prepares students to work thoughtfully in later Sim investigations.

3. Sharing What We Discovered (10 min)
The class spends time going over the Sim together to clarify the different views and features. They share initial ideas, discoveries, and questions brought about by their exploration of the Sim.

4. Ideas About Where the Stars Are (10 min)
In their first experience with the Think-Write-Pair-Share routine, students share their initial ideas about the Investigation Question: Where are the stars in space?

Patterns of Earth and Sky: Lesson 1.2

Materials	Digital Resources	Vocabulary
For Each Student • optional: 1 copy of Chapter 1 Home Investigation: Observing the Stars student sheet • Patterns of Earth and Sky Investigation Notebook (pages 5–6, optional: page 4) **For the Class** • 1 inflatable globe • folded world map • masking tape* • optional: Chapter 1 Home Investigation: Observing the Stars copymaster **For the Classroom Wall** • Chapter 1 Question: *Why don't we see a lot of stars during the daytime?* • Vocabulary: *model* **For Each Pair of Students** • 1 digital device* *teacher provided	• Optional: Chapter 1 Home Investigation: Observing the Stars copymaster • Projections: Lesson 1.2	• model • solar system • star

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Systems and System Models • Scale, Proportion, and Quantity

Patterns of Earth and Sky Lesson Planning Guide
Lesson 1.3: *How Big Is Big? How Far Is Far?* (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-2 students partner read and reflect on *How Big Is Big? How Far Is Far?*

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** The stars look very small.	**Students learn:** • One way to visualize as you read is to connect measurements and data in the book with everyday experiences; this helps you better understand the ideas in the book. • Diagrams, photos, and captions in informational text provide important information about key ideas. • The size of objects in space is relative; for instance, Earth can seem both big and small when compared to other objects in space. • Things in space are very far apart, but how far apart they seem depends on what other distances you compare them to.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 5, 8 **DCIs** ESS1.A, ESS3.C **CCCs** Patterns; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students obtain information from the book *How Big Is Big? How Far is Far?* about the relative size and distance of stars and other objects in space (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing *How Big Is Big? How Far Is Far?* (15 min)
Students are introduced to *How Big Is Big? How Far Is Far?* and to the sensemaking strategy of visualizing. They will use this strategy throughout the unit.

2. Partner Reading (35 min)
Students read with a partner and employ the sense-making strategy of visualizing. The class focuses on two data tables at the end of reading, which allows students to focus on the relative size and distance of several stars including the sun. This activity also includes an On-the-Fly Assessment to assess students' use of visualizing.

3. Thinking About Scale (10 min)
Observing as the teacher briefly scrolls through the images in the Scale Tool supports students' understanding of the relative size and distance of various stars.

Patterns of Earth and Sky: Lesson 1.3

Materials	Digital Resources	Vocabulary
For Each Student • Patterns of Earth and Sky Investigation Notebook (optional: pages 7–9) • 3 sticky notes* **For the Class** • 18 copies of *How Big is Big? How Far is Far?* • masking tape* **For the Classroom Wall** • vocabulary: *visualize, sun, solar system* • Partner Reading Guidelines chart (from Lesson 1.1) **For Each Pair of Students** • 1 copy of *How Big Is Big? How Far Is Far?* *teacher provided	• Projections: Lesson 1.3	• Earth • stars • solar system • sun

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	• Patterns • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 1.4: Distances to the Stars (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students collect data from the Patterns of Earth and Sky Simulation and revisit *How Big Is Big? How Far Is Far?*

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** The stars look very small.	**Students learn:** • Stars are very far away from Earth in every direction. • The sun is the only star in our solar system. Other stars are far outside our solar system. • Visualizing can be a helpful strategy for scientists to understand what they are investigating.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students investigate the distance to various stars in a digital model (systems and system models), then interpret their data by measuring these distances in a scale model, in order to visualize the scale of these distances (scale, proportion, and quantity) and where the stars are in space.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Preparing to Measure Distances (10 min)
A brief orientation to additional features of the *Patterns of Earth and Sky* Simulation and introduction to the purpose of this lesson's Sim activity prepares students for their first Sim investigation.

2. Investigating Distances to Stars (20 min)
Students use the Patterns of Earth and Sky Simulation to gather data about the distance from Earth to the sun and other stars.

3. Modeling the Sun and Other Stars (20 min)
A model helps students use their data to visualize the arrangement of stars in three dimensions. This activity also allows students to apply the sensemaking strategy of visualizing to a physical model.

4. Reflecting on Where Stars Are (10 min)
This activity allows students to reflect on their investigations and share responses to the Investigation Question.

Patterns of Earth and Sky: Lesson 1.4

Materials	Digital Resources	Vocabulary
For Each Student • Patterns of Earth and Sky Investigation Notebook (page 10; optional: page 11) **For the Class** • 5 small spheres (table tennis balls) • meterstick* • 3 sentence strips* • marker, wide tip* • masking tape* • scissors* **For the Classroom Wall** • key concept: *Stars are very far away from Earth in every direction.* • key concept: *The sun is the only star in our solar system. Other stars are far outside our solar system.* • vocabulary: *investigation, data* **For Each Pair of Students** • 1 digital device *supplied by teacher	• Projections: Lesson 1.4 • Classroom Model of the Great Square of Pegasus	• astronomer • data • investigation • model • solar system • star • sun

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information.	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • Transfer: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2, 4-PS3-4)	• Patterns • Scale, Proportion, and Quantity • Systems and System Model

Patterns of Earth and Sky Lesson Planning Guide
Lesson 1.5: Investigating Size and Distance (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 3 the class creates a scaled physical model.

Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** There are stars all around us, but we cannot always see them.	**Students learn:** • Objects look smaller when they are farther away, which is why the stars appear so small from Earth. • Stars are present in the sky in all directions during the daytime, even though they are not visible from Earth.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Scale, Proportion and Quantity; Systems and System Models

3-D statement: Students estimate the relative distance of the sun and another star in a scale model to investigate how the scale of the distance between Earth and stars affects how large the sun and other stars appear (scale, proportion, and quantity, cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Observing Artifacts (10 min)
Interpreting the symbols on the Museum of Archaeology's artifact and the Nebra Sky Disc prompts a new Investigation Question.

2. Investigating Stars in Daytime and Nighttime (20 min)
Students use the Patterns of Earth and Sky Simulation to make observations of stars in the daytime and the nighttime, which leads to investigating why most stars aren't visible during the daytime.

3. Size and Distance Investigation (30 min)
Students create a physical model of Earth, the sun, and Sirius to discover how the distance between Earth and stars in space affects how large or small they appear from Earth. They consider whether we don't see most stars during the daytime because they are farther from Earth than the sun and therefore appear much smaller.

Patterns of Earth and Sky: Lesson 1.5

Materials	Digital Resources	Vocabulary
For Each Student • Patterns of Earth and Sky Investigation Notebook (page 13, optional: page 12) **For the Class** • 1 copy of *How Big Is Big? How Far Is Far?* • 1 ball, 15 cm diameter • 1 very small round object, 1.3 mm diameter* (mustard seed, piece of millet, or coarse grain of sand) • masking tape* **For Each Pair of Students** • 1 digital device* *supplied by teacher	• Projections: Lesson 1.5	• data • investigation • model • solar system • sphere • star • sun • visualize

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 4:** Analyzing and Interpreting Data	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 1.6: The Brightness of Starlight (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students partner read and reflect on *Handbook of Stars and Constellations*.

Anchor Phenomenon and Everyday Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Everyday Phenomenon:** There are stars all around us, but we cannot always see them.	**Students learn:** • The sun looks bigger and brighter because it is much closer to Earth than other stars. • The sun is the only star we can see in the daytime because the sun looks so bright. • Evidence is information that supports an answer to a question	**Alignment to NGSS and NYSSLS** **SEPs** 4, 7, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students obtain and evaluate information from images, video, and the reference book, Handbook of Stars and Constellations, to figure out the effect (cause and effect) of the distance of the sun and other stars from Earth on their apparent brightness (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Distance and Size (15 min)
Students use the Think-Write-Pair-Share routine to discuss how the distance of the sun and other stars from Earth affects their apparent size and brightness. This section includes an On-the-Fly Assessment to assess students' understanding of the size and location of the sun and other stars relative to Earth.

2. Returning to the Reference Book (15 min)
Students refer to a brief passage in Handbook of Stars and Constellations as they seek information that will help them figure out why the sun is the only star that is visible in the daytime.

(Teacher Only). Reflecting on Brightness (15 min)
Students watch a video that serves as evidence that the light of stars can be overwhelmed by light that is closer to Earth. Students then have the opportunity to reflect on and share the evidence that they gathered for answering the Investigation Question.

3. Word Relationships (15 min)
Students practice using science vocabulary as they create and share sentences about concepts they have been learning.

Patterns of Earth and Sky: Lesson 1.6

Materials	Digital Resources	Vocabulary
For Each Group of Four Students • Chapter 2 Question: *How can Spruce the Sea Turtle survive where there are sharks?* • 1 vocabulary card: *predator* • What Scientists Do chart **For the Class** • *Whose Lunch Is This?* big book • masking tape* **For Each Student** • 1 small plastic cup, 2 oz. • 1 baby carrot* **For Each Student** • key concept: *The sun looks bigger and brighter because it is much closer to Earth than other stars.* • key concept: *The sun is the only star we can see in the daytime because the sun looks so bright.* • vocabulary: *evidence* • Partner Reading Guidelines chart (from Lesson 1.3) **For Each Student** • 1 copy of *Handbook of Stars and Constellations* *teacher provided	• Video: Lost in Light • Projections: Lesson 1.6	• observe • predator • scientist • structure • survive

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 1.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Crosscutting Concepts** • Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide Lesson 1.7: Explaining When We See Stars (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Literacy: In Activity 2 the class looks at sample scientific explanations. In Activity 3 students write scientific explanations.		
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Everyday Phenomenon:** During the daytime, we see the sun, but no other stars.	**Students learn:** • Making explanations is an important practice in science. • Science explanations describe the way natural events happen. • Scientific explanations describe things that are not easy to observe. • Scientists support their explanations with ideas from investigations and text	**Alignment to NGSS and NYSSLS** **SEPs** 6 & 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models
3-D statement: Students write explanations about why we don't see a lot of stars in the daytime, describing how distance plays a role in the apparent brightness of the sun and other stars (scale, proportion, and quantity) and how the brightness of the sun has the effect of overwhelming the light of other stars (cause and effect). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Discussing Ideas (10 min)** Students discuss the Chapter 1 Question in pairs. This provides students with an opportunity to review key ideas and to practice using scientific language before they begin to write. **2. Introducing Scientific Explanations (15 min)** Students are introduced to the basic components of a scientific explanation. Examining an explanation about a familiar topic prepares students to write their own explanations. **3. Writing Scientific Explanations (25 min)** Students write their own answers to the Chapter Question. The teacher uses this Critical Juncture Assessment as an opportunity to review students' understanding of the positions of the stars in space and the implications of the sun's and other stars' positions relative to Earth. **4. Reflecting on the Artifact (10 min)** Students briefly return to the artifact and think about what they know and could apply to understanding what is shown in terms of the sun and stars.		

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 18–19, optional: pages 17 and 20) **For the Class** • optional: Scaffolded Scientific Explanation copymaster • masking tape* **For the Classroom Wall** • vocabulary: *explanation* *teacher provided	• Scaffolded Scientific Explanation • Assessment Guide: Reviewing Students' Chapter 1 Explanations About Stars in the Daytime • Projections: Lesson 1.7	• evidence • explanation • model • solar system • stars • sun • visualize

Patterns of Earth and Sky Lesson Planning Guide

Lesson 1.7: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 2.1: Observing Patterns (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students are introduced to the Mount Nose Model.

Anchor Phenomenon / Everyday Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Everyday Phenomenon:** From a given point on Earth, the sun is only visible for part of the day.	**Students learn:** • There is a daily pattern in which the sun is visible in daytime, and the stars are visible during nighttime. • When scientists have new ideas about answers for their questions, they plan investigations and gather evidence to see if their ideas are supported.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students observe a daily pattern (patterns) of when stars are visible in a digital model (systems and system models), then use a kinesthetic model to connect which way Earth is facing to determine whether the sun or other stars are visible from Earth.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Looking for Patterns (10 min)
Observing the passage of several days in the Patterns of Earth and Sky Simulation allows students to begin to notice a pattern: the sun is visible from a given point on Earth for part of the day, and it is not visible for the other part of the day. Students may also begin to observe that Earth spins. This activity includes an On-the-Fly Assessment to assess students' understanding of daily patterns of when the sun or other stars are visible.

2. Making Observations from Mount Nose (20 min)
Partners work with a variety of materials to model structures that animals and plants use to defend themselves from being eaten. This modeling activity provides a foundation for subsequent modeling activities throughout Chapter 2. Included in this activity is an On-the-Fly Assessment that provides an opportunity to informally assess students' models of defensive structures and functions.

3. Reflecting on the Model (10 min)
Students share ideas with peers as they reflect on the patterns they observed in the Mount Nose Model. Having an opportunity to reflect prepares students for the next set of activities in which they will further investigate the patterns that they have begun to observe.

4. Preparing to Investigate Stars (20 min)
With support from the teacher, students prepare for the investigation that they will conduct using the Patterns of Earth and Sky Simulation in the following lesson.

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 22 and 24–25, optional: page 21) **For the Class** • 1 digital device* • 1 ball, 15 cm diameter (from Lesson 1.5) • masking tape* **For the Classroom Wall** • Chapter 2 Question: Why is the sun up sometimes, but not other times? • vocabulary: *constellation and pattern* *supplied by teacher	• Constellations and Time of Year • Projections: Lesson 2.1	• constellation • investigate • model • pattern • star • sun

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 2.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide Lesson 2.2: The Daily Pattern (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Students collect data from the *Patterns of Earth and Sky* Simulation.		
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** There is a daily pattern of when we see the sun and other stars.	**Students learn:** • Scientists plan investigations to answer their questions. They think about what they will observe and record, as well as what they will change and what they will keep the same. • A day is a period of time that is 24 hours long and includes daytime and nighttime.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 7, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models
3-D statement: Students use a digital model to investigate (systems and system models) what causes (cause and effect) the daily pattern of when stars are visible (patterns). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Reviewing the Investigation Plan (10 min)** Students review their investigation plans from the previous lesson as they prepare to collect data in the Sim that will help them answer the Investigation Question: What causes the daily pattern of when we see the sun and stars? **2. Daily Pattern Investigation in the Sim (25 min)** In pairs, students use the Sim to investigate the daily pattern of when the sun and other stars are visible. They systematically collect data and record it in their Investigation Notebooks. **3. Using Data in an Investigation (10 min)** Students use the data they collected with the Sim to generate answers to the Investigation Question about what causes the daily pattern of when stars are visible. **4. Reflecting on the Practice of Investigation (15 min)** Students reflect on the practice of investigation itself by critiquing an investigation. They discuss and think about the steps of investigation and what makes a well-planned investigation. The teacher uses this opportunity as an On-the-Fly Assessment to assess students' understanding of the science practice of planning an investigation.		

Materials	Digital Resources	Vocabulary
For Each Pair of Students • 1 digital device* **For Each Student** • *Patterns of Earth and Sky* Investigation Notebook (pages 24–25, 27; optional: page 26) **For the Class** • 1 inflatable globe • 1 sheet of chart paper* • marker, wide tip* • masking tape* **For the Classroom Wall** • key concept: *Scientists plan investigations to answer their questions. They think about what they will observe and record, as well as what they will change and what they will keep the same.* • vocabulary: *day* *teacher provided	• Two Completed Rows of the Data Table • Planning an Investigation chart • Projections: Lesson 2.2 • Constellations and Time of Year	• astronomer • constellation • data • investigation • model • pattern • star • sun

Patterns of Earth and Sky Lesson Planning Guide

Lesson 2.2: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 2.3: What We See as We Spin (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: in Activity 1 students return to the Mount Nose Model.

Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** There is a daily pattern of when we see the sun and other stars.	**Students learn:** • Earth's spin can be inferred by seeing the sun and other stars appear to move across the sky, and observed directly by seeing images of Earth from space. • Earth spins once each day. We face the sun in daytime, and we face away from the sun at nighttime.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students participate in a kinesthetic model and create a digital model to show how a spinning Earth causes the daily pattern of when stars are visible (cause and effect, patterns).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

(Teacher Only). Spinning Earth (15 min)
Using a series of photos and a video, students look for evidence to support the idea that Earth's spin causes the daily pattern of when we can see the sun and other stars.

1. Return to Mount Nose (10 min)
Students have the opportunity to connect their experience from the previous day's Patterns of Earth and Sky Simulation activity to the Mount Nose Model.

2. Modeling Our Ideas (20 min)
Students create a digital model to show their understanding of how a spinning Earth creates the experience of the repeating pattern of sun and stars for an observer.

3. Discussion Among Astronomers (15 min)
Students use the Word Relationships routine for the second time to discuss and reflect on what they have learned about why we see a daily pattern of sun and other stars.

Materials	Digital Resources	Vocabulary
For Each Group of Four Students • 1 set of 2.3 Word Relationships cards: (7 cards/set), clipped together **For Each Student** • Patterns of Earth and Sky Investigation Notebook (page 29, optional: page 28) **For the Class** • 1 ball, 15 cm diameter (from Lesson 2.1) • paper clips* • masking tape* **For Each Pair of Students** • 1 digital device* **For the Classroom Wall** • key concept: *Earth spins once each day. We face the sun in daytime, and we face away from the sun at nighttime.* *supplied by teacher	• Projections: Lesson 2.3 • Video: One Year on Earth • Investigating Shadows copymaster	• astronomer • day • evidence • model • pattern • sun • visualize

Patterns of Earth and Sky Lesson Planning Guide

Lesson 2.3: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Cause and Effect • Structure and Function

Patterns of Earth and Sky Lesson Planning Guide
Lesson 2.4: *Which Way is Up?* (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 2-3 students partner read and reflect on *Which Way Is Up?*

Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** When people in different locations on Earth drop rocks, the rocks always fall to the ground.	**Students learn:** • Earth pulls objects, including people, down toward the ground with the force of gravity. • Because of gravity, people all over Earth experience the same perception of up and down, even though Earth is a sphere and spins. • One way to visualize while reading is to use the text and diagrams to make a movie in your mind. • Basic laws of nature are the same everywhere in the universe.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 4, 5, 8 **DCIs** PS2.B, ESS1.B **CCCs** Systems and System Models, Energy and Matter, Structure and Function

3-D statement: Students obtain and evaluate information from a video and the book *Which Way Is Up?* about how gravity causes objects to fall down toward Earth and causes "up" to be away from Earth wherever you are on Earth (cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Making Predictions (10 min)
Students are introduced to the new Investigation Question: If Earth is spinning, which way is up? Students generate ideas about where rocks that are dropped on different sides of Earth would fall. This activity invites students to begin thinking about the force of gravity.

(Teacher Only) Observing The Way Things Fall (10 min)
Students watch a video of people dropping rocks all over Earth and reconsider their initial predictions about where the rocks would fall.

2. Partner Reading (30 min)
Students read *Which Way Is Up?* They use the sense-making strategy of visualizing to support their understanding of the text. This book introduces students to the role that the force of gravity plays in human perceptions of up and down. Included in this activity is an On-the-Fly Assessment to assess students' ability to use the sense-making strategy of visualizing.

3. Reflecting on the Reading (10 min)
After reading, students reflect on their new ideas about the directions up and down after reading Which Way Is Up? Students discuss the idea that down is toward Earth and up is always the opposite of down.

5th Grade Unit 1 Patterns of Earth and Sky

<table>
<tr><th>Materials</th><th>Digital Resources</th><th>Vocabulary</th></tr>
<tr><td>For Each Pair of Students
• 1 copy of Which Way Is Up?
For Each Student
• Patterns of Earth and Sky Investigation Notebook (pages 33–34, optional: pages 30–32)
• 3 sticky notes *
For the Class
• 1 copy of How Big Is Big? How Far Is Far?
• Partner Reading Guidelines chart* (from Lesson 1.6)
• masking tape*
For the Classroom Wall
• vocabulary: gravity
*teacher provided</td><td>• Video: The Way Things Fall</td><td>• day
• gravity
• sphere
• visualize</td></tr>
</table>

<table>
<tr><th colspan="3">Patterns of Earth and Sky Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 2.4: Alignment to NGSS and NYSSLS</th></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
<tr><td>• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 8: Obtaining, Evaluating, and Communicating Information</td><td>PS2.B: Types of Interactions:
• The gravitational force of Earth acting on an object near Earth’s surface pulls that object toward the planet’s center. (5-PS2-1)
ESS1.B: Earth and the Solar System:
• The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)</td><td>• Patterns
• Cause and Effect
• Scale, Proportion, and Quantity
• Systems and System Models</td></tr>
</table>

Patterns of Earth and Sky Lesson Planning Guide Lesson 2.5: How Does Up Change? (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activities 2-3 students use inflatable globes in a kinesthetic model.		
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** When people in different locations on Earth look up at the same time, they see different objects in the sky.	**Students learn:** • Earth pulls objects down toward the ground with the force of gravity, so up is away from the ground, anywhere on Earth. • At the same time, people who are at different locations on Earth may experience different objects when they look up. • The motion of the Moon around Earth results in the Moon sometimes being on the same side of Earth as the sun, and sometimes being on the opposite side of Earth. • The Earth's spin results in the Moon appearing to rise and set each day, just like the sun.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 5, 7, 8 **DCIs** PS2.B, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models
3-D statement: Students use digital and kinesthetic models (systems and system models) to make sense of how Earth's shape and spin cause people in different locations on Earth have different objects above them at the same time of day (cause and effect). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Up and Down at One Time (20 min)** Students have the opportunity to apply the ideas they have been constructing about what is up and what is down as they create a digital model. The teacher **2. Spinning Globes (25 min)** Through a kinesthetic model, students are able to observe how people in different locations on the spinning spherical Earth would have different objects up above them at the same time of day. **3. Positions of the Moon as it Orbits Earth (20 min)** Using the kinesthetic model of what people on Earth see above them as the Earth spins, and a diagram of the Moon's apparent motion, students consider where the Moon is in the sky at different times of day and at points in its orbit around Earth. **4. Up and Down at Two Times (15 min)** Students apply their ideas from the kinesthetic model and create a second digital model that shows how people at different locations on Earth could see the same object up above them at different times.		

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Materials

For Each Group of Four Students
- 1 inflatable globe
- 1 set of four sticky dots (1 each: red, blue, yellow, and green)
- 1 small sphere (table tennis ball)* (5 provided from Lesson 1.4)

For Each Student
- Patterns of Earth and Sky Investigation Notebook (optional: page 35)

For the Class
- 1 ball, 15 cm diameter (from Lesson 2.3)
- permanent marker*
- masking tape*

For the Classroom Wall
- key concept: *Earth pulls objects down toward the ground with the force of gravity, so up is away from the ground, anywhere on Earth.*

For Each Pair of Students
- 1 digital device*

*supplied by teacher

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Digital Resources
- Projections: Lesson 2.5

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Vocabulary
- gravity
- model
- pattern
- sphere
- star
- sun

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<table>
<tr><th colspan="3">Patterns of Earth and Sky Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 2.5: Alignment to NGSS and NYSSLS</th></tr>
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Science and Engineering Practices
- **Practice 2:** Developing and Using Models
- **Practice 3:** Planning and Carrying Out Investigations
- **Practice 5:** Using Mathematics and Computational Thinking
- **Practice 7:** Engaging in Argument from Evidence
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

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Disciplinary Core Ideas

PS2.B: Types of Interactions:
- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)

ESS1.B: Earth and the Solar System:
- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)

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Crosscutting Concepts
- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models

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Patterns of Earth and Sky Lesson Planning Guide
Lesson 2.6: Explaining the Effects of Earth's Spin (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students are introduced to new guidelines of scientific explanations. In Activity 3 students write scientific explanations.

Anchor Phenomenon / Everyday Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Everyday Phenomenon:** From a given point on Earth, the sun is only visible for part of the day.	• A scientific explanation uses scientific language and is written for an audience. • Models can help people reflect on new science ideas. • Science assumes consistent patterns in natural systems.	**SEPs** 2, 4, 6, 8 **DCIs** PS2.B, ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students write explanations to demonstrate their understanding of how Earth's spin causes people on Earth to see a daily pattern of the sun and other stars (patterns), and Earth's gravity causes "up" to be away from Earth everywhere on Earth (cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reviewing Important Ideas (15 min)
Pairs use Explanation Cards and revisit Mount Nose to review key ideas from the chapter. Discussing key ideas while using scientific language helps prepare students to write their own explanations in Activity 3.

2. Two New Scientific Explanation Guidelines (10 min)
Students review the Scientific Explanation Guidelines they learned about in Lesson 1.7 and extend their learning about this genre of scientific writing as they are introduced to two new guidelines.

3. Writing Scientific Explanations (20 min)
Students write an explanation answering the Chapter 2 Question: Why is the sun up sometimes, but not other times? The teacher uses this Critical Juncture Assessment as an opportunity to assess students' understanding of Earth's spin, the concept of gravity, and how gravity affects what we consider to be up.

4. Returning to the Artifact (15 min)
Students return to thinking about the artifact and observe the stars in each section, focusing specifically on recognizing constellations. They think about how it is possible for someone on one side of Earth to see the same constellation as someone else on the other side of Earth.

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • Optional: 1 copy of Chapter 2 Home Investigation: Earth and Stars Quiz student sheet • *Patterns of Earth and Sky* Investigation Notebook (pages 38–40, optional: page 36 and page 41) **For the Class** • optional: Chapter 2 Home Investigation: Earth and Stars Quiz copymaster • 1 inflated globe • sets of Explanation Cards (2 cards/set) • paper clips* **For Each Pair of Students** • 1 set of Explanation Cards, clipped together *teacher provided	• Optional: Chapter 2 Home Investigation: Earth and Stars Quiz • Chapter 2: Scaffolded Scientific Explanation • Assessment Guide: Reviewing Students' Chapter 2 Explanations About Why the Sun Is Up Sometimes, but Not Other Times • Projections: Lesson 2.6	• astronomer • Earth • gravity • sun • star

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 2.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information • **Practice 6:** Constructing Explanations and Designing Solutions	**PS2.B: Types of Interactions:** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1) **ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.1: Stars Through the Year (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students collect data and investigate in the *Patterns of Earth and Sky* Simulation.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** Archaeologists cannot see Orion in the sky at the dig site in June.	• Throughout the year, we see different stars. But every year on the same date, we see the same stars. • Reflecting on a poorly planned investigation can help us do a better job of planning our own systematic investigations.	**SEPs** 2, 3, 4, 5, 8 **DCIs** ESS1.B **CCCs** Patterns; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students evaluate a flawed investigation plan, then plan and conduct their own investigations in a digital model, and analyze their data to find that there is a yearly pattern for when particular stars can be observed (patterns).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. What Pattern Explains the Stars on the Artifact? (10 min)
Further examination of the artifact stimulates a question about whether we see different stars at different times of year.

2. Preparing to Investigate (20 min)
Reflecting on a flawed investigation plan prepares students to better plan their own systematic investigations in the Patterns of Earth and Sky Simulation. The investigation will help them answer the question of whether we see different stars at different times of year.

3. Investigating Stars Through the Year (20 min)
Students gather data in the Patterns of Earth and Sky Simulation and begin to notice a pattern of when the same stars are visible in the night sky.

4. Reflecting on the Data (10 min)
Reflecting on the data from their investigations allows students to confirm that the stars that are visible do change, but they also identify a yearly pattern for when the same stars can be observed. This activity includes an On-the-Fly Assessment of students' ideas about yearly patterns in the sky.

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 43-45, optional: Page 42) • optional: 1 copy of Chapter 3 Home Investigation: Planning and Conducting a Systematic Investigation student sheet **For the Class** • optional: Chapter 3 Home Investigation: Planning and Conducting a Systematic Investigation copymaster • masking tape* **For the Classroom Wall** • Chapter 3 Question: *Why do we see different stars at different times of year?* • key concept: *Throughout the year, we see different stars. But every year on the same date, we see the same stars.* • Planning an Investigation chart* (from Lesson 2.2) **For Each Pair of Students** • 1 digital device* *teacher provided	• Optional: Chapter 3 Home Investigation: Planning and Conducting a Systematic Investigation copymaster • Projections: Lesson 3.1 • Investigating the Sun Throughout the Year copymaster	• constellation • data • day • explanation • investigation • model • pattern • year

Patterns of Earth and Sky Lesson Planning Guide

Lesson 3.1: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Scale, Proportion, and Quantity • Systems and System Models

<table>
<tr><th colspan="3">Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.2: Modeling Earth's Orbit (60 minutes)</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.
Hands-On: In Activity 1 students create constellation posters. In Activity 3 students create a kinesthetic model of Earth, Sun, and stars.</td></tr>
<tr><td>Anchor Phenomenon:
Different sections of an ancient artifact show what the sky looked like from one location and depict different stars.
Investigative Phenomenon:
There is a yearly pattern of which stars and constellations are visible in the sky.</td><td>Students learn:
• A year is the length of time it takes for Earth to orbit the sun once.
• To orbit is to move in a regular path around something. The Earth orbits the sun.</td><td>Alignment to NGSS and NYSSLS
SEPs 2, 4, 5, 8
DCIs ESS1.A, ESS1.B
CCCs Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models</td></tr>
<tr><td colspan="3">3-D statement: Students obtain information about constellations from Handbook of Stars and Constellations, use a digital model to observe how Earth moves, then participate in a kinesthetic model (systems and system models) to visualize Earth's orbit around the sun and construct ideas about how Earth's orbit and spin affect which stars can be seen (cause and effect).
Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts</td></tr>
<tr><td colspan="3">Lesson at-a-Glance
1. Making Constellation Posters (25 min)
Students use the reference book to research a particular constellation and then each group creates a poster for their assigned constellation. Posters will be used in the kinesthetic classroom model during Activity 3.
2. Setting Up the Model (10 min)
Observing how Earth moves in the projected Patterns of Earth and Sky Simulation prepares students to visualize Earth's spin and orbit when they model these movements in the upcoming activity.
3. Modeling Earth, Sun, and Stars (25 min)
Students enact a physical, kinesthetic model of Earth, the sun, and other stars. This model allows students to visualize Earth's orbit around the sun and to begin to understand how Earth's orbit and spin affects what stars can be seen. The teacher uses this On-the-Fly Assessment to assess students' ability to demonstrate Earth's movement.</td></tr>
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Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (optional: page 46) **For the Class** • 8 sheets of 11" x 17" white paper • 1 ball, 15 cm diameter (from Lesson 2.5) • 1 digital device* • masking tape* **For Each Pair of Students** • *Handbook of Stars and Constellations* **For the Classroom Wall** • vocabulary: *orbit* • Partner Reading Guidelines chart (from Lesson 1.1) **For Each Group of Four Students** • 1 sheet of 11" x 17" white paper • dark markers* • ruler* (optional) *supplied by teacher	• Projections: Lesson 3.2	• constellation • day • model • orbit • spin • star • visualize

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 3.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.3: Seeing Stars for a Year (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students plan and conduct an investigation in the *Patterns of Earth and Sky* Simulation.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** There is a yearly pattern of which stars and constellations are visible in the sky.	• Stars are visible in the night sky when we are on the side of Earth that is facing away from the sun. • Earth orbits the sun at the same time as it spins.	**SEPs** 2, 3, 4, 5, 7, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Sytems and System Models

3-D statement: Students use a digital model to investigate patterns of star visibility throughout Earth's orbit (patterns), then use a physical model to visualize how Earth's orbit and spin cause the yearly pattern of which stars are visible (cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. The Relationship Between Spin and Orbit (5 min)
Students reflect on spin and orbit in order to distinguish between these types of motion.

2. Planning a Systematic Investigation (15 min)
Reviewing one poor and one good example of systematic data collection helps students plan their own investigations.

3. Investigating Star Visibility for One Year (20 min)
Students use the Sim to collect data on when a constellation is visible over the course of a year. This activity includes a three-dimensional On-the-Fly Assessment of students' systematic investigation of patterns of star visibility throughout Earth's orbit.

4. Timing of Star Visibility and the Yearly Pattern (15 min)
Students use the data from their Sim investigations to add the names of months to the constellation posters in the Mount Nose Model. These months represent the midpoint of when each constellation is visible. They consider the implications of the yearly pattern of stars that are visible from Earth.

5. Partner Discussion (5 min)
Speaking with peers about their ideas regarding the Investigation Question allows students to synthesize learning and reflect on their current understanding.

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 48-51, optional: pages 47) **For the Class** • 1 digital device* • 8 constellation posters* (from Lesson 3.2) • Planning an Investigation chart* (from Lesson 3.1) • 1 ball, 15 cm diameter (from Lesson 3.2) • 4 sentence strips* • marker, wide tip* • scissors* • masking tape* **For Each Pair of Students** • 1 digital device* **For the Classroom Wall** • vocabulary: *year* • key concept: *Earth orbits the sun as it spins.* *supplied by teacher	• Dates When Constellations Are Visible • Constellations and Time of Year • Projections: Lesson 3.3	• constellation • data • day • investigation • model • orbit • pattern • sun • year

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 3.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3**: Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.4: Dog Days of Summer (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Dog Day of Summer*.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: Different sections of an ancient artifact show what the sky looked like from one location and depict different stars. **Investigative Phenomenon:** There is a yearly pattern of which stars and constellations are visible in the sky.	**Students learn:** • Earth's position in its yearly orbit determines which stars we see in the night sky. • People long ago observed the stars and used yearly star patterns to help them track different times of year. • Visualizing when you read can help you understand things that are difficult to observe.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 8 **DCIs** ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students obtain information from the book *Dog Days of Summer* about how Earth's orbit affects the constellations that can be seen at a given time (patterns, cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing Dog Days of Summer (15 min)
Students are introduced to *Dog Days of Summer* and think more about how visualizing helps them understand science ideas, including those they encounter during reading.

2. Partner Reading (30 min)
Reading *Dog Days of Summer* provides an opportunity for students to explore how Earth's orbit affects the constellations that can be seen at a given time. Students are able to apply the sense-making strategy of visualizing as they work to understand this concept. This activity includes an On-the-Fly Assessment to assess students' understanding of the sensemaking strategy of visualizing.

3. Placing the Dog Star in the Classroom Model (15 min)
Students apply new ideas from their reading as they discuss where the Dog Star would be located in the classroom model and refer to other models for verification.

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (optional: pages 52-54) • 3 sticky notes* **For the Class** • Partner Reading Guidelines (from Lesson 1.1) • 8 constellation posters with labels* (from Lesson 3.2 and 3.3) • 1 sheet of 11" x 17" white paper • marker, wide tip* • 1 ball, 15 cm diameter (from Lesson 3.3) • masking tape* **For the Classroom Wall** • key concept: *Earth's position in its yearly orbit determines which stars we see in the night sky*. **For Each Pair of Students** • 1 copy of *Dog Days of Summer* *supplied by teacher	• Projections: Lesson 3.4	• astronomer • constellation • evidence • investigation • orbit • pattern • star • year

Patterns of Earth and Sky Lesson Planning Guide

Lesson 3.4: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.5: Modeling Constellations over Time (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students model ideas in the *Patterns of Earth and Sky* Modeling Tool and revisit *Handbook of Stars and Constellations*.

Anchor Phenomenon:
Different sections of an ancient artifact show what the sky looked like from one location and depict different stars.

Investigative Phenomenon: There is a yearly pattern of which stars and constellations are visible in the sky.

Students learn:
- Patterns can help scientists make predictions.

Alignment to NGSS and NYSSLS
SEPs 2, 4, 5, 6, 8
DCIs ESS1.B
CCCs Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students create digital models and write explanations to demonstrate their understanding of how Earth's movement causes a pattern in what stars are visible throughout the year (cause and effect, patterns).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Modeling Orbit and Stars (30 min)
Students use the Patterns of Earth and Sky Modeling Tool to demonstrate their current understanding of what time of year various constellations can be seen due to Earth's orbit. Students then write about how the movement of Earth affects how the visibility of stars changes throughout the year. The teacher uses this Critical Juncture Assessment as an opportunity to review students' understanding of how Earth's orbit affects which stars can be seen at a given time.

2. Identifying Another Constellation on the Artifact (20 min)
Students refer to the Mount Nose Model and the Patterns of Stars and Sky Simulation as they identify a second constellation on the artifact and the month it is most visible.

3. Identifying a Third Constellation (10 min)
Handbook of Stars and Constellations gives students the information they need to identify the third constellation on the artifact. This prepares students for the next lesson when they will finally work out what would have been depicted on the missing piece of the artifact.

Materials

For Each Student
- *Patterns of Earth and Sky* Investigation Notebook (pages 56-57, optional: pages 55)

For the Class
- 8 constellation posters and labels (from Lesson 3.4)
- masking tape*

For Each Pair of Students
- 1 copy of *Handbook of Stars and Constellations*
- 1 digital device*

*supplied by teacher

Digital Resources
- Projections: Lesson 3.5

Vocabulary
- constellation
- investigation
- orbit
- pattern
- year

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 3.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Crosscutting Concepts** • Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 3.6: End-of-Unit Assessment (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students write final scientific explanations

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
Different sections of an ancient artifact show what the sky looked like from one location and depict different stars.	• Sometimes investigations are not limited to a single correct response — there are multiple answers that would be both reasonable and possible.	**SEPs** 2, 4, 5, 6, 8 **DCIs** PS2.B, ESS1.A, ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students write explanations, applying their understanding of what causes the daily and yearly patterns of when people see the sun and other stars in the sky (cause and effect, patterns).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Identifying the Missing Constellation (20 min)
The teacher projects the Patterns of Earth and Sky Simulation to help students identify possible constellations for the missing piece of the artifact. Students solve the problem they have been working on since Lesson 1.1.

2. Writing Final Explanations (40 min)
Students share information for the Museum of Archaeology's artifact display. This engages students in writing the final explanation that answers the Chapter 3 Question, as well as in demonstrating their understanding of key concepts from Chapters 1 and 2. This writing serves as the End-of-Unit Assessment.

Materials

For Each Student
- 1 copy of End-of-Unit Writing: Explaining the Artifact Version A student sheet (optional: Version B)
- *Patterns of Earth and Sky* Investigation Notebook (page 59, optional: pages 58 and 60)

For the Class
- End-of-Unit Writing: Explaining the Artifact Version A copymaster (optional: Version B)
- stapler*
- digital device*

*supplied by teacher

Digital Resources
- Assessment Guide: Assessing Students' End-of-Unit Explanations About the Artifact
- End-of-Unit Writing: Explaining the Artifact Version A copymaster
- Optional: End-of-Unit Writing: Explaining the Artifact Version B copymaster
- Projections: Lesson 3.6

Vocabulary
- astronomy
- astronomer
- constellation
- day
- evidence
- explanation
- gravity
- investigation
- model
- orbit
- pattern
- solar system
- star
- sun
- year

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 3.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS2.B: Types of Interactions:** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1) **ESS1.A: The Universe and Its Stars:** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1) **ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	**Crosscutting Concepts** • Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide
Lesson 4.1: Star Scientist (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on Star Scientist.

Investigative Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
We see different stars in the sky on different nights.	• Scientists choose questions to investigate that can be answered through measurement and observation. • Scientists can sometimes use the same data to answer new questions. • Reading about the work of scientists can help students plan their own investigations. • Scientists use a variety of methods, tools, and techniques when they conduct investigations. • Science findings are based on recognizing patterns. • Science uses tools and technologies to make accurate measurements and observations. • Science findings are limited to what can be answered with evidence.	**SEPs** 1, 3, 4, 8 **DCIs** ESS1.B **CCCs** Patterns; Cause and Effect; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students read the book Star Scientist about an investigation that a team of astronomers conducted to figure out whether other stars besides the sun have planets orbiting them. They learn that, since the stars are so far away, the astronomers had to analyze a lot of data to find patterns that would help them answer their question (patterns).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing Star Scientist (5 min)
Students are introduced to Star Scientist and to the purpose for reading: prepare to plan and conduct their own investigations over the next two lessons.

2. Partner Reading (25 min)
Students continue visualizing as they read Star Scientist with a partner. The investigation highlighted in the text models the process of planning and conducting an investigation. This activity includes an On-the-Fly Assessment to assess students' understanding of the sense-making strategy of visualizing.

3. Returning to the Book (15 min)
Students return to the book and record ideas about how the astronomy team planned and conducted an investigation. This prepares them for planning and conducting their own investigations.

4. Choosing a Question (15 min)
Using the Think-Write-Pair-Share routine, students reflect on their new ideas about planning and completing an investigation. In pairs, they review the list of questions that they will choose from and investigate in the following lessons.

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 64–66, optional: pages 61–63) • 3 sticky notes* • optional: 1 copy of Chapter 4 Home Investigation: Making an Artifact student sheet **For the Class** • Partner Reading Guidelines (from Lesson 1.1) • optional: Chapter 4 Home Investigation: Making an Artifact copymaster • masking tape* **For Each Pair of Students** • 1 copy of Star Scientist **For the Classroom Wall** • Chapter 4 Question: *How can we investigate why we see different stars on different nights?* *supplied by teacher	• Optional: Chapter 4 Home Investigation: Making an Artifact copymaster • Projections: Lesson 4.1 • Review Student Supports for Each Investigation Question	• astronomer • data • investigation • orbit • pattern • star

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 4.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 1:** Asking Questions and Defining Problems • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Cause and Effect • Scale, Proportion, and Quantity • Systems and System Models

<table>
<tr><th colspan="3">Patterns of Earth and Sky Lesson Planning Guide
Lesson 4.2: Planning Investigations (60 minutes)</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.
Students plan an investigation in the Patterns of Earth and Sky Simulation.</td></tr>
<tr><td>Investigative Phenomenon:
We see different stars in the sky on different nights.</td><td>Students learn:
• Scientists carefully plan their investigations, including how they will record their data.
• Scientists often revise their investigation plans in order to improve them.
• Scientists offer feedback to their peers as a way of improving their plans.
• The methods scientists use are determined by the questions they are investigating.</td><td>Alignment to NGSS and NYSSLS
SEPs 1, 2, 3, 5, 8
DCIs ESS1.B
CCCs Patterns; Scale, Proportion, and Quantity; Systems and System Models</td></tr>
<tr><td colspan="3">3-D statement: Students ask questions and plan how to systematically collect data to investigate their questions about patterns in the visibility of stars and constellations (patterns).
Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts</td></tr>
<tr><td colspan="3">Lesson at-a-Glance
1. Modeling Planning an Investigation (10 min)
Students provide input as the teacher drafts a plan for systematic data collection. This modeling prepares students to work in pairs to draft an initial plan for investigating a constellation or star of their choosing later in the lesson.
2. Providing Feedback (15 min)
Students evaluate a poorly designed data collection plan and observe as the teacher revises the plan in response to their feedback. This activity prepares students to provide feedback to and receive feedback from their peers.
3. Drafting an Investigation Plan (25 min)
Students receive feedback from peers and revise the investigation plans that they will carry out in the following lesson. The teacher uses this opportunity as an On-the-Fly Assessment to assess students' understanding of planning an investigation in a systematic manner.
4. Modeling Data Collection (10 min)
The teacher projects the Patterns in Earth and Sky Simulation and models using the Sim to collect data to answer a question. This prepares students to collect their own data in the next lesson.</td></tr>
</table>

5th Grade Unit 1 Patterns of Earth and Sky

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 68–69, optional: page 67) **For the Class** • Planning an Investigation chart* (from Lesson 3.3) • 3 sheets of chart paper* • markers, 1 dark and 1 bright color* • masking tape* **For Each Pair of Students** • 1 digital device* *supplied by teacher	• Investigation Plan chart • Poorly Designed Data Table • Student Supports for Each Investigation Question • Projections: Lesson 4.2	• astronomer • constellation • data • day • investigation • pattern • star • year

Patterns of Earth and Sky Lesson Planning Guide

Lesson 4.2: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Scale, Proportion, and Quantity • Systems and System Models

Patterns of Earth and Sky Lesson Planning Guide Lesson 4.3: Student's Investigations of Constellations or Stars (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Students conduct their investigations in the *Patterns of Earth and Sky* Simulation.		
Investigative Phenomenon: We see different stars in the sky on different nights.	**Students learn:** • During an investigation, scientists revise their data collection methods when they encounter problems. • Scientists share and discuss their initial results in order to help them understand the data they are collecting.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4, 5, 8 **DCIs** ESS1.B **CCCs** Patterns; Scale, Proportion, and Quantity; Systems and System Models
3-D statement: Students conduct their investigations of patterns in the visibility of stars and constellations (patterns). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Conducting the Investigation (15 min)** Students begin to conduct the investigations they planned in the previous lesson. This initial investigation activity allows students to gauge whether additional revisions to their investigation plans will be needed. **2. Reflecting on Investigations (15 min)** Students support one another in a whole-class setting as they share questions or challenges that arose during the investigation. Students have an opportunity to revise their plans with their partners, as necessary, in preparation for restarting the investigation during the following activity. **3. Returning to the Investigation (25 min)** Students follow their updated investigation plans and conduct the investigation again. Student work from Activities 2 and 3 may be summatively assessed using the rubric provided in Assessment Guide: Assessing Students' Investigations of a Constellation or Star (in Digital Resources). **4. Concluding the Unit (5 min)** Students reflect on patterns and discuss some key science practice takeaways from the Patterns of Earth and Sky unit.		

Materials	Digital Resources	Vocabulary
For Each Student • *Patterns of Earth and Sky* Investigation Notebook (pages 68–69, 72–73, and 76; optional: pages 70, 74–75, and 77) **For the Class** • Planning an Investigation chart* (from Lesson 4.2) • masking tape* **For Each Pair of Students** • 1 digital device* • optional: 1 copy of *Handbook of Stars and Constellations* *supplied by teacher	• Assessment Guide: Assessing Students' Investigations of a Constellation or Star • Student Supports for Each Investigation Question	• constellation • data • day • evidence • investigation • orbit • pattern • star • sun • year

Patterns of Earth and Sky Lesson Planning Guide		
Lesson 4.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS1.B: Earth and the Solar System:** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	• Patterns • Scale, Proportion, and Quantity • Systems and System Models

Standards & Goals

5th Grade Unit 2
Modeling Matter
Recommended time frame: 8 weeks

This Implementation and Planning Guide includes text from one of the Unit Overview Documents, *Standards and Goals*.

Please see additional Unit Overview documents in the unit's Teacher's Guide for full reference and planning guidance.

Standards and Goals

Focal Performance Expectations

- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]
- 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.[Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]
- 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]
- 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Unit-level 3-D Statement:

- Students are introduced to the particulate model of matter (energy and matter) and apply it in their role as food scientists as they explain how to separate a food-coloring mixture and how to create a stable salad dressing (stability and change). They do this by making firsthand observations of a variety of macroscale phenomena involved in separating and creating mixtures and then by creating diagram models and using physical and digital models to visualize what might be happening at the nanoscale (scale, proportion, and quantity).

Key
Practices
Disciplinary Core Ideas
Crosscutting Concepts

Connections to Other Performance Expectations

This unit supports students in making connections to the disciplinary core ideas represented in these additional Performance Expectations, which are also addressed in other Amplify Science units.

- **5-PS1-4.** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

  Note: Students focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *The Earth System* unit, and they make additional connections to these concepts in the Amplify Science *Ecosystem Restoration* unit.

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

  Note: Students focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *The Earth System* unit, and they make additional connections to these concepts in the Amplify Science *Ecosystem Restoration* unit.

Standards & Goals

Science and Engineering Practices

The *Modeling Matter* unit provides students with exposure to all of the eight science and engineering practices described in the NGSS. For these practices (listed below in order of particular emphasis) the unit provides students with explicit instruction and expectations for increasing independence over the course of the unit.

- **Practice 2: Developing and Using Models.** Students receive explicit instruction and opportunities to practice using models and developing and revising models by 1) creating models of molecules at the nanoscale to explain what they observed on an observable scale, and 2) using physical models to show how properties of molecules affect interactions between and among different kinds of molecules.
- **Practice 6: Constructing Explanations.** Students learn about scientific explanations and have multiple opportunities to write increasingly complex explanations over the course of the unit, learning that they must make inferences about phenomena too small to be seen, based on evidence.
- **Practice 8: Obtaining, Evaluating, and Communicating Information.** Just as students focus on making inferences in science, students receive explicit instruction and have multiple opportunities to use the reading comprehension strategy of making inferences as they engage with the informational texts in the unit. They gather evidence through firsthand and secondhand sources, as well as participate in various discourse routines that help them communicate about and make sense of science ideas, using key vocabulary.
- **Practice 3: Planning and Carrying Out Investigations.** Students conduct various hands-on investigations to test substances in order to gather evidence about the observable-scale properties and interactions of various substances. They use this information as they work to understand and explain the related nanoscale phenomena. Students also carry out investigations about what is happening at the nanoscale, using the Modeling Matter Simulation and the Modeling Matter Diagramming Tool.
- **Practice 4: Analyzing and Interpreting Data.** While students are investigating substances, they are making observations to help draw conclusions about phenomena at the nanoscale.
- **Practice 7: Engaging in Argument from Evidence.** Throughout the unit, students evaluate one another's model's claims.
- **Practice 1: Asking Questions and Defining Problems.** When students use the Modeling Matter Simulation, they are asking questions they can investigate and predicting reasonable outcomes based on patterns and cause-and-effect relationships.
- **Practice 5: Using Mathematics and Computational Thinking.** Students look for patterns in a data set to determine whether more drops of water or more drops of oil fit on a penny.

In all Amplify Science units, practices from the NGSS, the CCSS-ELA, and the CCSS-Math are linked. For instance, when students make diagrams of the molecules in substances, they are also engaging in the CCSS-Math Practices 1 and 4 (Practice 1: Make sense of problems and persevere in solving them, Practice 4: Model with mathematics). When students analyze and interpret data, use that data to inform their explanations, and engage with science text, they are developing the foundational capacity to build knowledge about a phenomenon through research and to respond analytically to informational sources, as called for by the CCSS-ELA Standards.

5th Grade Unit 2 Modeling Matter

Disciplinary Core Ideas

Focal Disciplinary Core Ideas

This unit addresses the following core ideas:

PS1.A: Structure and Properties of Matter:

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1)
- (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
- Measurements of a variety of properties can be used to identify materials. (5-PS1-3)

Connections to Other Disciplinary Core Ideas

This unit provides opportunities to make connections to these core ideas, which are also addressed in other Amplify Science units.

PS1.B: Chemical Reactions:

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)

ETS1.B: Developing Possible Solutions:

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

Crosscutting Concepts

The crosscutting concept emphasized in the *Modeling Matter* unit is Scale, Proportion, and Quantity. In their role as food scientists, students delve deeply into the particulate nature of matter as they investigate what is happening at the macroscale and nanoscale in two food-related mixtures. As students begin to understand the nanoscale explanation for the observable macroscale separation of dyes, they create and revise a series of nanovision models of chromatography, dissolving, liquids that mix and don't mix, and emulsifiers to describe their thinking. Students return to the idea of scale again and again throughout the unit, through a variety of modalities.

Do. Students count the number of drops of a liquid that can stay on a penny and observe the shape of the liquid on the coin to notice that some liquids hold together better than others. Then, students engage in the All Aboard Model, as individual students (representing individual molecules of a liquid) attempt to all stand in a designated square on the floor (representing the penny). Students discover that when they hold on to one another, more students can fit in the square. They reflect on what this could indicate about the molecules in liquids that hold together well as compared to liquids that don't hold together as well.

Talk. Multiple opportunities for student-to-student talk engage the class in figuring out what they can infer about the properties of molecules, based on the observable properties of substances.

Read. Students read a book about the concept that everything is made of atoms and molecules, and they reflect on the relative size of these particles that are too small to see.

Write. During the course of the unit, students write several scientific explanations about changes that occur when they make or separate mixtures; they describe various phenomena at both the molecular level and at the observable scale.

Visualize. Through developing models, students work to visualize the properties of molecules and how those properties affect the observable interactions of substances.

There are also opportunities to emphasize the crosscutting concepts of Systems and System Models (e.g., students have numerous opportunities to work with models of the solar system and parts of the Milky Way); Cause and Effect (e.g., students investigate what causes the patterns of sun and stars that they observe); and Scale, Proportion, and Quantity (e.g., students explore the relative sizes of objects and distances between objects in space).

Background Knowledge and Alternate Conceptions

Background Knowledge and Alternate Conceptions	
Modeling Matter includes a pre-unit assessment in lesson 1.1 in which students make a scientific explanation. This pre-unit writing assessment is an opportunity for students to express their initial ideas about why some substances mix together and others do not. This provides students with an opportunity to connect their background knowledge and the initial ideas they have to the concepts they will be learning about in the Modeling Matter: The Chemistry of Food unit. It can also provide insight into students' thinking as you begin this unit of instruction. This will allow you to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding. **Note:** For full details, see the assessment task and associated Assessment Guide in lesson 1.1.	
Connecting to students' experiences. Examples of students' experiences to which you can connect the content of specific lessons in the unit: • cooking or helping with cooking • experience with common kitchen ingredients • dissolving substances in a sink or bathtub	**Building on prior knowledge**. Ideas about substances on which students can build: • Substances have distinctive properties (e.g., color, smell, texture, etc.). • Some substances mix or dissolve, while others do not.
Gauging students' facility with science practices. Since students write scientific explanations for this task, it offers an entry-level assessment of students' facility with this science and engineering practice.	**Applying crosscutting concepts.** Examples of ways students could demonstrate facility with the crosscutting concept of Scale, Proportion, and Quantity: • Substance B spread out into pieces that are still there, but are too small to see. (Applying the idea that *natural objects exist from the very small to the very large*.)
Preconceptions to watch out for over the course of the unit: • Matter is continuous rather than particulate. Students often think that substances, especially solids and liquids, are continuous—there is no level at which they are made of separable pieces. This is a sensible idea, as substances at the scale that we can observe appear smooth and consistent. • However, this view cannot explain phenomena such as a solid dissolving in a liquid. • Properties are the same at all scales. As students first learn about atoms and molecules, they often think of them as much smaller versions of the substance they observe, with the same characteristics such as color, hardness, or stickiness. While molecules do have properties, they typically do not parallel those of the observable substance. Water molecules, for example, have a relatively high attraction to one another and to many other molecules, but we do not experience water as sticky at the observable scale. • In dissolving or mixing, one substance takes on the properties of another. Students will sometimes explain the apparent disappearance or incorporation of a substance into another as one substance taking the property of another. When salt dissolves in water, for example, the water molecules become salty. • Substances do not mix because they can resist incorporation. Students will sometimes explain not mixing as the result of a substance being able to "resist" mixing with another substance. Sometimes this is associated with other properties of a substance (e.g., the substance wasn't hard enough to prevent it from mixing).	

5th Grade Unit 2 Modeling Matter

<table>
<tr><th colspan="3">Grade 5 Unit 2 Pacing Guidance at-a-glance
Modeling Matter</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: All lessons can be taught by either teacher. The lessons in bold include activities with a particular literacy emphasis and the lessons with * include activities with a particular hands-on emphasis. Keep in mind that all Amplify Science lessons engage students in reading, writing, and/or discourse, as well as in scientific inquiry, so refer to the lesson-by-lesson guidance for details as you plan to teach.</td></tr>
<tr><td colspan="3">Pacing assumes 1 lesson per day, 3 times per week. Lessons are each 60 minutes long. Occasional weeks with 2 lessons affords flex time, to make up instructional minutes and/or differentiate according to formative assessment.</td></tr>
<tr><td rowspan="8">Recommended time frame:
8 weeks

November through January</td><td>Week 1</td><td>1.1: Pre-Unit Assessment: Students' Initial Explanations
1.2: Introducing Food Science*</td></tr>
<tr><td>Week 2</td><td>1.3: Made of Matter
1.4: Separating a Food-Coloring Mixture*
1.5: Exploring Another Model of Chromatography*</td></tr>
<tr><td>Week 3</td><td>1.6: Nanovision Models of Chromatography
1.7: Break It Down
1.8: Evaluating Chromatography Models</td></tr>
<tr><td>Week 4</td><td>1.9: Revising Chromatography Models
1.10: Explaining Chromatography
2.1: Investigating Flavor Ingredients*</td></tr>
<tr><td>Week 5</td><td>2.2: Investigating Dissolving
2.3: Reading About Dissolving
2.4: Models of Solubility</td></tr>
<tr><td>Week 6</td><td>2.5: Making Sense of Solubility
3.1: Investigating Attraction*
3.2: Science You Can't See</td></tr>
<tr><td>Week 7</td><td>3.3: Modeling Mixtures
3.4: Investigating Emulsifiers*
3.5: Models of Emulsifiers</td></tr>
<tr><td>Week 8</td><td>3.6: Creating Digital Models of Emulsifiers
3.7: End-of-Unit Assessment</td></tr>
</table>

Modeling Matter Lesson Planning Guide
Lesson 1.1: Pre-Unit Assessment: Students' Initial Explanations (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students are introduced to the unit and to their role as well as *Food Scientist's Handbook*. In activity 2, students write their initial explanations as a pre-unit assessment.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
One powder disappears when mixed with a liquid, but another settles to the bottom of the liquid's container.	• Reflecting on what you understand and don't understand allows you to prepare for learning new things. • Food scientists create new foods and understand the science behind why things happen the way they do when creating mixtures. • Scientists use a variety of methods, tools, and techniques when they conduct investigations. • Scientists use tools and technologies to make accurate measurements and observations. • Science affects everyday life.	**SEPs** 6 and 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity

3-D statement: Students observe and compare photographs of two mixtures: a clear liquid mixed with Substance A (which dissolves) and Substance B (which doesn't dissolve), and they explain why something different happened with each of the two substances. This provides an opportunity to assess students' preconceptions about matter at different scales (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the Context (10 min.)
Students are introduced to the unit, *Modeling Matter*, and to what food scientists do.

2. Students Write Initial Explanations (20 min.)
Students look at images of two white powders, each of which is mixed in separate containers of the same clear liquid. Students' initial explanations (why substances mix or stay separate) reveal their initial understanding of the core content of the unit. Students' explanations can be interpreted by using Assessment Guide: Interpreting Students' Pre-Unit Explanations About Mixtures (in Digital Resources). In addition to providing insight to you, asking students to take stock of their initial knowledge helps prepare them to make connections to new knowledge.

3. Introducing Investigation Notebooks (10 min.)
Students receive their *Modeling Matter* Investigation Notebooks and learn some of the ways that scientists use notebooks.

4. Providing the Context of Food Science (20 min.)
Students are introduced to the unit's reference book, *Food Scientist's Handbook*.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	No Vocabulary
For the class • Pre-Unit Writing: Explaining Mixtures copymaster • Stapler* **For each pair of students** • 1 copy of *Food Scientist's Handbook* **For each student** • 1 copy of the Pre-Unit Writing: Explaining Mixtures student sheets • *Modeling Matter* Investigation Notebook (page 1) *teacher provided	• Pre-Unit Writing: Explaining Mixtures copymaster • Assessment Guide: Interpreting Students' Pre-Unit Explanations About Mixtures • Projections: Lesson 1.1 • Question Strategies for Grades 2-5 • Investigation Notebook	

Modeling Matter Lesson Planning Guide		
Lesson 1.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide Lesson 1.2: Introducing Food Science (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activities 1-2 students plan and conduct an investigation of food mixtures using food ingredients.		
Anchor Phenomenon: Different mixtures with different properties.	**Students learn:** • A property is what you can observe or measure about something that helps you identify or describe it. • A mixture is made of more than one substance. • Different substances have different observable properties.	**Alignment to NGSS and NYSSLS** **SEPs** 3, 4, 7, 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity; Cause and Effect; Patterns
3-D statement: Students investigate various mixtures of food substances in order to identify similarities and differences in the mixtures and classify mixtures based on their properties (e.g., thickness, color) (patterns). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Preparing to Investigate (10 min.)** Students learn about their role in this unit as food scientists and practice making observations of a familiar food mixture in order to get ready to investigate and talk like food scientists. They are introduced to the concept of properties. **2. Food-Mixture Investigations (30 min.)** Students engage in practices as food scientists do—they make firsthand observations and conduct simple tests with food mixtures to identify the properties of each mixture. This activity provides an On-the-Fly Assessment for observing and describing properties of mixtures. **3. Debriefing Properties of Food (20 min.)** The class discusses their observations of properties of the food mixtures, and then pairs further discuss their observations by using the Shared Listening routine. The teacher introduces the idea of posting new things they learn on the classroom wall. Students relate their findings back to the Unit Question and to their role as food scientists.		

5th Grade Unit 2 Modeling Matter

Materials

For the class

- Unit Question: *What happens when two substances are mixed together?*
- Section headers: Key Concepts, Vocabulary
- 4 vocabulary cards: *mixture, observe, property, substance*

For the Class

- Optional: Chapter 1 Home Investigation: Food Mixtures copymaster
- 3 bottles of food coloring (red, blue, yellow)
- 1 container of vinegar
- 1 plastic spoon
- 1 small plastic cup
- 1 paper-towel strip*
- flour*
- ketchup (or mustard, mayonnaise, ranch dressing)*
- 1-cup measuring cup*
- 1-tablespoon measuring spoon*
- pitcher*
- 3 bowls*
- 1 sheet of chart paper*
- newspaper*
- water*
- scissors*
- marker*
- masking tape*

Materials, cont.

For Each Group of Four Students

- 1 tray*
- Cup 1 (with flour and vinegar mixture)
- Cup 2 (with flour, food coloring, and water mixture)
- Cup 3 (with flour and water mixture)
- 6 paper-towel strips*
- 3 spoons
- 4 pairs of goggles*

For Each Student

- Optional: Chapter 1 Home Investigation: Food Mixtures student sheet
- *Modeling Matter* Investigation Notebook (pages 1, 3)

*teacher provided

Digital Resources

- Properties of Matter Chart: Completed
- Projections: Lesson 1.2
- Optional: Chapter 1 Home Investigation: Food Mixtures Copymaster

Vocabulary

- mixture
- observe
- property
- substance

Modeling Matter: Lesson 1.2

Modeling Matter Lesson Planning Guide		
Lesson 1.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 3:** Developing and Using Models • **Practice 4**: Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Scale, Proportion, and Quantity • Cause and Effect • Patterns

Modeling Matter Lesson Planning Guide
Lesson 1.3: Made of Matter (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Made of Matter.*

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
Different mixtures with different properties.	• All matter is made of atoms, the smallest pieces of matter. • Molecules are groups of atoms joined together. • Atoms and molecules are tiny nanoscale particles that are too small to see at the observable scale. • Diagrams, photos, and captions in informational text provide important information about key ideas.	**SEPs** 2 and 8 **DCIs** PS1.A,ETS1.B **CCCs** Scale, Proportion, and Quantity; Energy and Matter

3-D statement: Students read the book *Made of Matter* and explore with the digital Scale Tool to obtain and evaluate information about the particulate nature of matter (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the Nanoscale (10 min.)
In order to connect students' understanding of the observable scale to the nanoscale, the teacher demonstrates the Scale Tool. Students are introduced to the idea that everything is made of matter and that the tiny bits of matter are called atoms and molecules.

2. Previewing Made of Matter (10 min.)
Students are introduced to the book *Made of Matter* and discuss how the visual representations and captions are important in understanding the book's concepts.

3. Partner Reading (30 min.)
Students read the book *Made of Matter* to become more familiar with the particulate nature of matter and to learn a number of key concepts about matter, molecules, and atoms as they continue developing ideas about the nanoscale. This activity provides an On-the-Fly Assessment to informally assess students' understanding of the crosscutting concept of Scale.

4. Discussing Models and Matter (10 min.)
The class thinks more deeply about the use of models in *Made of Matter* and summarizes the relationship between atoms and molecules. The Matter chart is introduced, which helps frame the unit and provides an ongoing and accessible visual reference of new terms and related concepts.

Modeling Matter: Lesson 1.3

Materials	Digital Resources	Vocabulary
For the Classroom Wall • 4 vocabulary cards: *atom, matter, model, molecule* **For the Class** • 1 digital device, with Scale Tool • 2 sheets of chart paper* • marker* • masking tape* **For Each Pair of Students** • 1 copy of *Made of Matter* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 4–7) *teacher provided	• Master Chart: Completed • Partner Reading Guidelines	• atom • matter • mixture • model • molecule • substance

Modeling Matter Lesson Planning Guide		
Lesson 1.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	• Scale, Proportion, and Quantity • Energy and Matter

Modeling Matter Lesson Planning Guide
Lesson 1.4: Separating a Food-Coloring Mixture (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

The purpose of this lesson is for students to see that the technique of chromatography can be used to separate a mixture into its component parts and for students to begin to use models to try and figure out how chromatography works.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
A food coloring separates into three dyes.	• Water molecules are highly attracted to one another and to many other kinds of molecules. • Substances are made of only one kind of molecule. • All molecules of one substance are exactly the same, and they are different from molecules of any other substance. • Chromatography is a technique that scientists use to separate mixtures into their component substances.	**SEPs** 2, 3, 4, 6, 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity; Energy and Matter; and Patterns

3-D statement: Students use the process of chromatography to separate a mixture of food coloring into its component dyes. They then use a physical model to reflect on how similarities and differences in molecules (patterns) could help them explain what might be happening at the nanoscale that is causing the food dyes to separate (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the Harmful-Dye Context (5 min.)
Students receive their assignment from the president of Good Food Production, Inc.

2. Separating the Food Coloring (15 min.)
Students set up and conduct a chromatography test on Good Food Production, Inc.'s food coloring to see whether the food coloring is a mixture of dyes and, if so, what dyes might be part of the food coloring.

3. Making the Pasta Model (10 min.)
The class observes a model designed to demonstrate that the properties of individual molecules are an important aspect of understanding how chromatography might work.

4. Discussing Chromatography Results (15 min.)
After letting their chromatography tests run for about 10 minutes, students remove their chromatography strips from the water to observe the results. Partners explain and make sense of the results.

5. Writing About Molecules (15 min.)
Students use the Shared Listening routine to discuss the ways in which molecules are similar and different, and then they write about their ideas. This activity includes an On-the-Fly Assessment to take notice of students' developing ideas about molecules.

Modeling Matter: Lesson 1.4

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *All molecules of one substance are exactly the same, and they are different from molecules of any other substance.* • Matter chart • Properties of Matter chart **For the Class** • 1 strip of chromatography paper • 3 bottles of food coloring (red, blue, yellow) • 5 large plastic cups • 1 small plastic cup • large pasta (penne or shells) • small pasta (orzo) • medium pasta (elbow macaroni) • 1–2 toothpicks*X • 2 sheets of chart paper* • 1 sheet of paper towel* • 1 large clear container with lid (at least 16 oz.)* • pitcher* • water* • marker* • masking tape* • clear tape* • 1 pencil* • 1 pair of scissors* **For Each Group of Four Students** • 1 tray* • 2 large plastic cups • 2 prepared strips of chromatography paper • 2 pencils* • 2 small pieces of masking tape* • 4 small pieces of clear tape* • 1 pair of scissors* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 8–10) *teacher provided	• Projections: Lesson 1.4 • Chromatography Observations Chart • Chromatography Diagram Completed • Matter Chart Completed • Properties of Matter Chart Completed	• mixture • model • molecule • observe • substance

Modeling Matter Lesson Planning Guide		
Lesson 1.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Energy and Matter

Modeling Matter Lesson Planning Guide Lesson 1.5: Exploring Another Model of Chromatography (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activity 3 students use various materials to model chromatography with a fan.		
Anchor Phenomenon: A food coloring separates into three dyes.	**Students learn:** • Different molecules have different properties (size, weight, shape, attraction to one another). • Models help us understand things that we cannot directly observe. • Inferences are conclusions that we can draw from what is known and observable. • Scientists make inferences about the world by using models.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 6, 8 **DCIs** PS1.A **CCCs** Energy and Matter; Patterns; Scale, Proportion, and Quantity; Structure and Function
3-D statement: Students use a second physical model, the Fan Model, to identify more similarities and differences in molecules (patterns) that can help them explain what might be happening at the nanoscale that is causing the food dyes to separate (scale, proportion, and quantity). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Reading the President's Emails (5 min.)** Reading correspondence from the president of Good Food Production, Inc. sets the context for students' further explorations of what made the dye molecules in the food coloring separate. **2. Thinking About Chromatography (15 min.)** The class is reminded of what chromatography is—a method for separating mixtures. They learn that chromatography tests always include a medium (in this case, the chromatography paper), a solvent that travels up the medium (in this case, water), and a test substance that the solvent passes through (in this case, the food-coloring mixture). This helps students be able to connect the Fan Model of chromatography with the paper chromatography tests they did in the last lesson. The teacher also introduces the Models chart to help students think about the ways they are learning about things at the nanoscale. **3. Introducing the Fan Model (15 min.)** Students observe a demonstration that uses a fan to model chromatography. They observe that moving air from the fan (the model of a solvent) can move some objects (the model's molecules) across the floor but not others, providing evidence that the properties of the different objects can explain how far they travel across the floor (the model's medium). **4. Reflecting on Fan Model and Properties of Molecules (15 min.)** The class reflects on what they observed from the Fan Model and identifies two more properties of molecules—weight and attraction to other molecules. This activity includes an On-the-Fly Assessment as you listen to students' conversations about the properties of molecules. **5. Scientists Make Observations and Inferences (10 min.)** The teacher concludes the lesson by introducing the role of observations and inferences in science.		

<table>
<tr><th>Materials</th><th>Digital Resources</th><th>Vocabulary</th></tr>
<tr><td>For the Classroom Wall
• Chapter 1 Question: Why did the food coloring separate into different dyes?
• key concept: Different molecules have different properties.
• 3 vocabulary cards: attract, evidence, inference
• Chromatography Diagram
• Chromatography Observations chart
• Properties of Matter chart
For the Class
• 4 large plastic cups
• foam balls
• foam peanuts
• roll of hook-and-loop fastener
• 1 large piece of felt
• 1 sheet of chart paper*
• electric fan*
• small rocks (or similar heavy items)*
• scissors*
• marker*
• masking tape*
For Each Student
• Modeling Matter Investigation Notebook (pages 11–12)
*teacher provided</td><td>• Projections: Lesson 1.5
• Chromatography Diagram: Completed
• Models Chart: Completed
• Properties of Matter Chart: Completed</td><td>• attract
• evidence
• inference
• mixture
• model
• molecule
• observe
• substance</td></tr>
</table>

<table>
<tr><th colspan="3">Modeling Matter Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 1.5: Alignment to NGSS and NYSSLS</th></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
<tr><td>• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td><td>PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)</td><td>• Energy and Matter
• Patterns
• Scale, Proportion, and Quantity
• Structure and Function</td></tr>
</table>

Modeling Matter Lesson Planning Guide
Lesson 1.6: Nanovision Models of Chromatography (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students draw nanovision models and then model ideas in the *Modeling Matter* Diagramming Tool.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
A food coloring separates into three dyes.	• Creating models helps scientists work out their ideas. • Scientists get new ideas by looking at one another's models. • Models can be changed and improved. • Scientists check one another's models to see if the models make sense and fit with observations. • Scientific diagrams have features such as keys, labels, and arrows that help explain what the diagrams show.	**SEPs** 2, 6, and 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity; Structure and Function

3-D statement: Students create nanovision diagram models to make sense of what might be happening at the nanoscale that is causing the food dyes to separate (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Preparing to Make Nanovision Models of Chromatography (5 min.)
The teacher shows several different representations (models) of molecules to communicate that there is not one right way to depict molecules and to provide students with some ideas of how they might want to represent molecules in their nanovision models of chromatography. Even though students may not be sure of their ideas, the teacher encourages them to draw their first model and reassures them that they will have an opportunity to revise their models later.

2. Drawing Nanovision Models (15 min.)
Students create nanovision models of how the food-coloring mixture separates into dyes through chromatography. Drawing these models helps students think through and make visible their current mental models of why the different dyes separate. This is an On-the-Fly Assessment for the teacher to look at students' drawn models.

3. Model Swap (15 min.)
Partners look carefully at one another's nanovision models to evaluate the accuracy of the models against students' current understanding and observations of chromatography.

4. Making Digital Nanovision Models (25 min.)
The teacher shows students how to use the *Modeling Matter* Diagramming Tool, and pairs work together to make a new nanovision model of chromatography. Using the app enables students to focus more on how chromatography works in their models, rather than on how they will represent each molecule. Working together right after they have discussed and critiqued their first (drawn) models provides a reason for students to engage in discourse about their nanovision models. This is an on-the-fly opportunity for the teacher to look at students' digital nanovision models.

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chromatography Observations chart • Chromatography Diagram • Properties of Matter chart **For the Class** • 1 copy of *Made of Matter* • marker* **For Each Pair of Students** • 1 digital device **For Each Student** • *Modeling Matter* Investigation Notebook (pages 13–15) *teacher provided	• Two Models of a Water Molecule • Projections: Lesson 1.6	• atom • attract • property • matter • mixture • model • molecule • observe • substance

Modeling Matter Lesson Planning Guide		
Lesson 1.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	• Scale, Proportion, and Quantity • Structure and Function

Modeling Matter Lesson Planning Guide
Lesson 1.7: Break It Down (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Break It Down: How Scientists Separate Mixtures*.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A food coloring separates into three dyes. **Investigative Phenomenon:** Scientists separate mixtures such as salt water, blood, and mixtures from ancient times.	• Most things are mixtures. • Separating mixtures is an important part of many scientists' work. • Mixtures can be separated by using the properties of the different substances in the mixtures. • Readers make inferences as they read by putting together what they already know with evidence from the text.	**SEPs** 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity; Energy and Matter

3-D statement: Students read the book *Break It Down* to obtain and evaluate information about the ways and reasons that scientists separate mixtures, using the properties of different substances at the macroscale and nanoscale to do so (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Readers Make Inferences (10 min.)
The class is reminded how scientists infer and learn that readers, too, infer when they read. The teacher introduces the book *Break It Down* and models making inferences.

2. Partner Reading (35 min.)
Students make inferences from the book *Break It Down*, learning how and why scientists break down mixtures to learn a variety of information. This activity includes an On-the-Fly Assessment to learn about students' abilities to make inferences from reading.

3. Reflecting on the Book (15 min.)
Students reflect on their understanding of the book and their new knowledge about how scientists use the properties of molecules to learn more about them.

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Partner Reading Guidelines **For Each Pair of Students** • 1 copy of *Break It Down: How Scientists Separate Mixtures* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 16–19)	• NA	• inference • mixture • molecule • observe • substance

Modeling Matter Lesson Planning Guide		
Lesson 1.7: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Energy and Matter

Modeling Matter Lesson Planning Guide
Lesson 1.8: Evaluating Chromatography Models (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students revisit *Break It Down: How Scientists Separate Mixtures* and evaluate nanovision models of chromatography.

Anchor Phenomenon: A food coloring separates into three dyes.	**Students learn:** • The properties of a substance are determined by the properties of its molecules. • Scientists evaluate models and revise them when the models don't fit with what they know.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 6, and 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity; Energy and Matter

3-D statement: Students evaluate three different nanovision models of chromatography to see which fits with what they know about the particulate nature of matter and the properties of molecules (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reviewing Properties Used for Separation (20 min.)
Students return to *Break It Down* for a second read. They read for a specific purpose—to focus on properties of substances and molecules that scientists use to break down mixtures. Students use the diagrams in the book to aid in comprehension.

2. Shared Listening About Fan Model (10 min.)
Students begin their evaluation of models by thinking back to the Fan Model and the Pasta Model, comparing the ways the models did and did not accurately represent chromatography.

3. Evaluating Nanovision Models (25 min.)
After the teacher provides guidance in evaluating one nanovision model together, students practice evaluating other plausible explanations of chromatography. This activity provides an opportunity for an On-the-Fly Assessment as students evaluate models for accuracy.

4. Reflecting on Evaluations (5 min.)
The lesson concludes with a discussion of the importance of scientific evaluations.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *The properties of a substance are determined by the properties of its molecules.* • Properties of Matter chart • Models chart **For the Class** • masking tape* **For Each Group of Four Students** • 2 copies of *Break It Down: How Scientists Separate Mixtures* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 20–29) *teacher provided	• Projections: Lesson 1.8 • Models chart: Completed	• mixture • model • molecule • property • substance

Modeling Matter Lesson Planning Guide

Lesson 1.8: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Scale, Proportion, and Quantity • Energy and Matter

Modeling Matter Lesson Planning Guide
Lesson 1.9: Revising Chromatography Models (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students revise their nanovision models of chromatography and practice writing for an audience.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
A food coloring separates into three dyes.	• One way that scientists use models is to share their ideas with the scientific community. • A scientific explanation is written for an audience.	**SEPs** 2, 6, and 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity

3-D statement: Students apply what they have learned about the properties of molecules and the separation of mixtures to revise their nanovision diagram models of chromatography (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Word Relationships (20 min.)
Students use academic vocabulary as they discuss what they have learned in the unit so far. Groups share their favorite sentences with the class. This activity is meant to provide a low-stakes opportunity for students to talk about the new ideas they are learning while using the new vocabulary that has been introduced.

2. Critical Juncture: Drawing Revised Nanovision Models (30 min.)
Students revise their nanovision models to submit to the president of Good Food Production, Inc. They review prior models and concepts learned about molecules and incorporate changes into their revised nanovision models. The teacher uses this Critical Juncture Assessment as an opportunity to review students' understanding of the properties of molecules as determining substances' observable behavior.

3. Considering an Audience (10 min.)
The teacher reviews the president of Good Food Production, Inc.'s email with students in order to set the expectation that scientists write explanations with a particular audience in mind. Students examine two example explanations in order to illustrate the idea of writing for an audience. They then discuss what they plan to include in their written explanations to ensure that the president of Good Food Production, Inc. will understand their ideas about molecules.

Materials	Digital Resources	Vocabulary
For the Classroom Wall • 1 vocabulary card: *explain* • Properties of Matter chart • Matter chart **For the Class** • paper clips* • marker* • masking tape* **For Each Group of Four Students** • 1 set of Word Relationships Cards: Set 1, clipped together (8 cards/set) **For Each Student** • *Modeling Matter* Investigation Notebook (pages 30–32) *teacher provided	• Projections: Lesson 1.9	• mixture • model • molecule • property • substance

Modeling Matter Lesson Planning Guide

Lesson 1.9: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide
Lesson 1.10: Explaining Chromatography (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students write and share scientific explanations.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
A food coloring separates into three dyes.	• A scientific explanation answers a question about how something works or why something happens. • Scientists support their explanations with evidence. • Scientific explanations are written with an audience in mind. • Scientists often have different explanations for the same results. When this happens, scientists look for more evidence to support one explanation or the other.	**SEPs** 6 and 8 **DCIs** PS1.A **CCCs** Scale, Proportion, and Quantity

3-D statement: Students construct explanations about chromatography (to accompany their diagram models) that reflect their understanding of the particulate nature of matter and the properties of molecules (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Beginning a Scientific Explanation of Chromatography (15 min.)
Students learn that scientists often write explanations and that these explanations have certain elements that help communicate scientific phenomena. Students begin their explanations with teacher guidance about answering the Chapter 1 Question: Why did the food coloring separate into different dyes?

2. Critical Juncture: Writing Scientific Explanations (30 min.)
Students complete their explanations by identifying and incorporating evidence that supports their ideas about why the food coloring separated into different dyes. The teacher uses this Critical Juncture Assessment as an opportunity to review students' understanding of the properties of molecules as determining substances' observable behavior.

3. Sharing Writing (15 min.)
Students have the opportunity to share and compare their revised nanovision models and written scientific explanations of chromatography and see that there may be more than one possible explanation of a scientific phenomenon.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Matter chart • Properties of Matter chart • Models chart • Chromatography Diagram • Chromatography Observations chart **For the Class** • optional: Scientific Explanation of Chromatography, Version B copymaster • 1 sheet of chart paper* • stapler* • marker* • masking tape* **For Each Student** • optional: Scientific Explanation of Chromatography, Version B student sheet • *Modeling Matter* Investigation Notebook (pages 33–35) *teacher provided	• Projections: Lesson 1.10 • Supporting Evidence Chart • Assessment Guide: Reviewing Students' Chapter 1 Explanations About Chromatography • Optional: Scientific Explanation of Chromatography – Version B copymaster	• attract • mixture • molecule • substance

Modeling Matter Lesson Planning Guide		
Lesson 1.10: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 6:**Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide
Lesson 2.1: Investigating Flavor Ingredients (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students explore and investigate in the *Modeling Matter* Simulation.

Anchor Phenomenon / Everyday Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Everyday Phenomenon:** Sugar and citric acid disappear when mixed with water; cumin and pepper do not.	• Food scientists work to ensure that the products they develop have the desired properties. • When you mix a solid into a liquid until you cannot see it anymore, it has dissolved. • Though a substance may no longer be visible after it dissolves, it is still present in the liquid. • Some solids dissolve in water, and others do not.	**SEPs** 1, 3, 4, 6, 7, and 8 **DCIs** PS1.A, PS1.B, ETS1.B **CCCs** Scale, Proportion, and Quantity

3-D statement: Students conduct an investigation of four possible flavor ingredients, and they then analyze their data to determine which will meet their design goals for a salad dressing with specific macroscale properties (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the Salad-Dressing Context (10 min.)
An email from the president of Good Food Production, Inc. engages students with a new problem to solve—to use what they know about food science to create a new salad dressing.

2. Flavor Ingredients Test (35 min.)
Students investigate four different flavor ingredients that might work in their new salad dressing. They check for sediments by stirring ingredients into separate cups of water and observing the cups, and they check for good flavor by conducting taste tests.

3. Debriefing Data (15 min.)
The class compares results of the Flavor Ingredients Test and decides on the ingredients that meet their criteria of good flavor and leaving no sediment. Students discuss what it means when something is dissolved.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chapter 2 Question: *Why do some salad dressings have sediments, and others do not?* • key concept: *Some solids dissolve in water, and others do not.* • vocabulary card: *dissolve* • Properties of Matter chart • Matter chart **For the Class** • 9 stir sticks • 8 large plastic cups • 8 scoops (half-teaspoon measure) • preprinted self-adhesive labels: sugar • preprinted self-adhesive labels: citric acid • preprinted self-adhesive labels: cumin • preprinted self-adhesive labels: pepper • 24 scoops cumin • 24 scoops citric acid • 24 scoops pepper • 24 scoops sugar* • pitcher* • water* • 1 sheet of chart paper* • 1 marker* • masking tape* • paper or newspaper* **For Each Group of Four Students** • 1 tray* • 4 labeled large plastic cups (one each for sugar, citric acid, cumin, and pepper) • 8 small paper cups • 4 stir sticks • 4 pairs of goggles* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 37–38) *teacher provided	• Projections: Lesson 2.1 • Properties of Matter Chart: Completed • Salad-Dressing Ingredients Chart: Completed	• dissolve • mixture • molecule • observe • substance

Modeling Matter Lesson Planning Guide		
Lesson 2.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) **ETS1.B: Developing Possible Solutions:** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide
Lesson 2.2: Investigating Dissolving

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students explore and investigate in the *Modeling Matter* Simulation.

Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Sugar and citric acid disappear when mixed with water; cumin and pepper do not.	**Students learn:** • The level of attraction between molecules affects how they interact with each other.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4 **DCIs** PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity; Cause and Effect; Patterns

3-D statement: Students ask questions about why some substances dissolve in water and some do not and use a digital model of mixtures at the nanoscale (scale, proportion, and quantity) to investigate them.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing Dissolving at the Nanoscale (5 min)
The teacher connects what students did in the last lesson with their Flavor Ingredients Test (at the observable scale) with what they will do in this lesson (at the nanoscale). Students wonder what might be happening at the molecular level that could explain why one substance dissolves, and another does not.

2. Figuring Out How to Use the Simulation (15 min)
Students explore the Modeling Matter Simulation and its new representation of the nanoscale. In this activity, students focus on figuring out how the simulation works, and they learn what the model is designed to represent as well as what it does not represent. Providing this introduction to the Simulation will prepare students to do the kind of thoughtful investigation in the Simulation they will need to do later in the lesson.

3. Using the Simulation to Learn About Dissolving (20 min)
Now that students understand how the Modeling Matter Simulation is designed, they work to figure out what happens at the nanoscale when they combine two types of molecules and then stir. The Simulation provides information about the degree to which each molecule is attracted to other molecules of the same kind and to different molecules. Students use this information about attraction to look for patterns in how the molecules interact.

4. Creating Nanoscale Models of Dissolving (20 min)
Students are challenged to create models of what is happening at the nanoscale when a solid dissolves in a liquid and when a solid does NOT dissolve in a liquid. The ensuing discussion helps students become discerning about the models they create, and students develop a deeper understanding of what causes a solid to dissolve in a liquid.

Materials	Digital Resources	Vocabulary
For Each Pair of Students • 1 digital device* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 39–40) *teacher provided	• Projections: Lesson 2.2	• attract • dissolve • inference • mixture • molecule • observe • substance

Modeling Matter: Lesson 2.2

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<tr><th colspan="3">Modeling Matter Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 2.2: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data</td>
<td>Disciplinary Core Ideas
PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
PS1.A: Structure and Properties of Matter:
• Measurements of a variety of properties can be used to identify materials. (5-PS1-3)
PS1.B: Chemical Reactions:
• When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)</td>
<td>Crosscutting Concepts
• Scale, Proportion, and Quantity
• Cause and Effect
• Patterns</td>
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Modeling Matter Lesson Planning Guide
Lesson 2.3: Reading About Dissolving (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-4 students partner read and reflect on *Solving Dissolving*.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Sugar disappears when mixed with water; cinnamon does not.	**Students learn:** • If a substance is soluble, it means that it can dissolve in water or that the substance's molecules are attracted to water. • If a substance is not soluble, it means that it cannot dissolve in water or that the substance's molecules are not attracted to water. • Readers use the images as well as the text in order to make inferences about what they read.	**Alignment to NGSS and NYSSLS** **SEPs** 2 and 8 **DCIs** PS1.A and PS1.B **CCCs** Scale, Proportion, and Quantity; Cause and Effect

3-D statement: Students read the book *Solving Dissolving* to obtain and evaluate information about dissolving and solubility at the macroscale and the nanoscale (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Models and Inferences (10 min.)
Students add the Simulation, which they used in Lesson 2.2, to the Models chart and learn that they will see a number of new models in the book they will read in this lesson.

2. Reading: Solving Dissolving (30 min.)
In *Solving Dissolving*, students are introduced to the concept of solubility. They read about how a boy named Diego uses models and explanations to help his little sister Maya understand dissolving.

3. Observations and Inferences (10 min.)
Students record observations made in the text and the inferences that they can make from those observations. This activity includes an On-the-Fly Assessment that provides an opportunity to assess students' abilities to distinguish observations from inferences.

4. Discussing Solubility (10 min.)
By focusing specifically on the models that Diego uses in *Solving Dissolving*, students discuss the role of attraction in solubility.

Modeling Matter: Lesson 2.3

Materials	Digital Resources	Vocabulary
For the Classroom Wall • vocabulary card: soluble • Partner Reading Guidelines • Models chart **For the Class** • masking tape* **For Each Pair of Students** • 1 copy of Solving Dissolving **For Each Student** • *Modeling Matter* Investigation Notebook (pages 41–44) *teacher provided	• Projections: Lesson 2.3 • Models Chart: Completed	• attract • dissolve • mixture • molecule • substance • soluble

Modeling Matter Lesson Planning Guide		
Lesson 2.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structures of Property and Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity • Cause and Effect

Modeling Matter Lesson Planning Guide
Lesson 2.4: Models of Solubility (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 3 students write scientific explanations.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Sugar and citric acid disappear when mixed with water, cumin and pepper do not.	• Models show things that are too small to observe but can help explain what is observable. • When the molecules of a solid are attracted to the molecules of a liquid, they spread apart and mix together evenly. This is what dissolving looks like at the nanoscale. • When the molecules of a solid aren't attracted to the molecules of a liquid, they stay clustered together as a solid. This is what NOT dissolving looks like at the nanoscale. • *Solubility* is the word we use when we talk about whether the molecules of substances are attracted to the molecules of other substances. • Scientific explanations begin with a topic sentence and end with a concluding sentence.	**SEPs** 2, 4, 6, 7, and 8 **DCIs** PS1.A and PS1.B **CCCs** Scale, Proportion, and Quantity; Patterns

3-D statement: Students reflect on two models of solubility before creating their own nanovision diagram models and writing explanations (scale, proportion, and quantity) about which ingredients will dissolve in salad dressing and why.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Solubility and Attraction (15 min.)
Students discuss the ways that two nanoscale models of dissolving (solubility) represent the observable results—dissolving and not dissolving—from the sediment tests they did at the beginning of the chapter. Engaging in student-to-student talk provides students with the opportunity to consolidate and advance their understanding of the role that attraction might play in dissolving.

2. Modeling Dissolving (20 min.)
Pairs work together to create their own nanoscale models (diagrams), using the Modeling Matter Diagramming Tool they used in Chapter 1. Having this opportunity provides students with repeated opportunities to think and talk about what is happening at the nanoscale when something dissolves. Since students are creating rather than just recognizing a model, it will help them develop a deeper understanding of solubility. This activity includes an On-the-Fly Assessment to look at the digital nanoscale models that students create. At the end of this activity, students are ready to answer the Investigation Question: What happens to the molecules of a solid and the molecules a liquid when you mix them together?

Lesson at-a-Glanc, cont.

3. Writing Scientific Explanations of Solubility (25 min.)
This activity includes an On-the-Fly Assessment of students' explanations of the solubility of two of the ingredients they tested in Lesson 2.1. This is another opportunity to check in on students' thinking about how molecules of one substance can be attracted to the molecules of another substance.

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *When the molecules of a solid are attracted to the molecules of a liquid, they spread apart and mix together evenly.* • key concept: *When the molecules of a solid aren't attracted to the molecules of a liquid, they stay clustered together as a solid.* • Models chart **For the Class** • optional: Scientific Explanation of Chromatography, Version B copymaster • optional: Chapter 2 Home Investigation: Investigating More Mixtures copymaster • 1 sheet of chart paper* • marker* • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • optional: Scientific Explanation of Dissolving, Version B student sheet • optional: Chapter 2 Home Investigation: Investigating More Mixtures student sheet • *Modeling Matter* Investigation Notebook (pages 45–47) *teacher provided	• Projections: Lesson 2.4 • Models Chart: Completed • Supporting Evidence About Dissolving chart • Assessment Guide: Reviewing Students' Chapter 2 Explanations About Dissolving • Optional: Scientific Explanation of Dissolving, Version B copymaster	• attract • dissolve • mixture • molecule • soluble • substance

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<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
PS1.A: Structures of Property and Matter
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
• Measurements of a variety of properties can be used to identify materials. (5-PS1-3)
PS1.B: Chemical Reactions:
• When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)</td>
<td>Crosscutting Concepts
• Scale, Proportion, and Quantity
• Patterns</td>
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Modeling Matter Lesson Planning Guide
Lesson 2.5: Making Sense of Solubility (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students revisit *Food Scientist's Handbook*, investigate in the *Modeling Matter* Simulation, and evaluate examples of scientific explanations.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
A salad dressing has sediments and layers. **Investigative Phenomenon:** Sugar and citric acid disappear when mixed with water, cumin and pepper do not.	• Reference books use text features (such as the table of contents, headings, and an index) to indicate how the information is organized. This helps readers find information efficiently. • There is a continuum of solubility—ingredients can be more soluble or less soluble. • Scientific explanations can be evaluated based on how clearly they are written and the accuracy of the scientific information they contain.	**SEPs** 2, 6, 8 **DCIs** PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity

3-D statement: Students obtain and evaluate information from the unit's reference book, *Food Scientist's Handbook*, and from the results of their investigations with a digital model to understand that there is a continuum of solubility—ingredients can be more soluble or less soluble (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reading More About Ingredients (15 min.)
Students learn about using evidence from text and from their own observations. They make inferences about flavor ingredients by looking back at their Flavor Ingredients Test (in their notebooks) and by referencing information in *Food Scientist's Handbook*.

2. Critical Juncture: Making Models of Mixing (25 min.)
Students engage with the Solubility mode of the Simulation and consider the role of attraction in several different mixing scenarios. They learn that dissolving is not an all-or-nothing proposition but, in fact, that there are degrees of solubility. This activity allows students to apply their understanding of the role that attraction plays between molecules as they determine whether specific mixtures of molecules at the nanoscale will result in substances dissolving at the observable level.

3. Evaluating Explanations (20 min.)
By evaluating two different explanations of dissolving—utilizing the features of a scientific explanation—students have the opportunity to work with concrete examples of what makes a strong scientific explanation.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For Each Pair of Students • 1 digital device* • 1 copy of *Food Scientist's Handbook* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 49–57) *teacher provided	• Projections Lesson 2.5	• attract • dissolve • mixture • molecules • substance • soluble

Modeling Matter Lesson Planning Guide		
Lesson 2.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Informationn	**PS1.A: Structures of Property and Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide
Lesson 3.1: Investigating Attraction (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students investigate liquids. In Activity 4 students participate in a physical model of molecular attraction.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Oil and water separate after being mixed; vinegar and water stay mixed.	• Some liquid mixtures stay mixed, and others separate into layers over time. • Some liquids hold together better than others.	**SEPs** 2, 3, 4, 5, 7, 8 **DCIs** PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity; Stability and Change

3-D statement: Students conduct an investigation of attraction between molecules. They then analyze their results and use a physical model to deepen their understanding of the nanoscale properties of molecules that determine the macroscale properties of liquids (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Demonstrating Mixing Liquids (10 min.)
Students are reminded about their role as food scientists who are helping Good Food Production, Inc. understand how to create a salad dressing that can be mixed and does not separate into layers. After shaking both the vinegar mixed with water and the oil mixed with water, students observe that one separates, and one does not.

2. Testing Attraction (30 min.)
Students observe a drop of water on a penny and a drop of oil on a penny in order to collect data on the observable scale. Using that data, they will be able to make inferences about molecular attraction.

3. Debriefing Data (10 min.)
Students spend time collecting and then analyzing a class set of data with the goal of determining whether more drops of water or more drops of oil fit on a penny. Since the data includes some variability, it provides an opportunity for the class to analyze the variation in results they observed and to draw a conclusion based on the data. This activity includes an On-the-Fly Assessment that provides an opportunity to listen in on students' evaluations of the data they collected.

4. Introducing the All Aboard Model (10 min.)
To connect students' observable-scale data to the nanoscale, they participate in a physical model of molecular attraction in which they represent the molecules on the penny.

5th Grade Unit 2 Modeling Matter

Materials

For the Classroom Wall

- Chapter 3 Question: *Why can salad-dressing ingredients separate again after being mixed?*
- key concept: *Some liquid mixtures stay mixed, and others separate into layers over time.*
- key concept: *Some liquids hold together more than others.*
- Models chart
- Salad-Dressing Ingredients chart

For the Class

- Pasta Model (large jar with three different kinds of pasta, from Chapter 1)
- 2 plastic vials with lids
- food coloring (two colors)
- 1 dropper
- 1 small plastic or paper cup
- vegetable oil
- vinegar
- acetone (nail polish remover)
- 1 penny*
- 1 tray*
- pitcher*
- water*
- 1 sheet of chart paper*
- marker*
- masking tape*

For Each Group of Four Students

- 1 tray*
- 2 small plastic or paper cups
- 2 droppers
- 4 pennies*

For Each Student

- *Modeling Matter* Investigation Notebook (pages 58–59)

*teacher provided

Digital Resources

- Projections: Lesson 3.1
- Attractions Test: Results Chart
- Attraction Test with Acetone
- Models Chart: Completed

Vocabulary

- attract
- mixture
- molecule
- substance

Modeling Matter: Lesson 3.

Modeling Matter Lesson Planning Guide		
Lesson 3.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **ETS1.B: Developing Possible Solutions:** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Stability and Change

Modeling Matter Lesson Planning Guide
Lesson 3.2: Science You Can't See (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Science You Can't See.*

Anchor Phenomenon:	**Students learn:**	**Alignment to NGSS and NYSSLS**
A salad dressing has sediments and layers.	• Many scientists study things that can't be seen by making inferences based on evidence. • Science findings are based on recognizing patterns. • Science theories are based on a body of evidence and many tests. • Men and women from all cultures and backgrounds choose careers as scientists and engineers. • Science is a way of knowing that is used by many people.	**SEPs** 8 **DCIs** PS1.A **CCCs** Patterns; Scale, Proportion, and Quantity

3-D statement: Students read the book *Science You Can't See* to obtain and evaluate information about how scientists investigate phenomena that can't be observed directly, such as those that are too small to see (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Previewing Science You Can't See (10 min.)
Students preview the book *Science You Can't See*. They read about the three topics that scientists study and that scientists have to make inferences when they study topics that are too small, too hard to reach, or too far away to observe directly.

2. Finding Evidence (35 min.)
Partners read about each scientist's work and then make inferences, noting the evidence they used to understand the work of each scientist.

3. Making Inferences (15 min.)
Students discuss different scenarios about scientists who might need to make inferences. Students conclude the lesson by returning to the book *Science You Can't See* and making one more inference on a topic of their choosing. This activity includes an On-the-Fly Assessment that provides an opportunity to observe students' abilities to use evidence to make inferences.

Modeling Matter: Lesson 3.2

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Partner Reading Guidelines **For Each Pair of Students** • 1 copy of Science You Can't See **For Each Student** • *Modeling Matter* Investigation Notebook (pages 60–64)	• NA	• atom • infer • mixture • molecule • observe • property • substance

Modeling Matter Lesson Planning Guide		
Lesson 3.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: The Universe and Its Stars:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Patterns • Scale, Proportion, and Quantity

Modeling Matter Lesson Planning Guide
Lesson 3.3: Modeling Mixtures (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students investigate in the *Modeling Matter* Simulation and revisit the physical model of molecular attraction.

Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Oil and water separate after being mixed; vinegar and water stay mixed.	**Students learn:** • The more a liquid's molecules are attracted to one another, the more the liquid will hold together. • When the molecules of two different liquids are attracted to one another, they cluster together and become evenly distributed in the mixture. • It is the combination of attraction to self and attraction to other that determines what happens to liquids on the observable scale.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 7, 8 **DCIs** PS1.A **CCCs** Patterns; Scale, Proportion, and Quantity; Structure and Function

3-D statement: Students use a digital model to create mixtures and classify them by how well mixed they are (not mixed, slightly mixed, mostly mixed, or completely mixed) (patterns). They draw conclusions about how interactions at the nanoscale determine what happens at the macroscale when two liquids are mixed (scale, proportion, and quantity).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Liquid Mixtures (10 min.)
Students revisit the mixing demonstration with oil and water before proposing an answer to the question *What happens to the molecules of two liquids when you mix them together?* This section includes an On-the-Fly Assessment that provides an opportunity to review students' written ideas about the nanoscale.

2. Investigating Molecules in Mixing (20 min.)
Students investigate nanovision models of mixing in the Simulation. They investigate different combinations of molecules, paying attention to how attraction plays a role in the different levels of mixing they create.

3. Revisiting the All Aboard Model (15 min.)
Students participate in an extension activity of the All Aboard Model as they portray oil molecules and water molecules to show how the level of attraction of like molecules affects mixing.

4. Revising Ideas Based on Evidence (15 min.)
After students have gathered more evidence from the Simulation and from the All Aboard Model, they return to the accuracy of their answers from the beginning of the lesson and discuss this with one another. This leads the class to discuss two new key concepts.

Modeling Matter: Lesson 3.3

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *The more a liquid's molecules are attracted to one another, the more the liquid will hold together.* • key concept: *When the molecules of two different liquids are attracted to one another, they cluster together and become evenly distributed in the mixture.* • Models chart **For the Class** • 2 vials from Lesson 3.1 (one containing oil and water, one containing vinegar and water) • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 65–69) *teacher provided	• Projections: Lesson 3.3	• attract • mixture • model • molecule • substance

Modeling Matter Lesson Planning Guide		
Lesson 3.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3)	• Patterns • Scale, Proportion, and Quantity • Structure and Function

Modeling Matter Lesson Planning Guide Lesson 3.4: Investigating Emulsifiers (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activity 2 students use food ingredients to experiment with emulsifiers.		
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Certain substances, such as lecithin, help create stable mixtures of liquids.	**Students learn:** • An emulsifier is an ingredient that allows normally unmixable liquids to stay mixed. • A stable mixture is one that does not separate.	**Alignment to NGSS and NYSSLS** **SEPs** 3, 4, and 8 **DCIs** PS1.A, PS1.B, and ETS1.B **CCCs** Patterns; Scale, Proportion, and Quantity; Stability and Change
3-D statement: Students conduct an investigation of three possible texture ingredients for their salad dressing and then analyze their data to determine which will create the most stable mixture (stability and change). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Introducing Emulsifiers (5 min.)** Students are reminded of their challenge to create a salad dressing that does not form layers or leave sediments. They learn that emulsifiers are an ingredient that can help create a stable—or mixed—salad dressing. **2. Setting Up Stability Tests (20 min.)** Students test each of three different texture ingredients in vials with oil and water as possible emulsifiers: cornstarch, flour, and lecithin. They follow the procedure to mix and then wait for the ingredients to interact. **3. Word Relationships (15 min.)** While they wait for their Stability Tests to interact, students review what they have been learning by using the Word Relationships routine. **4. Debriefing Stability Tests (20 min.)** Students make final observations of their mixtures, record in their notebooks, discuss the results of their Stability Tests, and provide evidence from the reference book to conclude which of the three texture ingredients works best as an emulsifier.		

Modeling Matter: Lesson 3.4

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Salad-Dressing Ingredients chart **For the Class** • 9 scoops (half-teaspoon measure) • 9 stir sticks • 9 large plastic cups • 1 funnel • 3 pre-printed self-adhesive labels: flour • 3 pre-printed self-adhesive labels: cornstarch • 3 pre-printed self-adhesive labels: lecithin • 1 marker, black, permanent • cornstarch • lecithin powder • vegetable oil • flour* • pitcher* • water* • paper clips* • 3 sheets of chart paper or newspaper* **For Each Group of Four Students** • 1 tray* • 3 vials, each with oil-and-water mixture • 1 paper towel* • 1 timing device* • 4 pairs of goggles* • 1 set of Word Relationships Cards: Set 2, clipped together (8 cards/set) **For Each Pair of Students** • 1 copy of *Food Scientist's Handbook* **For each student** • *Modeling Matter* Investigation Notebook (pages 70–75) *teacher provided	• Projections: Lesson 3.4 • Salad-Dressing Ingredients Chart: Completed	• attract • dissolve • mixture • model • molecule • observe • soluble • substance

<table>
<tr><th colspan="3">Modeling Matter Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 3.4: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
PS1.A: Structure and Properties of Matter:
• Measurements of a variety of properties can be used to identify materials. (5-PS1-3)
PS1.B: Chemical Reactions:
• When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
ETS1.B: Developing Possible Solutions:
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
ETS1.B: Developing Possible Solutions:
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)</td>
<td>Crosscutting Concepts
• Patterns
• Scale, Proportion, and Quantity
• Stability and Change</td>
</tr>
</table>

Modeling Matter: Lesson 3.5

<table>
<tr><th colspan="3">Modeling Matter Lesson Planning Guide
Lesson 3.5: Models of Emulsifiers (60 minutes)</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.
Students draw nanovision models of emulsifiers then explore in the Modeling Matter Simulation.</td></tr>
<tr><td>Anchor Phenomenon:
A salad dressing has sediments and layers.
Investigative Phenomenon:
Certain substances, such as lecithin, help create stable mixtures of liquids.</td><td>Students learn:
• Molecules in an emulsifier (such as lecithin) attract and hold together molecules of liquids that don't normally mix (such as oil molecules and vinegar molecules).</td><td>Alignment to NGSS and NYSSLS
SEPs 2, 3, 4, 8
DCIs PS1.A, PS1.B
CCCs Patterns; Scale, Proportion, and Quantity; Stability and Change; Structure and Function</td></tr>
<tr><td colspan="3">3-D statement: Students use a digital model to investigate what happens at the nanoscale (scale, proportion, and quantity) when oil and vinegar are first combined (and separate into layers) and then what happens when an emulsifier is added to the mixture.
Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts</td></tr>
<tr><td colspan="3">Lesson at-a-Glance
1. Observing an Emulsifier (10 min.)
By looking at close-up images of oil, vinegar, and an emulsifier mixing, students connect what happens at the observable scale to their understanding of attraction.
2. Drawing Nanovision Models of Emulsifiers (15 min.)
Students make initial nanovision drawings of what they think is happening to the molecules of oil, vinegar, and lecithin to create a stable mixture. Drawing these models helps students think through and make visible their current mental models of how emulsifiers work. It is not important or necessarily expected that, during this initial model-making activity, students draw accurate models. Rather, it is important to prompt students to think about what is happening at the nanoscale and prime their thinking before the next activity. This activity includes an On-the-Fly Assessment that provides an opportunity to gauge students' initial understanding of emulsification at the nanoscale.
3. Exploring Emulsifiers in the Simulation (15 min.)
Students explore a new mode of the Simulation, the Emulsifier mode. Through mixing different combinations of molecules and then adding emulsifier molecules to their mixtures, students have the opportunity to visualize models of how an emulsifier works at the nanoscale.
4. Using the Simulation to Model Salad Dressing (20 min.)
Two pairs work together to make a model of two liquids that don't mix (such as oil and vinegar) and a model of those same two liquids after an emulsifier has been added. Then, pairs compare the model of the liquids with the added emulsifier to a new model of two liquids that mix without the addition of an emulsifier. This allows students to further understand how emulsifiers work at the nanoscale.</td></tr>
</table>

Materials	Digital Resources	Vocabulary
For Each Pair of Students • 1 digital device* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 76–79) *teacher provided	• Projections: Lesson 3.5	• attract • mixture • model • molecule • observe • soluble • substance

Modeling Matter Lesson Planning Guide

Lesson 3.5: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Patterns • Scale, Proportion, and Quantity • Structure and Function • Stability and Change

Modeling Matter Lesson Planning Guide
Lesson 3.6: Creating Digital Models of Emulsifiers (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Pairs create new models with the Modeling Matter Diagramming Tool, evaluate models, and revisit *Food Scientist's Handbook*.

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Certain substances, such as lecithin, help create stable mixtures of liquids.	• Scientists revise models when they get additional evidence that helps explain how something works or why something happens. • Reference books can be used to look up specific information or answer questions.	**SEPs** 2, 4, 6, and 8 **DCIs** PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity; Structure and Function

3-D statement: Students create diagram models of what happens at the nanoscale (scale, proportion, and quantity) when an emulsifier is added to a mixture of liquids that will not typically mix.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Critical Juncture: Models of Emulsifiers (20 min.)
The teacher reminds students how to use the *Modeling Matter* Diagramming Tool, and pairs use it to revise their initial hand-drawn models of emulsifiers (from Lesson 3.5). Included in this activity is a Critical Juncture Assessment that provides an opportunity to assess whether students are understanding how emulsifiers work at the nanoscale and the role that same-molecule attraction plays in whether or not liquids mix.

2. Evaluating Models of Emulsifiers (20 min.)
Partners swap their newly created digital models of emulsifiers and look carefully at one another's models to evaluate how well the models represent what the class has found out about the attraction between vinegar, oil, and lecithin. At the end of this activity, the teacher provides two additional models for the class to evaluate. Included in this activity is an On-the-Fly Assessment that provides an opportunity to hear students evaluate one another's models.

3. Gathering Evidence About Ingredients (20 min.)
Students receive their final email from the president of Good Food Production, Inc. They use *Food Scientist's Handbook* as well as their thoughts about their own investigations to write notes about the properties of oil, vinegar, and lecithin. This prepares students to write their last scientific explanations in the final lesson of the unit.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *Molecules of an emulsifier attract the molecules of two liquids that do not typically mix, allowing the molecules of the emulsifier and of the liquids to mix.* **For the Class** • masking tape* **For Each Pair of Students** • 1 digital device* • 1 copy of *Food Scientist's Handbook* **For Each Student** • *Modeling Matter* Investigation Notebook (pages 80–82) *teacher provided	• Projections: Lesson 3.6 • Optional: Making Sense of Mixing in the Simulation copymaster	• attract • evidence • mixture • model • molecule • observe • substance

Modeling Matter Lesson Planning Guide

Lesson 3.6: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity • Structure and Function

Modeling Matter Lesson Planning Guide
Lesson 3.7: End-of-Unit Assessment (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students write their final scientific explanations.

Hands-On: In Activity 3 students taste salad dressing.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A salad dressing has sediments and layers. **Investigative Phenomenon:** Certain substances, such as lecithin, help create stable mixtures of liquids.	**Students learn:** • Scientific explanations are stronger when they are based on evidence from more than one source. This evidence can come from first-hand investigations and from text.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 6, 8 **DCIs** PS1.A, PS1.B, ETS1.A, ETS1.B **CCCs** Scale, Proportion, and Quantity

3-D statement: Students create diagram models of what happens at the nanoscale (scale, proportion, and quantity) when an emulsifier is added to a mixture of liquids that will not typically mix.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reviewing Evidence (10 min.)
Students review evidence they have gathered about emulsification from their investigations and models. They organize their ideas in preparation for writing.

2. Writing Final Scientific Explanations (25 min.)
Students write to the President of Good Food Production, Inc. in order to explain why the proposed salad dressing will stay evenly mixed. Students' explanations serve as an End-of-Unit Assessment.

3. Taste-Testing the Salad Dressing (25 min.)
To conclude the unit, students instruct the teacher in how to make the salad dressing, reviewing what they have learned along the way. Students conclude the unit with a taste test of their salad dressing and spend time reflecting on their work as food scientists and on the unit as a whole.

5th Grade Unit 2 Modeling Matter

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Salad Dressing Ingredients chart • Models chart **For the Class** • End-of-Unit Writing: Explaining Emulsifiers in Salad Dressing, Version A copymaster (optional: Version B) • optional: Chapter 3 Home Investigation: Molecules in Salad Dressing Quiz copymaster • 1 large plastic cup • 2 spoons • oil • vinegar • lecithin • citric acid • sugar* • 1 tray* • marker* • stapler* • optional: lettuce leaves (or other vegetables)* • optional: toothpicks* • optional: vinegar (balsamic and/or red wine)* **For Each Group of Four Students** • 4 small paper cups **For Each Student** • End-of-Unit Writing: Explaining Emulsifiers in Salad Dressing, Version A student sheets (optional: Version B) • optional: Chapter 3 Home Investigation: Molecules in Salad Dressing Quiz student sheet • *Modeling Matter* Investigation Notebook (page 83) *teacher provided	• Projections: Lesson 3.7 • End-of-Unit Writing: Explaining Emulsifiers in Salad Dressing, Version A copymaster • End-of-Unit Writing: Explaining Emulsifiers in Salad Dressing, Version B copymaster • Assessment Guide: Assessing Students' End-of-Unit Explanations About Emulsifiers in Salad Dressing • Optional: Chapter 3 Home Investigation: Molecules in Salad Dressing Quiz copymaster • Models Chart: Completed	• attract • evidence • explain • mixture • model • molecule • observe • substance

<table>
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<tr><th colspan="3">Lesson 3.7: Alignment to NGSS and NYSSLS</th></tr>
<tr><td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td><td>Disciplinary Core Ideas
PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
• Measurements of a variety of properties can be used to identify materials. (5-PS1-3)
PS1.B: Chemical Reactions:
• When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
ETS1.B: Developing Possible Solutions:
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)</td><td>Crosscutting Concepts
• Scale, Proportion, and Quantity</td></tr>
</table>

5th Grade Unit 3
The Earth System
Recommended time frame: 9 weeks

This Implementation and Planning Guide includes text from one of the Unit Overview Documents, *Standards and Goals*.

Please see additional Unit Overview documents in the unit's Teacher's Guide for full reference and planning guidance.

Standards and Goals

Focal Performance Expectations

- 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]
- 5-ESS2-2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, groundwater, and polar ice caps, and does not include the atmosphere.]
- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

  Note: Students also focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Ecosystem Restoration* unit.
- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

  Note: Students also focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science Modeling Matter and Ecosystem Restoration units.

Unit-level 3-D Statement:

- Students investigate how interactions between the parts of the Earth system affect the movement and distribution of water (systems and system models), and they apply their understanding to design solutions for a water shortage. Students also obtain information from first-hand investigations, models, and text to figure out how new substances can form through chemical reactions, even though no matter is created or destroyed (energy and matter).

Key

Practices

Disciplinary Core Ideas

Crosscutting Concepts

Standards & Goals

Standards and Goals	
• 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.] **Note:** Students also focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Modeling Matter* unit. • 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances. **Note:** Students make additional connections to the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Modeling Matter* and *Ecosystem Restoration* units. • 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **Note:** Students make additional connections to the disciplinary core ideas represented in this Performance Expectation in the Amplify Science Ecosystem Restoration unit. • 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **Note:** Students make additional connections to the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Modeling Matter* and *Ecosystem Restoration* units. • 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	

Connections to Other Performance Expectations

This unit supports students in making connections to the disciplinary core ideas represented in these additional Performance Expectations, which are also addressed in other Amplify Science units.

- **5-PS1-3.** Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]

  Note: Students focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Modeling Matter* unit.

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

  Note: Students focus on the disciplinary core ideas represented in this Performance Expectation in the Amplify Science *Ecosystem Restoration* unit.

Standards & Goals

Science and Engineering Practices

As with all Amplify Science units, *The Earth System* unit provides students with exposure to most of the eight science and engineering practices described in the NGSS. This unit emphasizes all eight practices (listed in order of particular emphasis), providing students with explicit instruction and expectations for increasing independence over the course of the unit:

- **Practice 2: Developing and Using Models.** Students receive explicit instruction and opportunities to practice using models and developing and revising models by 1) creating models of water molecules in the atmosphere at the nanoscale to explain what they observed on an observable scale, 2) using physical models to show how a mountain can redirect wind and how water condenses high in the atmosphere where it is cold, and 3) creating diagrams showing how the hydrosphere, atmosphere, and geosphere interact to create the rain shadow effect.
- **Practice 3: Planning and Carrying Out Investigations.** Students conduct various investigations to construct understanding of rainfall patterns and chemical reactions at both the nanoscale and the observable scale. They use hands-on models to investigate condensation at the observable scale. Students then carry out investigations about what is happening at the nanoscale, using *The Earth System* Simulation. Finally, students investigate how combining substances differently can control the results of a chemical reaction.
- **Practice 6: Constructing Explanations and Designing Solutions.**Students learn about scientific explanations and have multiple opportunities to write increasingly complex explanations of a water shortage on a fictional island over the course of the unit, synthesizing ideas from a variety of sources. Students are also challenged to design solutions to the water shortage. Students design, build, test, and iterate on systems that can collect freshwater from salt water.
- **Practice 7: Engaging in Argument from Evidence.** Students have multiple opportunities to engage with each other as they use evidence to support their claims throughout the unit. One example of this is when they use evidence of the effectiveness of their freshwater collection devices to argue for specific design features.
- **Practice 8: Obtaining, Evaluating, and Communicating Information.** Students receive explicit instruction and have multiple opportunities to use the reading comprehension strategy of *synthesizing* as they engage with the informational texts in the unit. They gather evidence through firsthand and secondhand sources, as well as participate in various discourse routines that help them communicate about and make sense of science ideas, using key vocabulary.
- **Practice 4: Analyzing and Interpreting Data.** While students investigate rain formation, they make observations and analyze quantitative data to help draw conclusions about this phenomenon at the nanoscale and observable scale.
- **Practice 5: Using Mathematics and Computational Thinking.** Students collect quantitative data of water molecules in gas and liquid forms and create line graphs representing how the molecules change based on their position in the atmosphere. Students use this data to help them think about where condensation occurs and why it occurs higher in the atmosphere.
- **Practice 1: Asking Questions and Defining Problems.** Students spend the first chapter of the unit defining the problem they will investigate for the remainder of the unit: a water shortage in the fictional city of East Ferris. Students ask questions and think about how their questions can be answered when reading informational text, analyzing data, conducting firsthand investigations, and testing and analyzing designs for collecting freshwater from salt water.

In all Amplify Science units, practices from the NGSS, the CCSS-ELA, and the CCSS-Math are linked. For instance, when students use maps and diagrams to investigate water distribution over the land, they are also engaging in the CCSS-Math Practices 2 and 4 (Practice 2: Reason Abstractly and Quantitatively, Practice 4: Model with Mathematics). When students develop and use models, use those models to inform their design solutions, and engage with science text, they are developing the foundational capacity to build knowledge about a phenomenon through research and to respond analytically to informational sources, as called for by the CCSS-ELA Standards.

5th Grade Unit 3 The Earth System

Disciplinary Core Ideas

Focal Disciplinary Core Ideas

This unit addresses the following core ideas:

ESS2.A: Earth Materials and Systems:

- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

ESS2.C: The Roles of Water in Earth's Surface Processes:

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

ESS3.C: Human Impacts on Earth Systems:

- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

PS1.A: Structure and Properties of Matter:

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
- (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)

PS1.B: Chemical Reactions:

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
- No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)

ETS1.A: Defining and Delimiting Engineering Problems:

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

ETS1.B: Developing Possible Solutions:

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

ETS1.C: Optimizing the Design Solution:

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)the criteria and the constraints. (3-5-ETS1-3)

Standards & Goals

Crosscutting Concepts

The crosscutting concept emphasized in *The Earth System* unit is Systems and System Models. In their role as water resource engineers, students delve deeply into the Earth system and its interacting parts as they investigate water shortages, rain formation, and evaporation. Through these investigations, students construct an understanding of how the hydrosphere, atmosphere, and geosphere interact to affect rainfall patterns and how the biosphere affects water availability. Students apply their systems lens to engineering design as they construct systems for collecting freshwater from salt water. Students return to the idea of systems again and again throughout the unit, through a variety of modalities.

Do. Students design and construct freshwater collection systems, a potential solution to the water shortage in the fictional city of East Ferris. As they design, test, and refine their systems, students closely analyze the role that each part of their system plays and how to revise their systems to better meet their design criteria.

Talk. Multiple opportunities for student-to-student talk engage the class in figuring out what role Earth's spheres play in rain formation and how spheres interact with one another during that process.

Read. Students read a book about how Earth's spheres interacted when the dinosaurs went extinct and apply this understanding to explain how Earth's spheres interact during rain formation.

Write. During the course of the unit, students write several scientific explanations about rain formation. These explanations require students to apply a system-level understanding of the interactions of Earth's spheres to explain how rain forms.

Visualize. As students develop and use models, they visualize nanoscale interactions that occur during condensation and evaporation. These activities support students in understanding how Earth's spheres interact to result in rain formation.

There are also opportunities to emphasize the crosscutting concepts of Scale, Proportion, and Quantity (e.g., students learn that matter is made of particles too small to see, and they compare the observable scale and nanoscale interactions to develop a deep understanding of rain formation) and Energy and Matter (e.g., students learn that different substances have different properties, and matter is conserved).

Background Knowledge and Alternate Conceptions

The Earth System includes a pre-unit assessment in lesson 1.1 in which students make a scientific explanation. This pre-unit writing assessment is an opportunity for students to express their initial ideas about why some substances mix together and others do not. This provides students with an opportunity to connect their background knowledge and the initial ideas they have to the concepts they will be learning about in the Modeling Matter: The Chemistry of Food unit. It can also provide insight into students' thinking as you begin this unit of instruction. This will allow you to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding.

Note: For full details, see the assessment task and associated Assessment Guide in lesson 1.1.

Connecting to students' experiences. Examples of students' experiences to which you can connect the content of specific lessons in the unit: • Experience with humid and rainy days • Experience with condensation on a cup • Experience with droughts or other water shortages • Experience with some places getting a lot of rain and others getting very little rain	**Building on prior knowledge**. Ideas about substances on which students can build on throughout the unit: • Living things need water. • Polluted water is not usable. • Anything that takes up space is made of matter.
Gauging students' facility with science practices. Since students write scientific explanations for this task, it offers an entry-level assessment of students' facility with this science and engineering practice.	**Applying crosscutting concepts.** Examples of ways students could demonstrate facility with the crosscutting concept of Systems and System Models: • Water from the surface (puddles, ocean) can evaporate and become part of the air (applying the idea that a system can be described in terms of its components and their interactions). • It rains more in West Ferris because of something to do with the mountain (applying the idea that a system can be described in terms of its components and their interactions).

Preconceptions to watch out for over the course of the unit:

- The atmosphere is not made of matter. Because they cannot see it, many students might not consider air or the atmosphere to be made of anything. However, at the nanoscale, both air and the atmosphere are composed of a mix of molecules in the gas phase.
- Water is an unlimited resource. Water flows out of the tap on demand and is used for many things. However, there is a limited amount of water on Earth, especially freshwater that can be used by humans.
- Clouds are water storage containers. Clouds are not objects separate from the water that rains out of them. Clouds are in fact composed of tiny water droplets. When the water droplets come together and get large enough, they fall as rain.
- Chemical reactions are always dramatic. In fact, many chemical reactions are very slow or do not produce remarkable results at the observable scale.
- Chemical reactions create or destroy atoms. When a chemical reaction occurs, the atoms recombine to form new molecules, but the atoms themselves are not created or destroyed.

Standards & Goals

Grade 5 Unit 3 Pacing Guidance at-a-glance The Earth System		
Guidance for cluster teachers and classroom teachers: All lessons can be taught by either teacher. The lessons in bold include activities with a particular literacy emphasis and the the lessons with * include activities with a particular hands-on emphasis. Keep in mind that all Amplify Science lessons engage students in reading, writing, and/or discourse, as well as in scientific inquiry, so refer to the lesson-by-lesson guidance for details as you plan to teach.		
Pacing assumes 1 lesson per day, 3 times per week. Lessons are each 60 minutes long. Occasional weeks with 2 lessons affords flex time, to make up instructional minutes and/or differentiate according to formative assessment.		
Recommended time frame: 9 weeks February through beginning of April	**Week 1**	1.1: Pre-Unit Assessment: Students' Initial Explanations 1.2: **Water Shortages, Water Solutions**
	Week 2	1.3: **Explaining the East Ferris Water Shortage** 2.1: Investigating Water Drop Formation* 2.2: From Water Vapor to Liquid Water*
	Week 3	2.3: A Nanoscale View of Condensation* 2.4: Investigating Evaporation* 2.5: **Drinking Cleopatra's Tears***
	Week 4	2.6: **Explaining How Raindrops Form** 2.7: Designing Freshwater Collection Systems* 2.8: **Engineering Clean Water**
	Week 5	3.1: **Investigating Where Raindrops Form*** 3.2: Making Sense of Where Raindrops Form 3.3: **Explaining Why It Rains**
	Week 6	3.4: Iterating on Freshwater Collection Systems* 4.1: Investigating the Movement of Water Vapor* 4.2: Investigating Rainfall Distribution
	Week 7	4.3: **End-Of-Unit Assessment Part 1: Students' Explanations** 4.4: **How the Earth System Explains Dinosaur Extinction** 4.5: Final Design Iterations*
	Week 8	5.1: Investigating Wastewater Treatment* 5.2: **Chemical Reactions Everywhere** 5.3: Chemical Reactions at the Nanoscale
	Week 9	5.4: Controlling Chemical Reactions* 5.5: **End-Of-Unit Assessment Part 2: Students' Explanations** 5.6: Reflecting on Water Availability

The Earth System Lesson Planning Guide
Lesson 1.1: Pre-Unit Assessment: Students' Initial Explanations (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students are introduced to the unit and to their role as well as Water Encyclopedia. In activity 2, students write their initial explanations as a pre-unit assessment.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
One side of Ferris Island has a water shortage and the other does not.	• Reflecting on what you understand and don't understand allows you to prepare for learning new things. • An engineer is a person who uses science knowledge to design something in order to solve a problem. • Almost all of Earth's water is salt water in the ocean. The limited amount of freshwater is mostly in glaciers and groundwater. • There is a limited amount of water available to people because people only use freshwater.	**SEPs** 4, 5, 6, 8 **DCIs** ESS2.A, ESS2.C **CCCs** Systems and System Models; Scale, Proportion, and Quantity

3-D statement: Students write initial explanations about why some areas get more rain than other areas and how factors such as mountain ranges and the wind can affect rainfall. Students then analyze quantitative data (scale, proportion, and quantity) in the reference book, Water Encyclopedia, about the distribution of water on Earth.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the Unit (10 min.)
Students are introduced to The Earth System unit and their role as water resource engineers tasked with solving a problem.

2. Writing Initial Explanations (20 min.)
Students' written explanations reveal their initial understanding of why some areas get more rain than others and how factors like mountain ranges and the wind can affect rainfall.

3. Water and Land on Earth (10 min.)
Students toss an inflatable globe to one another and observe how often their hands land on water, discovering that water covers the vast majority of Earth's surface. This activity motivates a brief discussion about how a water shortage can happen even though there is so much water on Earth.

4. Water Distribution on Earth (20 min.)
Students are introduced to the reference book, Water Encyclopedia, and interpret graphs of global water distribution to discover that there is very little freshwater available for human use.

The Earth System: Lesson 1.1

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Unit Question: *What can determine how much water is available for human use?* • section headers: Key Concepts, Vocabulary • Chapter 1 Question: *Why is East Ferris running out of water while West Ferris is not?* • key concept: *Almost all of Earth's water is salt water in the ocean. The limited amount of freshwater is mostly in glaciers and groundwater.* • vocabulary: *engineer* **For the Class** • Pre-Unit Writing: Explaining Rain on Ferris Island copymaster • 1 inflatable globe • 1 sheet of chart paper* • marker* • stapler* • masking tape* **For Each Pair of Students** • 1 copy of *Water Encyclopedia* **For Each Student** • 1 copy of the Pre-Unit Writing: Explaining Rain on Ferris Island student sheets *teacher provided	• Projections: Lesson 1.1 • Pre-Unit Writing: Explaining Rain on Ferris Island copymaster • Assessment Guide: Interpreting Students' Pre-Unit Explanations About Rain on Ferris Island • Water and Land on Earth chart • Partner Reading Guidelines • The Earth System Investigation Notebook	• engineer • explanation • resource

The Earth System Lesson Planning Guide		
Lesson 1.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)	**Crosscutting Concepts** • Systems and System Models • Scale, Proportion, and Quantity

The Earth System Lesson Planning Guide
Lesson 1.2: Water Shortages, Water Solutions (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Water Shortages, Water Solutions*.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** There are water shortages around the world.	**Students learn:** • Droughts, overuse, and pollution can cause water shortages. • When people use water, there is less clean freshwater available to use. • Synthesizing can help readers understand informational text. • Science affects everyday life.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 6, and 8 **DCIs** ESS2.C, ESS3.C, and LS2.B **CCCs** Systems and System Models, Energy and Matter, Stability and Change

3-D statement: Students read the book *Water Shortages, Water Solutions* to obtain and evaluate information regarding how the actions of humans can change the availability of freshwater in a region (stability and change) in order to better define the problem of water availability in East Ferris.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Water Use (5 min.)
Students discuss how people use freshwater in their everyday lives. They are introduced to a new Investigation Question, which prepares them to read *Water Shortages, Water Solutions*.

2. Introducing Synthesizing (15 min.)
Students receive their Investigation Notebooks and learn some ways that scientists use notebooks. They review ideas from the previous lesson and are introduced to the sense-making strategy of synthesizing, which they will use throughout the unit. The teacher introduces *Water Shortages, Water Solutions* and models recording big ideas.

3. Partner Reading (25 min.)
Students read the book in pairs with the goal of learning about the causes of water shortages. They record big ideas that may help them answer the Investigation Question.

4. Synthesizing Ideas About Water Shortages (15 min.)
Students use what they learned from the *Water Shortages, Water Solutions* and connect these ideas to what they learned in Lesson 1.1. This activity provides an On-the-Fly Assessment to assess students' facility with the practice of synthesizing.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • vocabulary: *resource, synthesize* **For the Class** • optional: Chapter 1 Home Investigation: Saving Water copymaster • masking tape * **For Each Pair of Students** • 1 copy of Water Shortages, Water Solutions **For Each Student** • *The Earth System* Investigation Notebook (pages 3–5) • optional: 1 copy of the Chapter 1 Home Investigation: Saving Water student sheet *teacher provided	• Projections: Lesson 1.2 • Optional: Chapter 1 Home Investigation: Saving Water copymaster	• engineer • resource • synthesize

The Earth System Lesson Planning Guide

Lesson 1.2: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 1:** Asking Questions and Defining Problems • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	• Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide Lesson 1.3: Explaining the East Ferris Water Shortage (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Literacy emphasis: In Activity 3 students write a scientific explanation.		
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not.	**Students learn:** • The amount of available freshwater decreases when people use more than the amount that flows into their area. • Making explanations is an important practice in science. • A scientific explanation answers a question about how or why something happens. • A scientific explanation is based on ideas from investigations and text. • A scientific explanation is written for an audience. • The Earth system is made of different parts that interact.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 4, 6, 8 **DCIs** ESS2.C, ESS3.C, and LS2.B **CCCs** Systems and System Models, Energy and Matter, Stability and Change
3-D statement: Students obtain information about rainfall and population growth on Ferris Island and construct explanations about human impact on water—the interaction between the biosphere and the hydrosphere (systems and system models)—that is causing East Ferris' water shortage. **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. East Ferris's Water Shortage (10 min.)** Students receive additional information about East Ferris and West Ferris, then discuss why East Ferris is experiencing a water shortage while West Ferris is not. **2. Human Impact on Water (10 min.)** Students watch two videos that demonstrate how different amounts of water flowing into and out of a reservoir affect the level of water in the reservoir. Students apply ideas from the videos to figure out how an increasing population, and therefore increasing water demand, could explain East Ferris's water shortage. Students are introduced to two parts of the Earth system. **3. Diagramming Ferris Island (15 min.)** To help them reflect on their ideas and prepare to write a scientific explanation, students work with partners to create a diagram that illustrates why East Ferris is running out of water while West Ferris is not. **4. Writing a Scientific Explanation (25 min.)** Students are introduced to the scientific practice of writing explanations and then write an explanation of why East Ferris is running out of water. They also write about why West Ferris is not running out of water. This scaffolded writing opportunity provides a foundation from which to build throughout the unit. This activity provides an On-the-Fly Assessment to assess students' understanding of water availability.		

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *The amount of available freshwater decreases when people use more than the amount that flows into their area.* • vocabulary: *biosphere, explanation, hydrosphere* **For the Class** • optional: Scientific Explanation of the Water Shortage Version B copymaster • 2 plastic containers, 16 oz. • 2 plastic container lids • light-colored paper* • water* • 1 sheet of chart paper* • marker* • masking tape* **For Each Student** • optional: 1 copy of the Scientific Explanation of the Water Shortage Version B student sheets • *The Earth System* Investigation Notebook (pages 6–11) *teacher provided	• Projections: Lesson 1.3 • Parts of the Earth System chart • Video: Human Impact on Water Reservoirs Video 1 • Video: Human Impact on Water Reservoirs Video 2 • Optional: Scientific Explanation of the Water Shortage Version B copymaster	• biosphere • engineer • explanation • hydrosphere • system

The Earth System: Lesson 1.3

The Earth System Lesson Planning Guide		
Lesson 1.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide
Lesson 2.1: Investigating Water Drop Formation (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-on emphasis: In Activities 2-3 students observe and investigate water drops forming.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Everyday Phenomenon:** Water drops form on the outside of a cup of ice water.	**Students learn:** • Drops of water can form on cold surfaces. • For water drops to form on a cup, it must be cold. • Water drops that form on a cup do not come from water or ice inside the cup.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 7, 8 **DCIs** ESS2.A **CCCs** Systems and System Models, Energy and Matter, Stability and Change

3-D statement: Students investigate the process of water drops forming on the outside of a cold cup and consider where the water in the condensed drops comes from (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. A New Message from East Ferris (5 min.)
Students receive a message from Mayor McKnight about rain on Ferris Island. The message motivates students to investigate how water drops form.

2. Water Drop Formation Investigation (30 min.)
Students engage in close observation of what happens on the outside of a cup of ice water, watching as drops of liquid water form. This opportunity to observe as condensation forms on the outside of a cup provides students with important firsthand experience and evidence of how the water drops form.

3. Where the Water Drops Come From: Investigation 1 (10 min.)
The class brainstorms how they could answer the question of whether the liquid drops that form on the outside of a cup of ice water come from the water that is inside the cup. They observe a cold, empty cup taken out of a freezer and see that condensation can form even in the absence of liquid water. This leads to their realization that the drops on the outside of their cups of ice water did not come from the liquid inside the cups.

4. Discussing How Water Drops Form (10 min.)
By reflecting on why water formed on the cups and where it came from with the Think-Pair-Share discussion routine, students conclude that the water on the outside of their cups did not come from inside the cup and that it had to do with the cups being cold.

The Earth System: Lesson 2.1

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chapter 2 Question: *Why does more rain form over West Ferris than East Ferris?* **For the Class** • plastic cups, 9 oz. • hand lenses* • 2 identical glass cups, any size* • plastic trays* • 1 cooler* • 1 pitcher* • water* • ice* • masking tape* **For Each Group of Four Students** • 1 plastic tray* • 2 plastic cups with water • 2 hand lenses* • For Each Pair of Students • 3 ice cubes* **For Each Student** • *The Earth System* Investigation Notebook (pages 12–15) *teacher provided	• Projections: Lesson 2.1	• explanation

The Earth System Lesson Planning Guide		
Lesson 2.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)	• Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide
Lesson 2.2: From Water Vapor To Liquid Water (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 1, students continue their investigation of water drops.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Everyday Phenomenon:** Water drops form on the outside of a cup of ice water. **Everyday Phenomenon:** Raindrops fall from the sky.	**Students learn:** • There is water vapor in the air. • Water vapor in the air is the source of the water drops that form on the outside of a cold cup. • Drops of water can form when enough water vapor gets cold and condenses into liquid water. • Scientists synthesize what they learn from investigations with other sources of information to reach new understandings.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 8 **DCIs** ESS2.A, PS1.A **CCCs** Systems and System Models, Energy and Matter, Stability and Change

3-D statement: Students conduct a second investigation to figure out that the water in the condensed drops on the outside of the cold cup comes from water vapor in the air (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Where the Water Drops Come From: Investigation 2 (20 min.)
Students review what they learned from their investigations in Lesson 2.1. They set up a second investigation to see whether the drops of water that form on the outside of a cold cup come from air. This activity provides an On-the-Fly Assessment to assess students' understanding of what conditions allow condensation to occur.

2. What's in the Air? (15 min.)
A demonstration of a plastic globe getting inflated and a discussion about the gases that make up the air confront the common alternate conception that air is not a substance. This activity provides students with evidence that air is something (and not nothing) and that there is water vapor in the air.

3. Recording Investigation Results (15 min.)
Students record the results of the Where Do the Water Drops Come From: Investigation 2 through writing and drawing. They synthesize these results with what they learned in the Activity 2 and what they learned in Lesson 2.1 to explain how water drops form on the outside of a cup.

4. Discussing How Raindrops Form (10 min.)
Students are introduced to a new Investigation Question and apply what they have been learning about condensation to a discussion of how raindrops form.

The Earth System: Lesson 2.2

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *Drops of water can form when enough water vapor gets cold and condenses into liquid water.* • vocabulary: *atmosphere, condensation, water vapor* • Parts of the Earth System chart **For the Class** • plastic cups, 9 oz. • self-sealing plastic bags, quart size • 1 inflatable globe • plastic trays* • 1 cooler* • 1 pitcher* • water* • ice* • marker* **For Each Group of Four Students** • 1 plastic tray* • 4 plastic cups, 9 oz • 2 self-sealing plastic bags, quart size • 2 hand lenses* **For Each Pair of Students** • 6 ice cubes* • For Each Student • *The Earth System* Investigation Notebook (pages 16–18) *teacher provided	• Projections: Lesson 2.2	• atmosphere • condensation • synthesize • system • water vapor

The Earth System Lesson Planning Guide		
Lesson 2.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	**Crosscutting Concepts** • Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide
Lesson 2.3: A Nanoscale View of Condensation (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students revisit *Water Encyclopedia*, explore and investigate in *The Earth System* Simulation, and model ideas with *The Earth System* Modeling Tool.

Anchor Phenomenon / Everyday Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Everyday Phenomenon:** Raindrops fall from the sky.	• Water molecules are far apart in water vapor and close together in liquid water. • Raindrops can form when enough water vapor gets cold and condenses into liquid water. • When water vapor turns into liquid water, water molecules that were spread apart come together. • Nanoscale is a scale that is much too small to observe directly with our eyes. • A model is something scientists and engineers make to answer questions about the real world.	**SEPs** 1, 2, 3, 4,5, 7, 8 **DCIs** ESS2.A, PS1.A **CCCs** Scale, Proportion and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students use a digital model to investigate what happens at the nanoscale when raindrops form from water vapor (scale, proportion, and quantity). They then create a digital model to communicate their ideas.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reading About Phases of Water (15 min.)
From reading a section of *Water Encyclopedia*, students learn that water is made of water molecules, which can be far apart (as in water vapor) or close together (as in liquid water). Students apply this to an initial drawing of what happens to water molecules during condensation, preparing them to predict what will happen in *The Earth System* Simulation.

2. Exploring The Earth System Simulation (15 min.)
Students have the opportunity to explore *The Earth System* Simulation for the first time and become familiar with its features.

3. Investigating Condensation in the Sim (15 min.)
Students continue to investigate what happens at the nanoscale when condensation happens and raindrops form. They reflect on their learning by discussing different examples of condensation.

4. Reflecting on Raindrops (15 min.)
Students use the *The Earth System* Modeling Tool to reflect on the Investigation Question. Partners work together to create a digital model that shows what happens at the nanoscale when water vapor condenses and raindrops form. This activity provides an On-the-Fly Assessment to assess students' understanding of raindrop formation at the nanoscale.

5th Grade Unit 3 The Earth System

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<th>Materials</th>
<th>Digital Resources</th>
<th>Vocabulary</th>
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<td>
For the Classroom Wall

key concept: Water molecules are spread apart in water vapor. Water molecules are close together in liquid water.
key concept: Raindrops can form when enough water vapor gets cold and condenses into liquid water.
vocabulary: molecule
Parts of the Earth System chart
Partner Reading Guidelines

For the Class

1 inflatable globe
masking tape*

For Each Pair of Students

1 copy of Water Encyclopedia
1 digital device*

For Each Student

The Earth System Investigation Notebook (pages 19–22)

*teacher provided
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Projections Lesson 2.3

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atmosphere
condensation
molecule
water vapor

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<tr><th colspan="3">Lesson 2.3: Alignment to NGSS and NYSSLS</th></tr>
<tr><td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td><td>Disciplinary Core Ideas
ESS2.A: Earth Materials and Systems:
• Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)
PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)</td><td>Crosscutting Concepts
• Scale, Proportion, and Quantity
• Systems and System Models
• Energy and Matter</td></tr>
</table>

The Earth System Lesson Planning Guide Lesson 2.4: Investigating Evaporation (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activity 2, the teacher does a water vapor demonstration. In Activity 2 students investigate freshwater and saltwater drops.		
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Everyday Phenomenon:** There is water vapor in the air.	**Students learn:** • Water vapor can come from any body of water. • Evaporation is when liquid water turns into water vapor.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 7, 8 **DCIs** ESS2.A, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter
3-D statement: Students use a digital model, a demonstration, and a firsthand investigation to gather evidence that water vapor in the atmosphere comes from liquid bodies of water in the hydrosphere (systems and system models, energy and matter). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Exploring Water Vapor in the Sim (25 min)** Students use *The Earth System* Simulation to construct ideas about where water vapor comes from. They observe water vapor and track water molecules as they move. **2. Water Vapor Demonstration (10 min)** Students observe that paper that was taped inside a container with water is wet, but paper that was taped inside a dry container with is not wet. This provides additional evidence that water vapor comes from liquid water. **3. Freshwater and Saltwater Drops Investigation (15 min)** Students set up an investigation to observe what will happen when a drop of salt water and a drop of freshwater are exposed to the air, considering whether water vapor can come from a very small amount of water. **4. Discussing Water Vapor in the Air (10 min)** Students engage in a Think-Pair-Share routine, discussing where water vapor comes from based on evidence they gathered from the Sim. This activity provides an On-the-Fly Assessment to assess students' understanding of evaporation.		

The Earth System: Lesson 2.4

Materials	Digital Resources	Vocabulary
For the Class • Freshwater and Saltwater Drops Investigation copymaster • Water Vapor Demonstration containers, prepared in Lesson 1.3 • plastic cups, 9 oz. • plastic droppers • measuring spoon • plastic trays* • spoon* • pitcher* • water* • salt* • plastic trays* • dark-colored paper* • marker* • masking tape* **For Each Group of Four Students** • 1 plastic tray* • 1 plastic cup with water • 1 plastic cup with salt water, marked "S" • 2 plastic droppers **For Each Pair of Students** • 1 copy of Freshwater and Saltwater Drops Investigation student sheet • 1 digital device* **For Each Student** • *The Earth System* Investigation Notebook (pages 23–24) *teacher provided	• Projections Lesson 2.4 • Freshwater and Saltwater Drops Investigation copymaster	• atmosphere • condensation • evaporation • molecule • water vapor

The Earth System Lesson Planning Guide		
Lesson 2.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide Lesson 2.5: Drinking Cleopatra's Tears (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Hands-On: In Activity 1 students revisit their investigation of freshwater and saltwater drops. Literacy: In Activities 2-4 students partner read and reflect on *Drinking Cleopatra's Tears*.		
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** On Earth, water can take different forms.	**Students learn:** • Ideas in science are based on evidence. • When salt water evaporates, the salt is left behind. • Water vapor in the air comes from liquid water that has evaporated. • The water on Earth today is the same water that was on Earth hundreds of years ago. • Synthesizing ideas from multiple sources can help answer questions.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 6, 7, 8 **DCIs** ESS2.A, ESS2.C, PS1.A, LS2.B **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Stability and Change
3-D statement: Students read the book *Drinking Cleopatra's Tears* to obtain, evaluate, and communicate ideas about how water cycles through the parts of the Earth system (systems and system models, energy and matter). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Evidence for Evaporation (10 min.)** Students observe results of the Freshwater and Saltwater Drops Investigation, which allows them to consolidate their understanding of evaporation. **2: Introducing Drinking Cleopatra's Tears (15 min.)** The teacher introduces *Drinking Cleopatra's Tears* and explains what ideas students will be synthesizing. This prepares students to record big ideas while reading. **3. Partner Reading (20 min.)** Students read *Drinking Cleopatra's Tears* in pairs and then connect ideas from the text to ideas from their hands-on investigations. **4. Synthesizing Ideas About Water on Earth (15 min.)** Students share the ideas they gathered from the book and answer the question, *How can water from Cleopatra's tears be on Earth today?* This activity provides an On-the-Fly Assessment to assess student ability to synthesize information to answer a question.		

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *Water vapor in the air comes from liquid water that has evaporated.* • vocabulary: *evaporation* • Partner Reading Guidelines **For the Class** • optional: Chapter 2 Home Investigation: Evaporation and Condensation copymaster • masking tape* **For Each Group of Four Students** • tray with Freshwater and Saltwater Drops Investigation student sheets **For Each Pair of Students** • 1 copy of *Drinking Cleopatra's Tears* **For Each Student** • optional: 1 copy of the Chapter 2 Home Investigation: Evaporation and Condensation student sheet • *The Earth System* Investigation Notebook (pages 25–29) *teacher provided	• Optional Chapter 2 Home Investigation	• atmosphere • condensation • evaporation • synthesize • water vapor

The Earth System: Lesson 2.5

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<tr><th colspan="3">The Earth System Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 2.5: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
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• Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)
ESS2.C: The Roles of Water in Earth's Surface Processes:
• Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Scale, Proportion, and Quantity
• Systems and System Models
• Energy and Matter
• Stability and Change</td>
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The Earth System Lesson Planning Guide
Lesson 2.6: Explaining How Raindrops Form (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students write a scientific explanation.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Everyday Phenomenon:** Raindrops fall from the sky.	**Students learn:** • When water changes from gas to liquid or liquid to gas, water molecules are not created or destroyed. • A scientific explanation often describes things that are not easy to observe directly. • A scientific explanation uses scientific language. • The hydrosphere and atmosphere interact when liquid water evaporates to form water vapor in the atmosphere and when water vapor condenses to form rain. • The biosphere interacts with the hydrosphere when people use water. The biosphere interacts with the atmosphere when people breathe.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 6, 7, 8 **DCIs** ESS2.B, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students construct explanations about why a lot of rain forms over West Ferris, but not much rain forms over East Ferris. They then discuss the parts of the Earth system that are interacting on Ferris Island (systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Roundtable Discussion Routine (25 min.)
Students participate in their first Roundtable Discussion, a structured routine for student-guided, small-group discussions. Students discuss a series of questions about condensation and evaporation to review what they have learned so far.

2. Explaining How Raindrops Form (25 min.)
Students write scientific explanations to answer the question, Why does a lot of rain form over West Ferris? and also address the question, Why doesn't much rain form over East Ferris? This Critical Juncture writing task is designed to reveal students' understanding of key content. The lesson offers specific guidance for instructional follow-up based on students' performance.

3. Reflecting on Interacting Parts of the Earth System (10 min.)
Students revisit the Parts of the Earth System chart to reflect on how the atmosphere, biosphere, and hydrosphere interact in East Ferris and West Ferris.

The Earth System: Lesson 2.6

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Materials

For the Classroom Wall
- key concept: *When water changes from gas to liquid or liquid to gas, water molecules are not created or destroyed.*
- vocabulary: *system*
- Parts of the Earth System chart

For the Class
- optional: Scientific Explanation of How Raindrops Form Version B copymaster
- masking tape*

For Each Student
- optional: 1 copy of the Scientific Explanation of How Raindrops Form Version B student sheet
- *The Earth System* Investigation Notebook (pages 30–33)

*teacher provided

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Digital Resources
- Projections Lesson 2.6
- Optional: Scientific Explanation of How Raindrops Form Version B copymaster
- Assessment Guide: Reviewing Students' Chapter 2 Explanations About How Raindrops form

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Vocabulary
- atmosphere
- condensation
- engineer
- evaporation
- explanation
- molecule
- system
- water vapor

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The Earth System Lesson Planning Guide		
Lesson 2.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 2.7: Designing Freshwater Collection Systems (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activities 1-3 students brainstorm ideas and plan solutions. In Activity 4 students build freshwater collection systems.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Design Problem:** Convert salt water into fresh water.	**Students learn:** • Engineers use science knowledge to design solutions to problems. • Engineers often work collaboratively. • It is possible to separate freshwater from salt water.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 6 **DCIs** ESS2.C, ESS3.C, ETS1.A, ETS1.B, PS1.A **CCCs** Energy and Matter; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students apply what they have learned about interactions between the hydrosphere and the atmosphere to design systems (systems and system models) that convert salt water to fresh water.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introduction to Freshwater Collection Systems (10 min.)
Students read a message from Mayor McKnight asking them to design a solution to address East Ferris's water shortage problem by converting salt water to fresh water. Students discuss and record science concepts that may help them design freshwater collection systems.

2. Brainstorming Ideas (10 min.)
Students discuss design ideas for freshwater collection systems in pairs to prepare for collaborating in groups of four.

3. Planning Solutions (15 min.)
Pairs join to make groups of four and share their ideas for freshwater collection systems. They discuss their plans, select materials, and diagram their solution.

4. Building Solutions (25 min.)
Students work in groups of four to build their designs for freshwater collection systems.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Class • plastic cups, ½ oz • plastic cups, 9 oz • plastic cups, 16 oz • plastic containers, 16 oz • blue food coloring • aluminum foil • plastic wrap • plastic trays* • rocks, the approximate diameter of a quarter* • ice cubes* • cooler* • hot water* • masking tape* **For Each Group of Four Students** • 1 plastic tray* • 1 plastic cup, ½ oz • 1 plastic cup, 9 oz • 1 plastic cup, 16 oz • 1 plastic container, 16 oz • 1 rock* • 1 ice cube* **For Each Student** • *The Earth System* Investigation Notebook (pages 34–37) *teacher provided	• Projections: Lesson 2.7	• atmosphere • condensation • design • engineer • evaporation • system • water vapor

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<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 6: Constructing Explanations and Designing Solutions</td>
<td>Disciplinary Core Ideas
ESS2.C: The Roles of Water in Earth's Surface Processes:
• Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)
ESS3.C: Human Impacts on Earth Systems:
• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
ETS1.A: Defining and Delimiting Engineering Problems:
• Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)
ETS1.B: Developing Possible Solutions:
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
ETS1.B: Developing Possible Solutions:
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
ETS1.B: Developing Possible Solutions:
• Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)</td>
<td>Crosscutting Concepts
• Systems and System Models
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• Stability and Change</td>
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The Earth System Lesson Planning Guide
Lesson 2.8: Engineering Clean Water (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Engineering Clean Water*.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Design Problem:** Clean the water in Dhaka, Bangladesh.	**Students learn:** • Engineers use the design cycle when they design solutions to a problem. • Engineers iterate on their designs. • Most scientists and engineers work in teams. • Men and women from all cultures and backgrounds choose careers as scientists and engineers. • Creativity and imagination are important to science.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 6, 8 **DCIs** LS2.B, ETS1.A, ETS1.B, ETS1.C **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students read the book *Engineering Clean Water* to obtain information about the engineering design process. They apply what they learn to determine new design criteria for their freshwater collection systems (systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Freshwater Collection Systems (15 min.)
Students participate in the Think-Pair-Share routine to explain how the freshwater collection systems they designed in Lesson 2.7 are based on scientific concepts.

2. Partner Reading (30 min.)
Students read Engineering Clean Water, which introduces them to the design cycle and to iterating. The book's focus on iterating as part of the design process emphasizes an important engineering practice that students will participate in as the unit progresses.

3. Discussing Engineering Clean Water (15 min.)
The class discusses what they learned about how engineers design solutions and reflect on their own experiences. Students then discuss and share new criteria for their freshwater collection systems.

The Earth System: Lesson 2.8

Materials	Digital Resources	Vocabulary
For the Classroom Wall • vocabulary: *criteria, design, iterate* • Partner Reading Guidelines **For the Class** • 1 sheet of chart paper* • marker* • masking tape* **For Each Pair of Students** • 1 copy of *Engineering Clean Water* **For Each Student** • *The Earth System* Investigation Notebook (pages 38–45) *teacher provided	• Projections Lesson 2.8 • Designing Freshwater Collection Systems	• criteria • design • engineer • iterate • synthesize • wastewater

The Earth System Lesson Planning Guide		
Lesson 2.8: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **ETS1.A: Defining and Delimiting Engineering Problems:** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions:** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) **ETS1.B: Developing Possible Solutions:** • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution:** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 3.1: Investigating Where Raindrops Form (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students read a section in *Water Encyclopedia*. In Activity 4 students revisit *Drinking Cleopatra's Tears*.

Hands-On: In Activity 3 the teacher models condensation.

Anchor Phenomenon and related phenomena	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** Dewdrops, fog, and clouds form. **Everyday Phenomenon:** You can sometimes see your breath.	**Students learn:** • In the part of the atmosphere where weather happens, the air is colder higher up. • Wherever the atmosphere is cold enough, water vapor can condense.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4, 8 **DCIs** ESS2.A, ESS2.C, PS1.A, LS2.B **CCCs** Systems and System Models, Energy and Matter, Stability and Change

3-D statement: Students obtain information from the books *Water Encyclopedia* and *Drinking Cleopatra's Tears* and use physical models of the hydrosphere-atmosphere system (systems and system models) to support their developing understanding of where and why water vapor condenses in the atmosphere.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Ferris Island Weather Reports (10 min.)
After reading Ferris Island weather reports from Mayor McKnight, students are prompted to consider how more rain can form over West Ferris when it is not colder than East Ferris.

2. Reading About the Atmosphere (15 min.)
Students read about the atmosphere in *Water Encyclopedia* to learn that it is colder higher up in the troposphere, where weather happens.

3. Condensation in the Atmosphere Models (15 min.)
With input from the class, the teacher creates two models to help students think about what happens to water vapor at different heights and temperatures. These models provide a visual representation of how more liquid water can form and create raindrops high up where it is cold.

4. Reading More About Water Vapor (20 min.)
Students reread a few pages from *Drinking Cleopatra's Tears* and record information about where and why water vapor condenses. This reinforces the idea that water vapor must get cold to condense. It also highlights that water vapor is most likely to condense high up in the atmosphere, where it is always cold.

5. Discussing the Models (5 min.)
The teacher leads students in a discussion about where in the atmosphere water vapor condenses, providing the opportunity for students to share what they observe about the model and reflect on their reading.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chapter 3 Question: *Why is more water vapor getting cold over West Ferris than East Ferris?* • Partner Reading Guidelines **For the Class** • 2 foam cups • 1 plastic cup, 9 oz • 1 plastic cup, 16 oz • plastic tray* • hot water* • ice cube* • hand lenses* • masking tape* **For Each Pair of Students** • 1 copy of *Water Encyclopedia* • 1 copy of *Drinking Cleopatra's Tears* **For Each Student** • *The Earth System* Investigation Notebook (pages 46—50) *teacher provided	• Projections: Lesson 3.1 • Condensation in the Atmosphere Models	• atmosphere • condensation • evaporation • water vapor

The Earth System: Lesson 3.1

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<tr><th colspan="3">Lesson 3.1: Alignment to NGSS and NYSSLS</th></tr>
<tr>
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• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
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ESS2.C: The Roles of Water in Earth's Surface Processes:
• Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)
PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
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• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Systems and System Models
• Energy and Matter
• Stability and Change</td>
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The Earth System Lesson Planning Guide
Lesson 3.2: Making Sense of Where Raindrops Form (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students gather data in *The Earth System* Simulation and graph data with The Earth System Data Tool.

Anchor Phenomenon and Predicted Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Predicted Phenomenon:** The amount of condensation in different parts of the atmosphere	**Students learn:** • Water vapor condenses as it moves higher, to where the atmosphere is colder. • When liquid water evaporates, water molecules do not disappear; they change to water vapor. • Scientists and engineers graph data to help them visualize and recognize patterns.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 7, and 8 **DCIs** ESS2.A, ESS2.C, PS1.A, LS2.B **CCCs** Systems and System Models; Energy and Matter; Stability and Change; Scale, Proportion, and Quantity

3-D statement: Students collect, graph, and analyze data from a digital model to gather evidence that more condensation occurs high up in the atmosphere where it is colder and that the clouds we see in the sky are not created from nothing, but are the result of water molecules coming together (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Predicting Where Water Vapor Will Condense (5 min.)
Students participate in a Think-Pair-Share routine to predict how the amount of condensation will vary in different areas of the atmosphere in a Sim landscape.

2. Investigating Where Water Vapor Condenses (25 min.)
Students use the Sim to collect data about the heights and temperatures at which liquid water forms in the atmosphere. This data becomes the basis of the analysis that occurs in Activity 3.

3. Graphing Data from the Sim (25 min.)
Students graph their data using *The Earth System* Data Tool. They analyze their graphs to conclude that more condensation occurs higher up in the atmosphere because it is colder there. This activity provides an On-the-Fly Assessment to assess students' ability to analyze data and draw conclusions.

4. Reflecting on Condensation in the Atmosphere (5 min.)
Students revisit their initial predictions of where in the atmosphere the most condensation would occur to reflect on their learning.

The Earth System: Lesson 3.2

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *Water vapor condenses as it moves higher, to where the atmosphere is colder.* • *Partner Reading Guidelines* **For the Class** • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *The Earth System* Investigation Notebook (pages 51–53) *teacher provided	• Projections: Lesson 3.2	• atmosphere • condensation • evaporation • molecule • water vapor

The Earth System Lesson Planning Guide		
Lesson 3.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Systems and System Models • Energy and Matter • Stability and Change • Scale, Proportion, and Quantity

The Earth System Lesson Planning Guide
Lesson 3.3: Explaining Why It Rains (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 3 students write a scientific explanation.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Predicted Phenomenon:** The amount of condensation in different parts of the atmosphere	**Students learn:** • Scientists and engineers create models to show their thinking. • Scientists use information they gain to create a more complete explanation. • Scientists use scientific vocabulary to explain their ideas.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 6, 8 **DCIs** ESS2.A, ESS2.C, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Stability and Change

3-D statement: Students create models to show where raindrops form in the atmosphere and why. They then construct explanations, including nanoscale reasoning (scale, proportion, and quantity), about why it rains a lot more over West Ferris than over East Ferris.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Word Relationships (15 min.)
Students are introduced to the Word Relationships routine and use it to discuss and reflect on what they've learned. This provides practice with scientific vocabulary, which students will use in the explanations they write in Activity 3.

2. Modeling Where Raindrops Form (20 min.)
Students use *The Earth System* Modeling Tool to express their understanding of where raindrops form in the atmosphere and why.

3. Explaining Why It Rains (25 min.)
Students write scientific explanations to answer the question, *Why does a lot of rain form over West Ferris?* and also address the question, *Why doesn't much rain form over East Ferris?* This Critical Juncture writing task is designed to reveal how students' thinking has evolved since they wrote their scientific explanations in Lesson 2.6.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Class • optional: Scientific Explanation of Why It Rains in West Ferris Version B copymaster • optional: Chapter 3 Home Investigation: Rain Quiz copymaster • Word Relationships Cards: Set 1 • paper clips* **For Each Group of Four Students** • 1 set of Word Relationships Cards: Set 1, clipped together (4 cards/set) **For Each Student** • optional: Scientific Explanation of Why It Rains in West Ferris Version B student sheet • optional: 1 copy of the Chapter 3 Home Investigation: Rain Quiz student sheet • *The Earth System* Investigation Notebook (pages 54–57) *teacher provided	• Projections: Lesson 3.3 • Optional: Scientific Explanation of Why It Rains in West Ferris Version B copymaster • Assessment Guide: Reviewing Students' Chapter 3 Explanations About Why It Rains in West Ferris • Optional: Chapter 3 Home Investigation: Rain Quiz copymaster	• atmosphere • condensation • molecule • water vapor

The Earth System: Lesson 3.3

The Earth System Lesson Planning Guide		
Lesson 3.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide
Lesson 3.4: Iterating on Freshwater Collection Systems (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activities 1-4 students evaluate and revise their freshwater collection systems.

Anchor Phenomenon and Design Problem	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Design Problem:** Convert salt water into fresh water.	**Students learn:** • Testing a solution to a design problem and learning that it does not work is an important part of the design process. • Engineers can learn from sharing ideas with each other. • Iterating allows engineers to learn from and improve upon initial designs.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4, 5, 6, 8 **DCIs** ESS2.C, ESS3.C, PS1.A, ETS1.A, ETS1.B, ETS1.C **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students evaluate their freshwater collection system designs (systems and system models) and communicate with their peers—asking questions and comparing how well each of their designs met the specified criteria—in order to improve their designs.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Evaluating Freshwater Collection Systems (15 min.)
Students measure how much fresh water their systems collected. They record their observations of how well their solutions trapped water vapor, condensed water vapor, and collected the water that condensed. Students will use this information to redesign their systems in Activity 4.

2. Engineers' Jigsaw (15 min.)
Students participate in a jigsaw routine to learn about other groups' designs and consider ways to iterate on their own designs.

3. Planning Iterations (10 min.)
Students return to their groups to discuss lessons learned from other classmates and new science ideas they might incorporate into a revised solution. This activity provides an On-the-Fly Assessment to assess students' ability to iterate on initial designs.

4. Building New Systems (20 min.)
Students iterate on their designs by building new freshwater collection systems to be tested over the next few days.

The Earth System: Lesson 3.4

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Designing Freshwater Collection Systems chart from Lesson 2.8 **For the Class** • 1 copy of *Engineering Clean Water* • plastic cups, ½ oz • droppers • trays with freshwater collection systems and unused materials from Lesson 2.7 • blue food coloring • aluminum foil • plastic wrap • ice cubes* • cooler* • hot water* • masking tape* • bucket or large bowl for water disposal (optional)* **For Each Group of Four Students** • 1 plastic cup, ½ oz • 1 dropper • tray with freshwater collection systems and unused materials from Lesson 2.7 • 1 ice cube* **For Each Student** • *The Earth System* Investigation Notebook (pages 58–63) *teacher provided	• Projections: Lesson 3.4	• condensation • design • diagram • engineer • evaporation • iterate • system • water vapor

The Earth System Lesson Planning Guide		
Lesson 3.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **ESS3.C: Human Impacts on Earth Systems:** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) **ETS1.A: Defining and Delimiting Engineering Problems:** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions:** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter • Stability and Change

The Earth System: Lesson 3.4

The Earth System Lesson Planning Guide		
Lesson 3.4: Alignment to NGSS and NYSSLS		
	ETS1.B: Developing Possible Solutions: • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution:** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

The Earth System Lesson Planning Guide
Lesson 4.1: Investigating the Movement of Water (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 3 students use materials to investigate what happens when air hits a mountain.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** One side of a mountain can get more rain than the other side.	**Students learn:** • Wind and mountains affect the movement of water vapor in the atmosphere. • When the wind blows toward a mountain, the mountain can direct the wind upward, moving water vapor higher in the atmosphere.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 7, 8 **DCIs** ESS2.A, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Stability and Change

3-D statement: Students use a digital and a physical model to investigate how the shape of the land can affect the movement of water vapor in the atmosphere (systems and system models, energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Revisiting Ferris Island (5 min.)
Students consider what they have discovered about Ferris Island so far. They are then introduced to Chapter 4 Question and the new Investigation Question.

2. Investigating Water Vapor in the Sim (25 min.)
Students use The Earth System Simulation to investigate what factors can affect the movement of water vapor in the atmosphere. They discover that water vapor moves in the direction of the wind and a mountain can direct the wind upward.

3. Redirecting Air Investigation (20 min.)
Students gather information about how the wind and a mountain can affect the movement of water vapor using physical models. The purpose of this activity is for students to gain first-hand experience with how mountains redirect water vapor upward.

4. Reflecting on the Movement of Water Vapor (10 min.)
Students participate in a Think-Pair-Share routine to reflect on what they have learned about the wind and mountains and begin to think about how these factors can affect rainfall. This activity provides an On-the-Fly Assessment to assess students' understanding of how the wind and mountains move water vapor higher in the atmosphere.

The Earth System: Lesson 4.1

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chapter 4 Question: *Why is there more water vapor high up over West Ferris than East Ferris?* **For the Class** • tissue paper • scissors* • masking tape* **For Each Pair of Students** • 1 square of tissue paper, 4 x 4 inches • 1 digital device* **For Each Student** • *The Earth System* Investigation Notebook (pages 64–67) *teacher provided	• Projections: Lesson 4.1	• atmosphere • condensation • evaporation • molecule • water vapor

The Earth System Lesson Planning Guide		
Lesson 4.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter • Stability and Change

The Earth System Lesson Planning Guide
Lesson 4.2: Investigating Rainfall Distribution (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students gather data in *The Earth System* Simulation and model ideas with *The Earth System* Modeling Tool.

Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** One side of a mountain can get more rain than the other side	**Students learn:** • When liquid water falls as rain, there is less water left in the atmosphere. • The rain shadow effect is the uneven pattern of rain that occurs when wind blows from a body of water towards a mountain and creates a lot of rain on the windward side of the mountain and very little on the opposite side. • The geosphere interacts with the atmosphere when water vapor in the atmosphere is redirected by a mountain. • The geosphere interacts with the hydrosphere when a mountain redirects water vapor upward, where it condenses and falls as rain.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 8 **DCIs** ESS2.A, ESS2.C, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter; Stability and Change

3-D statement: Students create a digital model to show how water vapor in the atmosphere interacts with landforms to create a rain shadow (systems and system models, energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Investigating Rain (20 min.)
Students work with *The Earth System* Simulation to investigate more about what happens to water in the atmosphere to create the rain shadow effect and record data in their notebooks.

2. Rain Shadow Model (20 min.)
Partners work with the 4.2 Rain Shadow Model to model what happens to water in the atmosphere to create a rain shadow. The process of making the model and discussing it with a partner helps students synthesize ideas about rain formation from Chapters 2–3 with what they've learned about how wind and mountains affect the movement of water vapor. This activity serves as the third and final Critical Juncture in the unit. It is an opportunity to assess students' understanding of key content and to prepare to tailor instruction before proceeding to the End-of-Unit Assessment, if necessary.

3. Modeling Rainfall Patterns (20 min.)
As a class, students discuss how to complete the 4.2 Rainfall Patterns Models. This provides an opportunity for students to apply the new understanding they gained from the lesson.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *When wind blows toward a mountain, the mountain can direct the wind upward. This moves water vapor higher in the atmosphere.* • 1 vocabulary card: *geosphere* • Parts of the Earth System chart **For the Class** • 1 inflatable globe • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *The Earth System* Investigation Notebook (pages 68–70) *teacher provided	• Projections: Lesson 4.2 • Hydrosphere-Geosphere Interactions copymaster	• atmosphere • condensation • evaporation • molecule • water vapor

The Earth System: Lesson 4.2

<table>
<tr><th colspan="3">The Earth System Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 4.2 Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
ESS2.A: Earth Materials and Systems:
• Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)
ESS2.C: The Roles of Water in Earth's Surface Processes:
• Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)
PS1.A: Structure and Properties of Matter:
• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
•</td>
<td>Crosscutting Concepts
• Scale, Proportion, and Quantity
• Systems and System Models
• Energy and Matter
• Stability and Change</td>
</tr>
</table>

The Earth System Lesson Planning Guide
Lesson 4.3: End-of-Unit Assessment Part 1 (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students write a scientific explanation..

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** One side of a mountain can get more rain than the other side.	**Students learn:** • Scientists and engineers often convene and discuss possible answers to the questions they are investigating.	**Alignment to NGSS and NYSSLS** **SEPs** 6, 7, 8 **DCIs** ESS2.A, PS1.A **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students construct written explanations about the movement of water in the atmosphere, which causes more rain to form over West Ferris than over East Ferris (systems and system models; energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Roundtable Discussion (20 min.)
Through a Roundtable Discussion, students discuss a series of questions about rain formation and the rain shadow effect to review key ideas from the unit so far.

2. End-of-Unit Assessment Part 1 (30 min.)
Students apply what they have learned throughout the unit to write a scientific explanation of why more rain forms over West Ferris than East Ferris. These written explanations are the first of a two-part End-of-Unit Assessment.

3. Solutions for East Ferris's Water Shortage (10 min.)
Students share their scientific explanations with their partners and then discuss what the people of East Ferris should do to solve the water shortage.

Materials	Digital Resources	Vocabulary
For the Class • End-of-Unit Writing Part 1: Explaining the Rain Shadow on Ferris Island Version A copymaster (optional: Version B) **For Each Student** • 1 copy of End-of-Unit Writing Part 1: Explaining the Rain Shadow on Ferris Island Version A student sheet (optional: Version B) • *The Earth System* Investigation Notebook (pages 71–73)	• Projections: Lesson 4.3 • Assessment Guide: Assessing Students' End-of-Unit Part 1 Explanations About the Rain Shadow on Ferris Island • End-of-Unit Writing Part 1: Explaining the Rain Shadow on Ferris Island Version A copymaster • Optional: End-of-Unit Writing Part 1: Explaining the Rain Shadow on Ferris Island Version B copymaster	• atmosphere • condensation • engineer • evaporation • explanation • molecule • water vapor

The Earth System: Lesson 4.3

The Earth System Lesson Planning Guide		
Lesson 4.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 4.4: How the Earth System Explains Dinosaur Extinction (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 1 students partner read and reflect on *How the Earth System Explains Dinosaur Extinction*.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
One side of Ferris Island has a water shortage and the other does not. **Investigative Phenomenon:** Dinosaurs went extinct.	• Changes in one part of the Earth system can cause changes in another part. • Dinosaur extinction was caused by interactions between the parts of the Earth system. • The rain shadow effect is created by interactions between the parts of the Earth system.	**SEPs** 2, 8 **DCIs** ESS2.A **CCCs** Systems and System Models, Energy and Matter, Stability and Change

3-D statement: Students read the book *How the Earth System Explains Dinosaur Extinction* to obtain and evaluate information about how Earth system interactions cause phenomena on Earth (systems and system models). Students then apply their understanding to complete a diagram model of the Earth system interactions that cause a rain shadow on Ferris Island (systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Partner Reading (25 min.)
Students read *How the Earth System Explains Dinosaur Extinction*, which illustrates how Earth is a system of interacting parts, with the purpose of recording big ideas about how Earth functions as a system.

2. Synthesizing Ideas About the Earth System (10 min.)
After reading, students discuss their ideas about Earth as a system of interacting parts. Then, they synthesize ideas from the text with ideas from their investigations to think about how the water shortage in East Ferris is an example of Earth system interactions. This activity provides an On-the-Fly Assessment to assess students' ability to synthesize information from text and investigations as well as their understanding of the concept of the Earth system.

3. Labeling Interactions on Ferris Island (10 min.)
Students work in pairs to label Earth system interactions on a diagram of Ferris Island. This provides an opportunity for students to apply their understanding of the Earth as a system of interacting parts.

4. Word Relationships (15 min.)
To conclude the lesson, students participate in the Word Relationships routine. They gain practice using scientific vocabulary as they reflect on how the parts of the Earth system interact.

The Earth System: Lesson 4.4

<table>
<tr><th>Materials</th><th>Digital Resources</th><th>Vocabulary</th></tr>
<tr><td>For the Classroom Wall
• Parts of the Earth System chart
• Partner Reading Guidelines
For the Class
• Labeling Earth System Interactions copymaster
• optional: Chapter 4 Home Investigation: Earth System Interactions copymaster
• Word Relationships Cards: Set 2
• paper clips*
• marker*
• masking tape*
For Each Group of Four Students
• 1 set of Word Relationships Cards: Set 2, clipped together (8 cards/set)
For Each Pair of Students
• 1 copy of How the Earth System Explains Dinosaur Extinction
For Each Student
• Labeling Earth System Interactions student sheet
• optional: 1 copy of the Chapter 4 Home Investigation: Earth System Interactions student sheet
• The Earth System Investigation Notebook (pages 74–81)
*teacher provided</td><td>• Projections Lesson 4.4
• Labeling Earth Systems Interactions copymaster
• Optional Chapter 4 Home Investigation: Earth System Interactions copymaster</td><td>• atmosphere
• biosphere
• condensation
• evaporation
• geosphere
• hydrosphere
• synthesize
• system
• water vapor</td></tr>
</table>

The Earth System Lesson Planning Guide		
Lesson 4.4 Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)	**Crosscutting Concepts** • Systems and System Models • Energy and Matter • Stability and Change

<table>
<tr><th colspan="3">The Earth System Lesson Planning Guide
Lesson 4.5: Final Design Iterations (60 minutes)</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.
Hands-On: In Activity 1 students reflect on their freshwater collection system redesigns.</td></tr>
<tr><td>Anchor Phenomenon:
One side of Ferris Island has a water shortage and the other does not.
Design Problem:
Convert saltwater into freshwater.</td><td>Students learn:
• Iterating allows engineers to improve their solutions to problems.
• Engineers may iterate on their solutions multiple times.</td><td>Alignment to NGSS and NYSSLS
SEPs 1, 2, 3, 4, 5, 6, 8
DCIs ESS2.C, ESS3.C, PS1.A, ETS1.A, ETS1.B, ETS1.C
CCCs Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter</td></tr>
<tr><td colspan="3">3-D statement: Students evaluate their freshwater collection system designs (systems and system models) and communicate with their peers—asking questions and comparing how well each of their designs met the specified criteria—in order to improve their designs.
Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts</td></tr>
<tr><td colspan="3">Lesson at-a-Glance
1. Evaluating Freshwater Collection Systems (20 min.)
Students measure how much fresh water their redesigned systems collected and record their observations. Students will use this information to redesign their systems in Activity 3.
2. Engineer's Jigsaw (20 min.)
Students participate in a jigsaw routine to learn about other groups' designs and consider ways to iterate on their own designs.
3. Planning Final Design Iterations (20 min.)
Students return to their groups to discuss lessons learned from other classmates and new science ideas they might incorporate into a revised solution. Using the information they have gathered, each student independently writes and draws a plan for a final design of their freshwater collection system. This activity provides an On-the-Fly Assessment to assess students' ability to iterate on their redesigns.</td></tr>
</table>

5th Grade Unit 3 The Earth System

<table>
<tr><th>Materials</th><th>Digital Resources</th><th>Vocabulary</th></tr>
<tr><td>

For the Classroom Wall
- key concept: *Iterating allows engineers to improve their solutions to problems.*
- Designing Freshwater Collection Systems chart from Lesson 3.4

For the Class
- plastic cups, ½ oz
- droppers
- trays with freshwater collection systems from Lesson 3.4
- masking tape*
- bucket or large bowl for water disposal (optional)*

For Each Group of Four Students
- 1 plastic cup, ½ oz
- 1 dropper
- tray with freshwater collection systems from Lesson 3.4

For Each Student
- *The Earth System* Investigation Notebook (pages 82–87)

*teacher provided
</td><td>

- Projections Lesson 4.5
</td><td>

- condensation
- design
- engineer
- evaporation
- iterate
- system
- water vapor
</td></tr>
</table>

The Earth System: Lesson 4.5

<table>
<tr><th colspan="3">The Earth System Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 4.5: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
ESS2.C: The Roles of Water in Earth's Surface Processes:
• Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)
ESS3.C: Human Impacts on Earth Systems:
• Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)
PS1.A: Structure and Properties of Matter:
• (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
ETS1.A: Defining and Delimiting Engineering Problems:
• Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)
ETS1.B: Developing Possible Solutions:
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
ETS1.B: Developing Possible Solutions:
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)</td>
<td>Crosscutting Concepts
• Systems and System Models
• Energy and Matter
• Stability and Change</td>
</tr>
</table>

The Earth System Lesson Planning Guide		
Lesson 4.5: Alignment to NGSS and NYSSLS		
	ETS1.B: Developing Possible Solutions: • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution:** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	

The Earth System Lesson Planning Guide
Lesson 5.1: Investigating Wastewater Treatment (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activities 2-3 students mix substances to cause a chemical reaction.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A wastewater treatment plant turns wastewater into clean freshwater. **Investigative Phenomenon:** Mixing substances can result in changes to temperature and color, as well as the creation of gas.	**Students learn:** • In the wastewater treatment process, scientists treat water that has harmful substances in it to produce clean freshwater. • Different substances can have different properties.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 3, 8 **DCIs** ESS2.C, ESS3.C, PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students investigate by observing the properties of substances before and after a chemical reaction to figure out how new substances form (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Discussing Wastewater Treatment (15 min.)
Students read a new message from Mayor McKnight, which requests that they look into wastewater treatment as another solution to East Ferris's water problem. Students begin to consider how some substances disappear and others appear in the process of wastewater treatment.

2. Observing Substances (15 min.)
Students observe the substances that they will mix in Activity 3, focusing on the properties of those substances. This primes students to notice changes that happen when they mix the substances.

3. Mixing Substances Investigation (20 min.)
Students mix substances and observe a chemical reaction. A firsthand experience with this chemical reaction provides students with a valuable schema that they will elaborate on in future activities.

4. Debriefing the Investigation (10 min.)
Students share observations and discuss how the properties of the substances they put into their bags differed from the properties of the substances they ended up with. This discussion positions students to identify what they observed as a chemical reaction in Lesson 5.2.

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Classroom Wall • Chapter 5 Question: *How can East Ferris turn wastewater into clean freshwater?* • vocabulary: *property, wastewater* **For the Class** • plastic cups, 9 oz • plastic cup lids • graduated cylinders, 25 mL • baking soda • calcium chloride • phenol red concentrate • squeeze bottles • measuring spoons • wooden sticks • self-sealing plastic bags, quart-size • “baking soda” labels • “calcium chloride” labels • “phenol red + water” labels • hand lenses* • plastic trays* • safety goggles* • 1 sheet of chart paper* • marker* • masking tape* **For Each Group of Four Students** • 1 graduated cylinder, 25 mL • 1 plastic cup with baking soda, 6 teaspoons • 1 plastic cup with calcium chloride, 12 teaspoons • 1 squeeze bottle of phenol red solution • 2 measuring spoons • 2 wooden sticks • 1 self-sealing plastic bag, quart size • 1 plastic tray* • 2 hand lenses* **For Each Student** • safety goggles* • *The Earth System* Investigation Notebook (pages 88–90) *teacher provided	• Projections Lesson 5.1 • 5.1 Mixing Substances Investigation Chart	• molecule • property • substance • wastewater

The Earth System: Lesson 5.1

The Earth System Lesson Planning Guide		
Lesson 5.1: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 3:** Planning and Carrying Out Investigations • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **ESS3.C: Human Impacts on Earth Systems:** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it see ms to vanish. (5-PS1-2) **PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 5.2: Chemical Reactions Everywhere (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-2 students partner read and reflect on *Chemical Reactions Everywhere*.

Anchor Phenomenon:
A wastewater treatment plant turns wastewater into clean freshwater.

Investigative Phenomenon:
Objects such as apples, fireworks, and candles change.

Students learn:

- In a chemical reaction, substances are mixed and at least one new substance with different properties is formed.
- Physical changes such as changing color, producing light, or producing gas can be evidence of a chemical reaction.
- We cannot always tell that a chemical reaction has happened based on physical evidence.

Alignment to NGSS and NYSSLS
SEPs 1, 6, 7, 8
DCIs PS1.A, PS1.B
CCCs Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students obtain and evaluate information from the book *Chemical Reactions Everywhere* and communicate whether a chemical reaction occurred when they mixed substances together (energy and matter) in the previous lesson.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Partner Reading (25 min.)
Students read *Chemical Reactions Everywhere* in pairs and connect ideas from the text to the Investigation Question: *How do new substances form?*

2. Evidence of Chemical Reactions (15 min.)
Students determine whether a chemical reaction happened during the Mixing Substances Investigation. This allows them to reflect on how observing different properties after combining substances may provide evidence of a chemical reaction.

3. Synthesizing Ideas About Reactions (10 min.)
Students share the ideas they gathered from the book and answer the question, *Is what happened in the Mixing Substances Investigation the result of a chemical reaction? Why do you think so?*

4. Did a Chemical Reaction Happen? (10 min.)
Students apply ideas from *Chemical Reactions Everywhere* to determine whether or not the changes represented in a series of images are the result of chemical reactions. Students realize that a change in properties is not always sufficient evidence that a chemical reaction happened.

The Earth System: Lesson 5.2

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *In a chemical reaction, substances are mixed and at least one new substance with different properties is formed.* • vocabulary: *chemical reaction* • Mixing Substances Investigation chart • Partner Reading Guidelines **For the Class** • optional: Chapter 5 Home Investigation: Chemical Reactions at Home copymaster • masking tape* **For Each Pair of Students** • 1 copy of *Chemical Reactions Everywhere* **For Each Student** • optional: 1 copy of the Chapter 5 Home Investigation: Chemical Reactions at Home student sheet • *The Earth System* Investigation Notebook (pages 91–98) *teacher provided	• Projections Lesson 5.2 • 5.2 Mixing Substances Investigation Chart • Optional Chapter 5 Home Investigation	• chemical reaction • matter • molecule • property • substance • wastewater

The Earth System Lesson Planning Guide		
Lesson 5.2: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 1:** Asking Questions and Defining Problems • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) **PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 5.3: Chemical Reactions at the Nanoscale (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students analyze diagrams and use *The Earth System* Modeling Tool to model chemical reactions.

Anchor Phenomenon and Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: A wastewater treatment plant turns wastewater into clean freshwater. **Investigative Phenomenon:** Mixing substances can result in changes to temperature and color, as well as the creation of gas.	**Students learn:** • In a chemical reaction, the atoms in molecules that make up the substances recombine to make new molecules. • Matter is the stuff that things are made of. • In a chemical reaction, matter is not created or destroyed.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 7, 8 **DCIs** PS1.A and PS1.B **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students use diagram models and a digital model to construct the understanding at the nanoscale (scale, proportion, and quantity) that in a chemical reaction, the atoms that make up substances recombine to make new molecules, but matter is not created or destroyed (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Exploring Chemical Reactions at the Nanoscale (25 min.)
Students analyze nanoscale diagrams to observe that when new substances are formed in a chemical reaction, they are made of different molecules than the initial substances.

2. Substances and Mixtures at the Nanoscale (10 min.)
Students work in pairs to review diagrams of substances and mixtures at the nanoscale in preparation for thinking about what happens to molecules during a chemical reaction.

3. Modeling Chemical Reactions (25 min.)
Students use *The Earth System* Modeling Tool to show what happens to the atoms and molecules in two chemical reactions. Modeling helps students to understand that the atoms that make up the initial substances in a chemical reaction do not appear or disappear, but instead recombine to form new substances. This activity provides an On-the-Fly Assessment to assess students' understanding of chemical reactions at the nanoscale.

The Earth System: Lesson 5.3

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *In a chemical reaction, matter is not created or destroyed.* • vocabulary: *substance, matter* **For the Class** • 1 sheet of chart paper* • markers (assorted colors)* • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *The Earth System* Investigation Notebook (pages 99–104) *teacher provided	• Projections: Lesson 5.3 • Mixtures and Chemical Reactions at • the Nanoscale	• chemical reaction • evidence • matter • molecule • property • substance • wastewater

The Earth System Lesson Planning Guide		
Lesson 5.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.A: Structure and Properties of Matter:** • (NYSED) The total amount of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) **PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

<table>
<tr><th colspan="3">The Earth System Lesson Planning Guide
Lesson 5.4: Controlling Chemical Reactions (60 minutes)</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.
Hands-On: In Activity 2 students plan and test chemical reactions.</td></tr>
<tr><td>Anchor Phenomenon:
A wastewater treatment plant turns wastewater into clean freshwater.
Investigative Phenomenon:
Mixing substances can result in changes to temperature and color, as well as the creation of gas.</td><td>Students learn:
• By choosing which substances to combine, engineers can control the results of a chemical reaction.
• When scientists or engineers plan investigations, they use fair tests, changing only one thing at a time.</td><td>Alignment to NGSS and NYSSLS
SEPs 1, 3, 4, 8
DCIs PS1.A and PS1.B
CCCs Cause and Effect; Systems and System Models; Energy and Matter; Scale, Proportion, and Quantity</td></tr>
<tr><td colspan="3">3-D statement: Students investigate how to change the results of a chemical reaction by mixing different substances (energy and matter).
Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts</td></tr>
<tr><td colspan="3">Lesson at-a-Glance
1. Discussing Chemical Reactions (10 min)
The class discusses a new Investigation Question to motivate further investigation of the Hot Yellow Gas (HYG) reaction.
2. Controlling Reactions (40 min)
By manipulating the substances used in the HYG reaction over a series of tests, students figure out that different combinations of substances produce different results.
3. Discussing Results (10 min)
Students discuss observations from their tests, which leads them to conclude that changing the reactants in a chemical reaction can change its products.</td></tr>
</table>

The Earth System: Lesson 5.4

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *By choosing which substances to combine, engineers can control the results of a chemical reaction.* **For the Class** • trays with HYG materials (from Lesson 5.1) • 1 graduated cylinder • plastic bags, self-sealing, quart-size • squeeze bottles • "water" labels • water* • safety goggles* • masking tape* **For Each Group of Four Students** • 1 tray with HYG materials (from Lesson 5.1) • 1 graduated cylinder • 9 plastic bags, self-sealing, quart-size • 1 squeeze bottle of water **For Each Pair of Students** • 1 copy of *How the Earth System Explains Dinosaur Extinction* **For Each Student** • safety goggles* • *The Earth System* Investigation Notebook (pages 105–107) *teacher provided	• Projections: Lesson 5.4 • Answer Key for Investigating the • HYG Results	• chemical reaction • matter • molecule • property • substance • synthesize • wastewater

The Earth System Lesson Planning Guide		
Lesson 5.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter:** • Measurements of a variety of properties can be used to identify materials. (5-PS1-3) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	**Crosscutting Concepts** • Cause and Effect • Systems and System Models • Energy and Matter • Scale, Proportion, and Quantity

The Earth System Lesson Planning Guide Lesson 5.5: End-of-Unit Assessment Part 2 (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Literacy: In Activity 1 students read a section of Water Encyclopedia. In Activity 2 students write a scientific explanation.		
Anchor Phenomenon: A wastewater treatment plant turns wastewater into clean freshwater.	**Students learn:** • Wastewater treatment plants use chemical reactions to help them clean wastewater.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 6, 8 **DCIs** ESS3.C, PS1.B, LS2.B, ETS1.A, ETS1.B **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter
3-D statement: Students construct written explanations about how chemical reactions can be used in wastewater treatment to turn harmful substances into new substances with different properties (energy and matter). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Chemical Reactions in Wastewater Treatment (20 min)** Students read about wastewater treatment in Water Encyclopedia. Reading about wastewater treatment helps students to see a real-world application of what they have been learning about chemical reactions. **2. Word Relationships (10 min)** Students engage in the Word Relationships routine for the third time. They work in groups to build sentences using science vocabulary related to chemical reactions. This helps students articulate their ideas before writing scientific explanations. **3. End-of-Unit Assessment Part 2 (30 min)** Students apply what they have learned throughout this chapter to write a scientific explanation of how adding substances to wastewater allows engineers to get rid of harmful substances. These written explanations are the second of a two-part End-of-Unit Assessment.		

5th Grade Unit 3 The Earth System

Materials	Digital Resources	Vocabulary
For the Class • End-of-Unit Writing Part 2: Explaining Wastewater Treatment Version • A copymaster (optional: Version B) • Word Relationships Cards: Set 3 • paper clips* **For Each Group of Four Students** • 1 set of Word Relationships Cards: Set 3, clipped together (6 cards/set) **For Each Pair of Students** • 1 copy of *Water Encyclopedia* **For Each Student** • 1 copy of End-of-Unit Writing Part 2: Explaining Wastewater • Treatment Version A student sheet (optional: Version B) • *The Earth System* Investigation Notebook (pages 108–109) *teacher provided	• Projections: Lesson 5.5 • Assessment Guide: Assessing Students' End-of-Unit Part 2 Explanations About Wastewater Treatment • End-of-Unit Writing Part 2: Explaining Wastewater Treatment Version A copymaster	• chemical reaction • engineer • evidence • explanation • matter • molecule • property • substance • wastewater

The Earth System: Lesson 5.5

The Earth System Lesson Planning Guide		
Lesson 5.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **ETS1.A: Defining and Delimiting Engineering Problems:** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide
Lesson 5.6: Reflecting on Water Availability (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students prepare for a participate in a mock Town Hall meeting.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
One side of Ferris Island has a water shortage and the other does not.	• People can design solutions to protect Earth's resources.	**SEPs** 1, 6, 8 **DCIs** ESS2.A, ESS2.C, ESS3.C, PS1.A, PS1.B, LS2.B, ETS1.A, ETS1.B **CCCs** Scale, Proportion, and Quantity; Systems and System Models; Energy and Matter

3-D statement: Students communicate their ideas about the Earth system interactions that are causing East Ferris' water shortage (systems and system models) and what people can do to help protect their water supply.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Preparing for Town the Hall Meeting (20 min)
Students prepare for the Town Hall Meeting in groups. They have a chance to review what they have learned and organize their thoughts, allowing for rich discussion during the meeting.

2. Town Hall Meeting (35 min)
Students discuss East Ferris's water shortage problem and possible solutions. This is a final opportunity for students to synthesize and communicate the information they have learned throughout the unit.

3. Concluding the Unit (5 min)
The teacher concludes the unit and students reflect on what they have learned.

Materials	Digital Resources	Vocabulary
For the Classroom Wall • key concept: *People can design solutions to protect Earth's resources.* **For Each Student** • *The Earth System* Investigation Notebook (pages 110–117) *teacher provided	• Projections: Lesson 5.6 • Town Hall Meeting Script copymasterr	• atmosphere • chemical reaction • condensation • engineer • evaporation • hydrosphere • molecule • property • substance • synthesize • wastewater • water vapor

The Earth System Lesson Planning Guide

Lesson 5.6: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 1:** Asking Questions and Defining Problems • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**ESS2.A: Earth Materials and Systems:** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1) **ESS2.C: The Roles of Water in Earth's Surface Processes:** • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	• Scale, Proportion, and Quantity • Systems and System Models • Energy and Matter

The Earth System Lesson Planning Guide		
Lesson 5.6: Alignment to NGSS and NYSSLS		
	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems: • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **ETS1.A: Defining and Delimiting Engineering Problems:** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions:** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) **ETS1.B: Developing Possible Solutions:** • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)	

Standards & Goals

5th Grade Unit 4 Ecosystem Restoration Recommended time frame: 8 weeks

This Implementation and Planning Guide includes text from one of the Unit Overview Documents, *Standards and Goals*.

Please see additional Unit Overview documents in the unit's Teacher's Guide for full reference and planning guidance.

Standards and Goals

Focal Performance Expectations

- 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]
- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

  Note: Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science The Earth System unit.
- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]

  Note: Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science Modeling Matter and The Earth System units.
- 5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. [Clarification Statement: Examples of models could include diagrams and flowcharts.]

Unit-level 3-D Statement:

- Students investigate how interactions between the parts of the Earth system affect the movement and distribution of water (systems and system models), and they apply their understanding to design solutions for a water shortage. Students also obtain information from first-hand investigations, models, and text to figure out how new substances can form through chemical reactions, even though no matter is created or destroyed (energy and matter).

Key

Practices

Disciplinary Core Ideas

Crosscutting Concepts

5th Grade Unit 4 Ecosystem Restoration

Standards and Goals	
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. **Note:** Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science The Earth System unit.	

Connections to Other Performance Expectations

This unit supports students in making connections to the disciplinary core ideas represented in these additional Performance Expectations, which are also addressed in other Amplify Science units.

- **5-PS1-4.** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

  Note: Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science The Earth System unit.

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

  Note: Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science The Earth System unit.

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

  Note: Students also get experience with the disciplinary core ideas represented in this Performance Expectation in the Amplify Science Modeling Matter and The Earth System units.

Science and Engineering Practices

As with all Amplify Science units, the *Ecosystem Restoration* unit provides students with exposure to most of the eight science and engineering practices described in the NGSS. This unit emphasizes the following practices (listed in order of particular emphasis), providing students with explicit instruction and expectations for increasing independence over the course of the unit:

- **Practice 7: Engaging in Argument from Evidence.** Throughout the unit, students engage with multiple examples of scientific arguments based on evidence. Students work with data from the restoration project area in order to make arguments about why the organisms in the ecosystem are not growing and thriving. The unit provides explicit instruction to help students link data with scientific ideas in order to support claims. Students read Why Do Scientists Argue? and discuss the critical role that argumentation plays in moving science forward.
- **Practice 4: Analyzing and Interpreting Data.** Students work with a variety of data sets that provide information about the restoration project area. Students must use what they have been learning to make sense of and interpret the data to help them understand what is happening in the project area.
- **Practice 2: Developing and Using Models.** Students receive explicit instruction and opportunities to create and use physical models to show how food matter, as well as energy, can be traced through an ecosystem. The Ecosystem Restoration Simulation and the Ecosystem Modeling Tool both provide extensive opportunities for students to engage with models and manipulate different parts of the ecosystem to determine and show the effects of a change.
- **Practice 6: Constructing Explanations.** Students have multiple opportunities to discuss and write explanations over the course of the unit, learning that they must synthesize ideas from multiple sources in order to understand how matter and energy flows through ecosystems.
- **Practice 5: Using Mathematics and Computational Thinking.** As students investigate with the Ecosystem Restoration Simulation, they describe and estimate quantities as they observe the changes that occur. These changes reveal patterns that suggest relationships between the number of organisms in a population and the matter available to a consumer, as well as illustrating the relationship between energy transfer and flow through an ecosystem
- **Practice 8: Obtaining, Evaluating, and Communicating Information.** Just as students focus on synthesizing ideas in science, they receive explicit instruction and have multiple opportunities to use the reading comprehension strategy of synthesizing as they engage with the informational texts in the unit. Students gather evidence through firsthand and secondhand sources, as well as participate in various discourse routines that help them communicate about and make sense of scientific ideas by using key vocabulary.
- **Practice 3: Planning and Carrying Out Investigations.** Students use both hands-on investigation and a digital simulation to make observations of the living and nonliving matter in an ecosystem.
- **Practice 1: Asking Questions and Defining Problems.** At multiple places across the unit, students learn new ideas, and then describe how those new ideas can help them solve the unit's focal problem.

In all Amplify Science units, practices from the NGSS, the CCSS-ELA, and the CCSS-Math are linked. For instance, when students use maps and diagrams to investigate water distribution over the land, they are also engaging in the CCSS-Math Practices 2 and 4 (Practice 2: Reason Abstractly and Quantitatively, Practice 4: Model with Mathematics). When students develop and use models, use those models to inform their design solutions, and engage with science text, they are developing the foundational capacity to build knowledge about a phenomenon through research and to respond analytically to informational sources, as called for by the CCSS-ELA Standards.

5^{th} Grade Unit 4 Ecosystem Restoration

Disciplinary Core Ideas

Focal Disciplinary Core Ideas

This unit addresses the following core ideas:

LS1.C: Organization for Matter and Energy Flow in Organisms:

- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1)
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

LS2.A: Interdependent Relationships in Ecosystems:

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

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:

- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

ESS3.C: Human Impacts on Earth Systems:

- Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments. (5-ESS3-1)

PS1.A: Structure and Properties of Matter:

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)

PS3.D: Energy in Chemical Processes and Everyday Life:

- The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

Standards & Goals

Connections to Other Disciplinary Core Ideas

This unit provides opportunities to make connections to these core ideas, which are also addressed in other Amplify Science units.

PS1.B: Chemical Reactions:

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)

ETS1.A: Defining and Delimiting Engineering Problems:

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

ETS1.B: Developing Possible Solutions:

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)

Crosscutting Concepts

The crosscutting concept emphasized in the *Ecosystem Restoration* unit is Energy and Matter. In their role as ecologists, students gain an understanding of the necessary and limiting role that energy and matter flows play in a system. As students investigate a failing ecosystem, they develop an understanding of plants' and animals' need for matter in the form of food molecules. Through participating in argumentation to explain why the organisms in the ecosystem are not growing and thriving, students trace matter back from animals to plants to water and carbon dioxide, and they trace the energy that all living things need back to the sun. Students also find that while plants bring matter into the ecosystem, nutrients released by decomposers are also critical for plant growth. Students return to the idea of energy and matter again and again throughout the unit, through a variety of modalities.

Do. Students use the *Ecosystem Restoration* Simulation to track matter from one organism to another through an ecosystem. Students use cubes to represent the transformation of matter as molecules go from being an organism's food to being part of an organism's body. Students make a physical model of a food web by using yarn to demonstrate that the matter that ends up as part of a secondary consumer (e.g., an alligator) had to come from a primary consumer (e.g., a frog) and eventually a plant. Students add to their understanding as they model how plants make their own food by taking in carbon dioxide and water and using this matter as well as energy from the sun to grow. Students synthesize their understanding as they trace matter and energy through an ecosystem in the *Ecosystem Restoration* Simulation and using the Ecosystem Modeling Tool.

Talk. Multiple opportunities for student-to-student talk engage the class in figuring out where the matter and energy that each organism needs comes from and then putting together each of those transfers to trace matter and energy through the ecosystem.

Read. Students read the book *Matter Makes It All Up* and consider that all the organisms in an ecosystem, even though they are different in many ways, are made of matter. Students later read *Energy Makes It All Go* and reflect on the need for energy that all organisms have and the transfer of matter that allows for the transfer of energy.

Write. During the course of the unit, students write several scientific arguments about why the organisms in the project area are not growing and thriving. Students draw from data about the amount of matter in different populations and scientific ideas about the flow of matter and energy to support their claims.

Visualize. Through tracking individual interactions, students work to visualize the path of energy and matter through an ecosystem.

There are also opportunities to emphasize the crosscutting concepts of Systems and System Models (e.g., students look at the inputs of air and water molecules, and of energy, to the system that is defined by the organisms of the ecosystem); Scale, Proportion, and Quantity (e.g., students build on their understanding of matter as they put together interactions and changes at the molecular level with observable eating relationships and growth, and as they work with the scientific idea of air as being made of molecules too small to see); and Cause and Effect (e.g., students develop arguments that support the scientific idea that a change to one part of the ecosystem can cause changes to all other parts of the ecosystem).

Background Knowledge and Alternate Conceptions

Background Knowledge and Alternate Conceptions
This pre-unit writing assessment is an opportunity for students to articulate their initial ideas about a problem in an ecosystem. This provides students with an opportunity to connect their background knowledge and the initial ideas they have to the concepts they will be learning about in the Ecosystem Restoration: Matter and Energy in a Rainforest unit. It can also provide insight into students' thinking as you begin this unit of instruction. This will allow you to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding. In particular, look for the following: **Note:** For full details, see the assessment task and associated Assessment Guide in lesson 1.1.

Connecting to students' experiences. Examples of students' experiences to which you can connect the content of specific lessons in the unit: • Students have experience taking care of an animal or a plant. • Students have experience exploring the outdoors.	**Building on prior knowledge**. Ideas about animals and plants on which you and students can build throughout the unit: • People need food to grow and live. People get energy from eating. • Animals need food to live. • Animals get food from eating plants or other animals. • Plants need sunlight and water to grow and live. • Growing means getting larger
Gauging students' facility with science practices. Since students write a scientific explanation for this task, it offers an entry-level assessment of student facility with this science and engineering practice.	**Applying crosscutting concepts.** Alternate conceptions to address or watch out for as the unit unfolds: • Snakes aren't growing because they don't have enough food. Snakes need food in order to grow bigger. (applying the idea that matter is conserved) • Grass is food for mice, and mice are food for snakes. (applying the idea that matter can be tracked and is transported into, out of, and within systems)

Preconceptions to watch out for over the course of the unit:

- Plants take in food from the outside environment or plants get their food from the soil. Many students understand that plants often grow in soil, which leads them to believe that plants get their food from soil. In fact, plants make their food from carbon dioxide and water, using energy from the sun.
- Plants do not need food. Since students do not feed a plant the way they might feed an animal, they might believe that plants do not need food to grow. This, again, contradicts evidence that plants make their food by using air, water, and energy from the sun.
- An organism higher on a food web preys on all below it. Although it is true that organisms typically have a variety of food sources, top predators do not eat all other organisms in a food web. Feeding patterns in an ecosystem can be quite complex—the arrows in a food web indicate where organisms receive their food matter from.
- Ecosystems contain only living parts, or the nonliving parts of the ecosystem are not important. Interactions between living and nonliving parts of an ecosystem are critical for organisms' survival. Organisms are constantly interacting with the nonliving parts of their ecosystem—through breathing, elimination of waste, food creation in plants, and animals' intake of water.

Grade 5 Unit 4 Pacing Guidance at-a-glance

<table>
<tr><th colspan="3">Grade 5 Unit 4 Pacing Guidance at-a-glance
Ecosystem Restoration</th></tr>
<tr><td colspan="3">Guidance for cluster teachers and classroom teachers: All lessons can be taught by either teacher.
The lessons in bold include activities with a particular literacy emphasis and the the lessons with * include activities with a particular hands-on emphasis. Keep in mind that all Amplify Science lessons engage students in reading, writing, and/or discourse, as well as in scientific inquiry, so refer to the lesson-by-lesson guidance for details as you plan to teach.</td></tr>
<tr><td colspan="3">Pacing assumes 1 lesson per day, 3 times per week. Lessons are each 60 minutes long. Occasional weeks with 2 lessons affords flex time, to make up instructional minutes and/or differentiate according to formative assessment.</td></tr>
<tr><td rowspan="8">Recommended time frame:
8 weeks

April to EOY</td><td>Week 1</td><td>1.1: Pre-Unit Assessment: Students' Initial Explanations
1.2: Introducing Ecosystems</td></tr>
<tr><td>Week 2</td><td>1.3: Matter Makes It All Up
1.4: Investigating How Animals Grow*
1.5: Modeling How Animals Use Food Matter</td></tr>
<tr><td>Week 3</td><td>1.6: The Role of Food in an Ecosystem
1.7: Modeling Food Webs</td></tr>
<tr><td>Week 4</td><td>1.8: Arguments About Animals in the Ecosystem*
2.1: Even Plants Need Food
2.2: Energy Makes It All Go</td></tr>
<tr><td>Week 5</td><td>2.3: How Plants Make Food
2.4: Claims and Evidence About Energy
2.5: Energy in Ecosystems*</td></tr>
<tr><td>Week 6</td><td>2.6: Why Do Scientists Argue?
2.7: Arguments About Plants in the Ecosystem
3.1: Investigating Soil*</td></tr>
<tr><td>Week 7</td><td>3.2: Walk in the Woods
3.3: Differences in Soil
3.4: Nutrients and Soil</td></tr>
<tr><td>Week 8</td><td>3.5: Decomposers, Nutrients, and Ecosystems
3.6: Arguments About Soil in the Ecosystem
3.7: End-of-Unit Assessment</td></tr>
</table>

Ecosystem Restoration Lesson Planning Guide Lesson 1.1: Pre-Unit Assessment: Students' Initial Explanations (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Students are introduced to the unit and to their role. In activity 2, students write their initial arguments as a pre-unit assessment.		
Investigative Phenomenon: Snakes are not growing and thriving in a forest ecosystem.	**Students learn:** • An ecologist is a scientist who studies ecosystems. • Reflecting on what you understand and don't understand allows you to prepare for learning new things. • Ecologists and other scientists often make and use simulations to study things that they cannot see or measure directly.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 5, 7 **DCIs** LS1.C, LS2.A **CCCs** Energy and Matter, Systems and System Models
3-D statement: Students write initial arguments and explore a digital model about the growth of organisms in an ecosystem (energy and matter, systems and system models). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Introducing the Unit (10 min)** Students are exposed to a key vocabulary word, ecologist, as they are introduced to the unit and their role as ecologists. **2. Writing Initial Arguments (25 min)** Students' written arguments about a problem in an ecosystem reveal their initial understanding of unit content. **3. Exploring the Simulation (20 min)** Students have the opportunity to explore the Ecosystem Restoration Simulation for the first time. This allows them to familiarize themselves with its basic functions and prepares them for the focused task in Lesson 1.5. **4. Introducing the Investigation Notebook (5 min)** Students receive their Ecosystem Restoration Investigation Notebooks and learn some of the ways that scientists use notebooks.		

Ecosystem Restoration: Lesson 1.1

<table>
<tr><th>Materials</th><th>Digital Resources</th><th>Vocabulary</th></tr>
<tr>
<td>
For the classroom wall

Unit Question: How do organisms in an ecosystem get the matter and energy they need to grow and thrive?
vocabulary: ecologist

For the Class

Pre-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving copymaster
masking tape*
stapler*

For Each Pair of Students

1 digital device*

For Each Student

1 copy of the Pre-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving student sheets
Ecosystem Restoration Investigation Notebook (page 1)

*teacher provided
</td>
<td>

Projections: Lesson 1.1
Pre-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving copymaster
Assessment Guide: Interpreting Students' Pre-Unit Arguments About Why a Forest Ecosystem Is Not Thriving
Ecosystem Restoration Investigation Notebook

</td>
<td>

argument
ecologist
ecosystem
organism

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</tr>
</table>

Ecosystem Restoration Lesson Planning Guide

Lesson 1.1: Alignment to NGSS and NYSSLS

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Practice 2:** Developing and Using Models • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence	**LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)	• Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide
Lesson 1.2: Introducing Ecosystems (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students set up terrariums.

Investigative Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.	• An ecosystem is a community of organisms in an environment. • There are many different kinds of ecosystems. • A terrarium is a model ecosystem.	**SEPs** 1, 2, 8 **DCIs** ESS3.C, LS1.C, LS2.A **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students create a model ecosystem (systems and system models) and make observations of different kinds of ecosystems (systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing the RainForest Problem (15 min)
Students are introduced to the fictional unit context and receive more information about their role as ecologists.

2. Setting Up the Terrariums (25 min)
Students build familiarity with the parts of an ecosystem through the firsthand experience of building terrariums.

3. Observing Ecosystems (20 min)
Students work with illustrations of three ecosystems to practice making observations.

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • Chapter 1 Question: *Why aren't the jaguars and sloths growing and thriving?* • vocabulary: *observe* **For the Class** • Setting Up a Terrarium copymaster • optional: Chapter 1 Home Investigation: Helping the Ecosystem copymaster • nutrient-rich soil: Soil A • grass seed • alfalfa seed • 2 spray bottles (water misters) • plastic cups • 1 plastic bag, resealable* • leaf litter* • newspaper* • marker, permanent* • water* • masking tape* **For Each Group of Four Students** • 1 tray* • 1 large plastic container, with lid • 1 empty plastic cup • 1 "A" cup (with alfalfa seeds) • 1 "G" cup (with grass seeds) • leaf litter* • 1 copy of the Setting Up a Terrarium student sheet • 4 pairs of safety goggles* • 1 pencil* • 1 piece of masking tape* **For Each Student** • optional: 1 copy of the Chapter 1 Home Investigation: Helping the Ecosystem student sheet • *Ecosystem Restoration* Investigation Notebook (page 3-6) *teacher provided	• Projections: Lesson 1.2 • Setting Up a Terrarium copymaster • Optional: Chapter 1 Home Investigation: Helping the Ecosystem copymaster	• ecologist • ecosystem • observe • organism

Ecosystem Restoration: Lesson 1.2

<table>
<tr><th colspan="3">Ecosystem Restoration Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 1.2: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
ESS3.C: Human Impacts on Earth Systems:
• Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models</td>
</tr>
</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 1.3: Matter Makes It All Up (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 2-4 students partner read and reflect on *Matter Makes It All Up*.

Investigative Phenomenon / Students learn / Alignment		
Investigative Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** A baby alligator grows into an adult.	**Students learn:** • Organisms are made of matter. Matter is made of molecules. • Molecules are tiny bits of matter that are too small to be seen. • Synthesizing can help readers understand informational text.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 5, 6, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS1.A **CCCs** Energy and Matter; Scale, Proportion and Quantity; Systems and System Models

3-D statement: Students read the book *Matter Makes It All Up* to obtain and evaluate information about how all parts of an ecosystem are made of matter, which in turn is made of molecules (energy and matter; scale, proportion, and quantity; systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Thinking About Scale (15 min)
By observing the nanoscale in the digital Scale Tool, students are introduced to the relative size of the molecules which they will read about in *Matter Makes It All Up*.

2. Partner Reading (20 min)
Matter Makes It All Up introduces students to foundational ideas for this unit: everything, including organisms, is made of matter, and matter is made of molecules. Students read the first half of the book in order to gather information about how animals grow.

3. Discussing Matter and Molecules (10 min)
The teacher helps the class debrief what they read by creating the Matter chart, which depicts concepts about matter, molecules, and atoms. The chart is intended to provide a visual representation to which students' can refer throughout the unit.

4. Synthesizing Ideas About How Animals Grow (15 min)
The teacher guides students as they synthesize ideas from *Matter Makes It All Up* in order to come to a new understanding of how animals grow. This activity includes an On-the-Fly Assessment to assess students' initial facility with the practice of synthesizing.

Ecosystem Restoration: Lesson 1.3

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Everything is made of matter. Matter is made of molecules.* • vocabulary: *matter, molecule, synthesize* **For the Class** • 1 digital device • 2 sheets of chart paper* • marker, wide tip* • masking tape* **For Each Pair of Students** • 1 copy of *Matter Makes It All Up* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 7-10)tion Investigation Notebook (page 1) *teacher provided	• Partner Reading Guidelines • Matter chart	• ecologist • ecosystem • matter • molecule • organism • synthesize

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Energy and Matter • Scale, Proportion, and Quantity • Systems and System Models

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.3: Alignment to NGSS and NYSSLS		
	PS1.A: Structure and Properties of Matter: • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 1.4: Investigating How Animals Grow (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students are introduced to scientific argumentation, claims, and evidence.

Hands-On: In Activity 4 students model animals growing with cubes.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Animals grow.	• Scientists make arguments that are supported with evidence. • A scientific argument is a claim together with the evidence that supports it. • Scientists make models to help them answer questions about the world. • Animals get their food molecules from the body matter of plants or other animals.	**SEPs** 2, 5, 7, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS1.A, PS1.B **CCCs** Scale, Proportion, and Quantity, Energy and Matter

3-D statement: Students create physical models to demonstrate their understanding of how animals obtain and use the molecules they need to grow (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introduction to Argumentation (20 min)
The teacher presents students with an accessible argument to introduce scientific argumentation. Students identify the claim and the evidence in the example argument. The class discusses argumentation as a key practice of science.

2. Observing Animals in their Environment (10 min)
Observing a video of otters interacting with their environment sets a real context for students' investigation of how animals grow.

3. Evidence About How Animals Grow (15 min)
Students reflect on the evidence they have gathered about how animals grow by adding molecules to their bodies. Students write brief arguments in support of a claim about this scientific idea. Included in this activity is an On-the-Fly Assessment to informally assess students' initial understanding of the practice of argumentation.

4. Modeling How Animals Grow (15 min)
Students make models of animals by using interlocking cubes to represent matter. These models allow students to construct the understanding that when animals grow, they add more matter to their bodies and that animals change the molecules in the food they eat into molecules to build their bodies.

Ecosystem Restoration: Lesson 1.4

Materials	Digital Resources	Vocabulary
For the classroom wall • vocabulary: *argument, claim, environment, evidence, model* • Matter chart **For the Class** • Otter video • blue interlocking cubes • plastic cups • masking tape* **For Each Pair of Students** • 1 cup of 10 blue cubes • 1 copy of *Matter Makes It All Up* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 11-13) *teacher provided	• Projections: Lesson 1.4 • Video: Otter	• argument • claim • ecosystem • environment • evidence • matter • model • molecule • organism

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	**Crosscutting Concepts** • Scale, Proportion, and Quantity • Energy and Matter

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.4: Alignment to NGSS and NYSSLS		
	PS1.B: Chemical Reactions: • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)	

Ecosystem Restoration Lesson Planning Guide
Lesson 1.5: Modeling How Animals Use Food Matter (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students investigate in the *Ecosystem Restoration* Simulation, revisit *Matter Makes It All Up*, and model ideas with the Food Matter Model.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Animals grow.	**Students learn:** • Animals use some food molecules to release energy for movement and growth. • Synthesizing is a sense-making strategy that scientists use to come to a new understanding or to help them to answer a question	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 5, 6, 8 **DCIs** PS3.D, LS1.C, LS2.A, LS2.B **CCCs** Energy and Matter; Scale, Proportion and Quantity

3-D statement: Students use a digital model to demonstrate their understanding of how animals use food matter (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. How Animals Use Food Molecules (25 min)
Students work with the *Ecosystem Restoration* Simulation to investigate more about how animals use food molecules. They record what they find out in their notebooks.

2. Synthesizing Ideas Across Multiple Sources (15 min)
The teacher models how to synthesize information from the book *Matter Makes It All Up* and the Simulation in order to come to a new understanding about how animals grow. Then, students have the opportunity to try synthesizing on their own.

3. Modeling Food Matter (20 min)
Students are introduced to a new app, which they use to demonstrate their understanding of how animals use food molecules in their bodies. Using the digital Food Matter Model, students label familiar images from the Simulation.

Ecosystem Restoration: Lesson 1.5

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Animals grow by changing food molecules into body molecules that can build their bodies.* • key concept: *Animals use some food molecules to release energy for movement and growth.* **For the Class** • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 14-17) *teacher provided	• NA	• ecologist • ecosystem • matter • model • molecule

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<tr><th colspan="3">Ecosystem Restoration Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 1.5: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models</td>
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Ecosystem Restoration Lesson Planning Guide
Lesson 1.6: The Role of Food in an Ecosystem (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students model ideas with the Ecosystem Modeling Tool and read the rest of *Matter Makes It All Up*.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.	• A system is a group of parts that work together. Each part in the system plays a role. • An ecosystem is a system. • There are many ways that organisms in an ecosystem get their food molecules—organisms eat a variety of things. • A food web is a diagram that ecologists make to show what eats what in an ecosystem	**SEPs** 2, 4, 6, 7, 8 **DCIs** PS3.D, LS1.C, LS2.A, LS1.C, LS2.B **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students use a digital model to represent their growing understanding of how matter flows between organisms in an ecosystem (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Making Arguments About the Investigation Question (5 min)
The teacher guides students to answer the Investigation Question: How do animals grow? by using an evidence-based argument. This serves as a model for the arguments that students will write later in this lesson.

2. Modeling the Flow of Matter (15 min)
In this activity, students work with the digital Ecosystem Modeling Tool, which allows them to demonstrate their growing understanding of how matter flows between organisms in an ecosystem.

3. Critical Juncture: Writing About Rainforest Animals (15 min)
In this brief writing activity, students apply their new understanding of how animals grow to the context of the Costa Rican rainforest. This Critical Juncture also serves as a formative assessment: It provides teachers the opportunity to assess students' learning of key unit content before proceeding with the unit. In addition, the writing activity sparks a class discussion about the crosscutting concept of Systems and System Models.

4. Partner Reading (25 min)
Reading the remainder of the book *Matter Makes It All Up* provides students with an introduction to food webs. Engaging in the Shared Listening routine after reading allows students to consider their initial ideas about food webs.

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • vocabulary: *ecosystem* **For the Class** • masking tape* **For Each Pair of Students** • 1 copy of *Matter Makes It All Up* • 1 digital device* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 18-23) *teacher provided	• Projections: Lesson 1.6	• food web • matter • model • molecule • organism

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<tr>
<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Plants acquire their material for growth chiefly from air and water. (5-LS1-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models</td>
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</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 1.7: Modeling Food Webs (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students use cubes to model a food web.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Organisms in an ecosystem get the food molecules they need.	**Students learn:** • Food molecules in an ecosystem can always be traced back to plants. • Models are like the real world in some ways and different in other ways.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 6, 7, 8 **DCIs** PS3.D, LS1.C, LS2.A, LS2.B **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students create an ecosystem model and figure out that food molecules in an ecosystem can always be traced back to plants (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Reflecting on the Language of Science (10 min)
Reflecting on the language of science and discussing everyday approximations supports students in their use of science vocabulary words.

2. Food Web Model (35 min)
This physical model provides an engaging opportunity for students to visualize and investigate food webs.

3. The Importance of Plants (15 min)
Students discuss the Food Web Model and trace the flow of molecules back to plants. This activity provides an On-the-Fly Assessment to informally assess students' understanding of the flow of molecules between organisms in an ecosystem.

Ecosystem Restoration: Lesson 1.7

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Food molecules in an ecosystem can always be traced back to plants.* • vocabulary: *food web, organism* • Matter chart **For the Class** • Organism Name Cards: Set 1 (set of 36 cards) • plastic bags • Yarn • blue cubes • white cubes • red cubes • green cubes • 1 sheet of chart paper* • scissors* • rubber band* • marker, wide tip* • masking tape* **For Each Student** • 1 plastic bag with materials (1 Organism Name Card and cube stack) • *Ecosystem Restoration* Investigation Notebook (page 24) *teacher provided	• Projections: Lesson 1.7 • Science/Everyday Words chart	• ecosystem • environment • food web • matter • model • molecule • organism

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.7: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide
Lesson 1.8: Arguments About Animals in the Ecosystem (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students discuss claims and evidence. In Activity 3 students write a scientific argument.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.	• Both data and scientific ideas are kinds of evidence that can be used to support a claim. • Strong arguments link a scientific idea to data to help explain why the data supports the claim. • Scientists discuss their arguments with one another in order to determine how evidence supports a claim.	**SEPs** 1, 4, 6, 7, 8 **DCIs** PS3.D, LS1.C, LS2.A, 3-5-ETS1-1, 3-5-ETS1-2 **CCCs** Systems and System models, Energy and Matter

3-D statement: Students use evidence to construct written arguments about why jaguars and sloths aren't growing and thriving in the rainforest ecosystem (energy and matter, systems and system models) and then design restoration plans for the project area.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. More About Evidence (10 min)
The teacher reminds the class about scientific argumentation and students revisit an example argument to help them think in detail about evidence that can be used to support a claim.

2. Evidence Circles (20 min)
Students are introduced to and participate in their first Evidence Circles, a structured routine for student-guided, small-group discussions about evidence. Students receive data and scientific ideas on printed Evidence Cards and use these in their discussions.

3. Writing a Scientific Argument (20 min)
The teacher introduces some key features of a scientific argument. Based on their Evidence Circle discussions, students write arguments about why the animals are not growing and thriving in the project area. This activity provides an On-the-Fly Assessment to assess students' ability to connect two pieces of evidence to provide support for a claim.

4. Action Steps for Restoring the Ecosystem (10 min)
The teacher introduces action steps that the class might suggest as part of the solution to restore the rainforest ecosystem in the project area. The class writes action steps to create their first Rain Forest Restoration Plan of the unit.

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • vocabulary: *data, restoration* • Science/Everyday Words chart **For the Class** • sets of Evidence Cards: Animals • optional: Rain Forest Restoration Plan 1 Version B copymaster • 1 sheet of chart paper* • paper clips* • marker, wide tip* • masking tape* • stapler* **For Each Group of 4 Students** • 1 set of Evidence Cards: Animals, clipped together (5 cards/set) **For Each Student** • optional: 1 copy of the Rain Forest Restoration Plan 1 Version B student sheets • *Ecosystem Restoration* Investigation Notebook (page 25-30) *teacher provided	• Projections: Lesson 1.8 • Science/Everyday Words chart • Rain Forest Restoration Plan 1 Action Steps chart • Optional: Rain Forest Restoration Plan 1 Version B copymaster	• argument • claim • data • ecosystem • evidence • matter • molecule • organism • restoration

Ecosystem Restoration: Lesson 1.8

Ecosystem Restoration Lesson Planning Guide		
Lesson 1.8: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **3-5-ETS1-1: Defining and Delimiting Engineering Problems:** • Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2: Developing Possible Solutions:** • Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	**Crosscutting Concepts** • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide
Lesson 2.1: Even Plants Need Food (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students observe their terrariums.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Plants grow and thrive differently in different terrariums. **Everyday Phenomenon:** Air takes up space inside a balloon, and light does not.	**Students learn:** • Plants' needs must be met in order for them to grow and thrive in an ecosystem. • Air and water are made of matter.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4, 5, 6, 7, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Energy and Matter; Scale, Proportion, and Quantity; Systems and System Models

3-D statement: Students use physical and digital models to investigate where plants get their food molecules (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Restoration Project Update (10 min)
Reviewing new images and analyzing data from the Costa Rican rainforest project area prompts students to wonder why the plants in that area aren't growing as well as those in a healthy rainforest. This activity serves as the transition to the next series of investigations in the unit.

2. Terrarium Observations (20 min)
Groups observe their terrariums and compare them with another group's terrarium. This activity serves as an opportunity for students to hone their observation skills and to prompt them to begin to think about what might cause some plants to grow better than others.

3. Exploring Plants in the Simulation (20 min)
Revisiting the Ecosystem Restoration Simulation allows students to observe how plants obtain their food molecules. Making these observations prepares students, as they proceed in the unit, to think about what plants need to grow and thrive.

4. What Is Made of Matter? (10 min)
The demonstration in this activity allows students to observe that water and air are made of matter but that sunlight is not. This activity is designed to provide concrete evidence for students to help prevent the alternate conception that sunlight is made of matter.

Ecosystem Restoration: Lesson 2.1

Materials	Digital Resources	Vocabulary
For the classroom wall • Chapter 2 Question: *Why aren't the cecropia trees growing and thriving?* • Matter chart **For the Class** • 3 balloons • flashlight* • water* • 1 tray* **For Each Pair of Students** • 1 digital device* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 31-34) *teacher provided	• Projections: Lesson 2.1 • Matter chart	• data • ecosystem • matter • model • molecule • observe • organism • restoration

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<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Plants acquire their material for growth chiefly from air and water. (5-LS1-1)
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models
• Scale, Proportion, and Quantity</td>
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Ecosystem Restoration: Lesson 2.1

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.1: Alignment to NGSS and NYSSLS		
	PS3.D: Energy in Chemical Processes and Everyday Life: • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 2.2: Energy Makes It All Go(60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-4 students partner read and reflect on *Energy Makes It All Go*.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Plants get food.	**Students learn:** • Sunlight is energy, not matter. • Organisms need energy in order to move and grow. • Plants use energy from sunlight to change water and carbon dioxide into food matter	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 4, 6, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students read the book *Energy Makes It All Go* to obtain and evaluate information about where plants get their food molecules (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Preparing to Read (15 min)
Students review what they have learned related to the Investigation Question: Where do food molecules for plants come from? Then, they preview the book *Energy Makes It All Go* by using the headings in the book.

2. Partner Reading (30 min)
Partners read *Energy Makes It All Go* and record ideas about where plants get their food molecules.

3. Synthesizing Ideas (15 min)
Students synthesize the ideas they gathered from the text, and the teacher guides the class in synthesizing ideas from multiple sources. The explanations that students begin to construct about where plants get their food molecules will be built upon in the next lesson. This activity includes an On-the-Fly Assessment to assess students' developing facility with the sense-making strategy of synthesizing.

Materials

For the classroom wall
- vocabulary: *energy*
- Partner Reading Guidelines

For the Class
- 1 digital device*
- 1 sheet of chart paper*
- marker, wide tip*
- masking tape*
- stapler*

For Each Pair of Students
- 1 copy of *Energy Makes It All Go*

For Each Student
- *Ecosystem Restoration* Investigation Notebook (page 35–38)

*teacher provided

Digital Resources
- Synthesizing Ideas About Plants

Vocabulary
- ecosystem
- energy
- environment
- matter
- molecules
- organism

Ecosystem Restoration: Lesson 2.2

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• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Plants acquire their material for growth chiefly from air and water. (5-LS1-1)
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models</td>
</tr>
</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 2.3: How Plants Make Food (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 1 students play a game to model how plants make food.

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Plants get food.	**Students learn:** • Plants use water molecules, carbon dioxide molecules from the air, and energy from the sun to make food. • Animals and plants grow by changing food molecules into body molecules that can build their bodies. • Models show some things accurately and some things inaccurately.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 5, 6, 8 **DCIs** PS1.A, PS1.B, PS3.D, LS1.C, LS2.A, LS2.B **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students use game-based and digital models to demonstrate their understanding of how plants make their own food (energy and matter)

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Modeling How Plants Make Food (25 min)
The interactive Leaves and Roots game allows students to model how plants use carbon dioxide molecules and water molecules, along with energy from the sun, to make food the plants can use in order to grow.

2. Debriefing the Model (5 min)
Students discuss what they learned from the model, and the teacher posts two new key concepts.

3. Modeling Plants in an Ecosystem (20 min)
Partners work with the Ecosystem Modeling Tool to create a model that shows their thinking about where plants get their food. The process of making the model and discussing it with a partner helps students clarify their thinking.

4. Writing About Plants in the Rainforest (10 min)
During a short writing activity about plants in the rainforest, students demonstrate their understanding of where plants get their food molecules. This activity includes an On-the-Fly Assessment to assess students' comprehension of what plants need in order to make their own food molecules.

Ecosystem Restoration: Lesson 2.3

Materials

For the classroom wall

- key concept: *Plants use water molecules, carbon dioxide molecules from the air, and energy from the sun to make food.*
- key concept: *Animals and plants grow by changing food molecules into body molecules that can build their bodies.*

For the Class

- Leaves and Roots Game Directions copymaster
- sets of Leaves and Roots Game Cards
- optional: Chapter 2 Home Investigation: The Story of My Food copymaster
- brown pipe cleaners
- green pipe cleaners
- yellow tokens
- white cubes
- blue cubes
- plastic cups
- rubber bands*
- scissors*
- marker, permanent*
- masking tape*

For Each Group of 4 Students

- 1 tray*
- 2 Leaves and Roots game boards
- 2 copies of the Leaves and Roots Game Directions
- 1 set of Leaves and Roots Game Cards, rubber-banded together (28 cards/set)
- 1 cup of leaves (green pipe cleaners)
- 1 cup of roots (brown pipe cleaners)
- 1 cup of carbon dioxide (white cubes)
- 1 cup of water (blue cubes)
- 1 cup of sunlight (yellow tokens)

Materials, cont.

For Each Pair of Students

- 1 digital device*

For Each Student

- optional: 1 copy of the Chapter 2 Home Investigation: The Story of My Food student sheet
- *Ecosystem Restoration* Investigation Notebook (pages 39–40)

*supplied by teacher

Digital Resources

- Projections: Lesson 2.3
- Leaves and Roots Game Directions copymaster
- Optional: Chapter 2 Home Investigation: The Story of My Food copymaster

Vocabulary

- ecosystem
- energy
- environment
- matter
- molecule
- organism

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.3: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS1.A: Structure and Properties of Matter:** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) **PS1.B: Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	**Crosscutting Concepts** • Energy and Matter • Systems and System Models

Ecosystem Restoration: Lesson 2.3

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.3: Alignment to NGSS and NYSSLS		
	LS2.A: Interdependent Relationships in Ecosystems: • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 2.4: Claims and Evidence About Energy (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students investigate in the *Ecosystem Restoration* Simulation.

Anchor Phenomenon and Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Organisms in an ecosystem get the energy they need.	**Students learn:** • Animals and plants use some food molecules to release energy for movement and growth.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 6, 7, 8 **DCIs** PS3.D, LS1.C, LS2.A, LS2.B **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students use evidence to construct oral argument about the source of energy in an ecosystem (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Revising a Key Concept About Food Molecules (15 min)
Students revisit a key concept from Lesson 1.5 and wonder whether plants, like animals, use some of their food molecules to release energy. Students find evidence in the *Ecosystem Restoration* Simulation to support the claim that, in fact, plants do get energy from their food molecules. This activity provides students with another experience to construct a scientific argument, which prepares them for the next activity in which they will do this more independently.

2. Gathering Evidence About Energy (30 min)
Students transition from thinking about energy in plants to thinking about energy in a whole ecosystem. They are introduced to the Investigation Question: Where does energy in an ecosystem come from? and are presented with two possible claims to answer this question. Students work in pairs to observe energy flow in the Simulation in order to search for evidence that supports each claim.

3. Making Arguments About Energy in Ecosystems (15 min)
Students reflect on the evidence they gathered from the Simulation, as well as draw upon what they read in *Energy Makes It All Go*. Students use the Shared Listening routine to help them decide which claim is best supported.

Ecosystem Restoration: Lesson

<table>
<tr>
<th>Materials</th>
<th>Digital Resources</th>
<th>Vocabulary</th>
</tr>
<tr>
<td>
For the classroom wall
• key concept: Animals and plants use some food molecules to release energy for movement and growth.
• Science/Everyday Words chart
For the Class
• masking tape*
For Each Pair of Students
• 1 digital device*
• 1 copy of Energy Makes It All Go
For Each Student
• Ecosystem Restoration Investigation Notebook (page 41–42)
*teacher provided
</td>
<td>• Projections: Lesson 2.4</td>
<td>
• argument
• claim
• ecosystem
• energy
• evidence
• matter
• molecule
• observe
</td>
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</table>

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide
Lesson 2.5: Energy in Ecosystem (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity students model energy in an ecosystem with cards and other materials.

Literacy: In Activity 3 students partner read and reflect on a section of *Restoration Case Studies*..

Anchor Phenomenon / Investigative Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Organisms in an ecosystem get the energy they need.	**Students learn:** • Energy in an ecosystem can always be traced back to the sun. • Human activities can have a negative impact on ecosystems; different communities are working to minimize that impact.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 7, 8 **DCIs** PS3.D, LS1.C, LS2.A, LS2.B, ESS3.C **CCCs** Cause and Effect, Systems and System Models, Energy and Matter

3-D statement: Students create models of how energy enters and flows through an ecosystem (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Modeling Energy in an Ecosystem (25 min)
Students apply their understanding of energy in ecosystems as they work in small groups to model the paths that energy takes through an ecosystem. Students are challenged to identify the role of the sun in the ecosystem.

2. Debriefing the Model (15 min)
Students share their models with the class and reflect on how energy enters and flows through an ecosystem. Students note similarities between their models and ultimately will conclude that the energy for ecosystems comes from the sun. This activity includes an On-the-Fly Assessment to assess students' understanding of the path that energy travels through an ecosystem.

3. Reading a Restoration Case Study (20 min)
Students read about a problem with plants in an ecosystem in *Restoration Case Studies*, the reference book for this unit. Students connect the problems in the Yellowstone National Park ecosystem they read about to the scientific practice of argumentation. Students will continue to explore the scientific practice of argumentation in depth in the next two lessons

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Energy in an ecosystem can always be traced back to the sun.* • Science/Everyday Words chart **For the Class** • Organism Name Cards: Set 2 (36 cards, collated into 6 groups) • yarn • rubber band* • paper clips* • scissors* • marker, wide tip* • masking tape* **For Each Group of 6 Students** • 1 tray* • 1 group of 6 Organism Name Cards, clipped together • 1 piece of yarn • 1 copy of *Energy Makes It All Go* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 43–44) **For Each Pair of Students** • 1 copy of *Restoration Case Studies* *teacher provided	• Projections: Lesson 2.5 • Science/Everyday Words chart	• argument • claim • ecosystem • energy • evidence • food web • restoration

Ecosystem Restoration: Lesson 2.5

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	• Cause and Effect • Systems and System Models • Energy and Matter

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.5: Alignment to NGSS and NYSSLS		
	ESS3.C: Human Impacts on Earth Systems: • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 2.6: Why Do Scientists Argue? (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Why Do Scientists Argue?*

Anchor Phenomenon / Investigative Phenomenon	Students learn:	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Pesticides affect ecosystems.	• Scientists convince others that their claims are correct by using data and ideas as evidence. • Scientists don't always agree. • Scientists use tools and technologies to make accurate measurements and observations. • Scientific explanations can change based on new evidence. • Scientific theories are based on a body of evidence and many tests. • Most scientists and engineers work in teams. • Science affects everyday life. • Science findings are limited to what can be answered with evidence.	**SEPs** 1, 7, 8 **DCIs** LS2.A, ESS3.C **CCCs** Cause and Effect, Systems and System Models, Energy and Matter

3-D statement: Students read the book *Why Do Scientists Argue?* to obtain and evaluate information about Rachel Carson's work on the impact of pesticides on ecosystems, with an eye to seeing how and why scientists engage in arguments (systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Introducing Why Do Scientists Argue? (10 min)
Students connect what they learned in the previous lesson, as well as their work as ecologists, to what they will read about in the book *Why Do Scientists Argue?*

2. Partner Reading (30 min)
Students read about how scientist Rachel Carson engaged in argumentation, as well as about how scientists of today engage in the practice of scientific argumentation.

3. Synthesizing Ideas About How Scientists Argue (20 min)
Students reflect on their own argumentation experiences and synthesize ideas to come to a new understanding about how scientists argue. This activity includes an On-the-Fly Assessment to assess students' understanding of argumentation.

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Scientists convince others that their claims are correct by using data and ideas as evidence* **For the Class** • 1 copy of *Restoration Case Studies* • masking tape* **For Each Pair of Students** • 1 copy of *Why Do Scientists Argue?* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 45–48) *teacher provided	• NA	• argument • claim • data • ecologist • ecosystem • evidence • molecules • soil

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
• **Practice 1:** Asking Questions and Defining Problems • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	• Cause and Effect • Systems and System Models • Energy and Matter

Ecosystem Restoration Lesson Planning Guide Lesson 2.7: Arguments About Plants in the Ecosystem (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Literacy: In Activity 2 students discuss claims and evidence. In Activity 3 students write a scientific argument.		
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.	**Students learn:** • Plants can fail to grow and thrive when they cannot get enough of the matter and energy they need from the environment. • Scientific arguments are written for an audience.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 4, 6, 7, 8 **DCIs** 3-5-ETS1-1, 3-5-ETS1-2, ESS3.C, LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Cause and Effect, Energy and Matter, Systems and System Models
3-D statement: Students use evidence to construct oral and written arguments about why the cecropia trees are not growing and thriving in that area of the rainforest ecosystem (energy and matter, cause and effect, systems and system models). Students then revise and add to their ecosystem restoration plans. **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		

Lesson at-a-Glance

1. Restoration Project Update (5 min)
Students are introduced to new data comparing seven days of weather in the restoration project area with the weather in the nearby healthy rainforest. This new data will be used as evidence in an argument to answer the question Why aren't the cecropia trees growing and thriving?

2. Evidence Circles (25 min)
In small groups, students review the evidence and consider three possible claims that answer the question about cecropia trees in the project area. Working in small groups to review and discuss the evidence prepares students to write their own scientific arguments.

3. Critical Juncture: Writing a Scientific Argument (20 min)
Students decide which claim is supported by the evidence and support that claim with evidence in written arguments. Students are reminded that they must write their arguments for an audience, Natural Resources Rescue, for the purpose of convincing them that one claim is the best. This activity serves as the second Critical Juncture in the unit. It is an opportunity to assess students' understanding of key content and to prepare to tailor instruction before proceeding to Chapter 3, if necessary.

4. Action Steps for Restoring the Rainforest (10 min)
The discussion and writing in this activity provides students with an opportunity to apply their ideas from their written arguments. After discussing possible action steps as a class, students write an action step as part of their second Rainforest Restoration Plan.

5^{th} Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • Restoration Plan 1: Action Steps chart (from Lesson 1.8) **For the Class** • sets of Evidence Cards: Plants • optional: Rainforest Restoration Plan 2 Version B copymaster • paper clips* • stapler* **For Each Group of 4 Students** • 1 set of Evidence Cards: Plants, clipped together (5 cards/set) **For Each Student** • optional: 1 copy of the Rainforest Restoration Plan 2 Version B student sheets • *Ecosystem Restoration* Investigation Notebook (pages 49–54) *teacher provided	• Projections: Lesson 2.7 • Optional: Rainforest Restoration Plan 2 Version B copymaster • Assessment Guide: Reviewing Students' Chapter 2 Arguments About Why the Cecropia Trees Aren't Growing and Thriving	• argument • claim • data • ecosystem • energy • evidence • matter • molecule • organism • restoration

Ecosystem Restoration: Lesson 2.7

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.7: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **3-5-ETS1-1: Defining and Delimiting Engineering Problems:** • Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2: Developing Possible Solutions:** • Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	**Crosscutting Concepts** • Cause and Effect • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide		
Lesson 2.7: Alignment to NGSS and NYSSLS		
	LS2.A: Interdependent Relationships in Ecosystems: • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 3.1: Investigating Soil (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Hands-On: In Activity 2 students investigate soil samples. In Activity 3 students observe their terrariums.

Anchor Phenomenon	Students learn	Alignment to NGSS and NYSSLS
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Plants grow and thrive differently in different terrariums.	**Students learn:** • When presented with new information, scientists sometimes change their ideas. • Soil can be different in different places	**Alignment to NGSS and NYSSLS** **SEPs** 1, 2, 3, 4, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Energy and Matter, Systems and System Models

3-D statement: Students analyze and interpret new data from a healthy ecosystem and the project area to consider why the cecropia trees in this area of the rainforest ecosystem aren't growing and thriving (energy and matter, systems and system models)

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Project Report Update (10 min)
Students are presented with new weather data and review soil observations from the rainforest project area and from a healthy rainforest ecosystem. After reviewing the new information, students conclude that there must be another factor affecting the growth and health of the cecropia trees in the project area besides water, sun, or air.

2 Soil Sample Analysis (30 min)
By observing and comparing two soil samples, students begin to formulate ideas about the ways in which soil can be different. This prepares students for the next lesson in which they are introduced to decomposers and the role of decomposers in the ecosystem.

3 Observing Terrariums (20 min)
Groups observe their terrariums in order to think about what might affect the growth and health of plants in an ecosystem.

5^{th} Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • Chapter 3 Question: *Why aren't the cecropia trees growing and thriving in the soil?* **For the Class** • Notes on Soil Observations copymaster • Soil A: Nutrient-Rich soil • Soil B: Nutrient-Poor soil • spray bottle • 1 sheet of chart paper* • marker, permanent* • marker, wide tip* • masking tape* • pitcher* • water* • newspaper* **For Each Pair of Students** • 1 copy of the Notes on Soil Observations student sheet **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 55–58) **For Each Group of Four Students** • group's terrarium • 1 tray* • 1 "A" cup (with nutrient-rich soil) • 1 "B" cup (with nutrient-poor soil) • 1 empty plastic cup • 2 plastic spoons • 2 wooden sticks • 2 sheets of white copy paper* • 2 hand lenses* • 4 pairs of safety goggles* *teacher provided	• Projections: Lesson 3.1 • Soil Observations T-chart • Notes on Soil Observations copymaster	• data • ecosystem • matter • observe • organism • soil

<table>
<tr><th colspan="3">Ecosystem Restoration Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 3.1: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)</td>
<td>Crosscutting Concepts
• Energy and Matter
• Systems and System Models</td>
</tr>
</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 3.2: Walk in the Woods (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Walk in the Woods*.

Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** The remains of a dead laurel tree, a California bay laurel leaf, and a gopher snake decompose into soil.	**Students learn:** • Everything in the environment can become part of soil. • Soil is made of matter from living and nonliving things in the environment. • Decomposers are organisms that break down dead matter. • Soil scientists study soil and look for evidence of soil being formed.	**Alignment to NGSS and NYSSLS** **SEPs** 1, 6, 8 **DCIs** LS2.A, LS2.B, LS1.C **CCCs** Cause and Effect, Energy and Matter, Systems and System Models

3-D statement: Students read the book *Walk in the Woods* to obtain and evaluate information about decomposition and the different kinds of matter from living and nonliving things that can be found in soil (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Preparing to Read (10 min)
Students use the Shared Listening routine to recall what they learned about soil through observing soil samples. This prepares them to read *Walk in the Woods*.

2. Partner Reading (30 min)
Partners read *Walk in the Woods* to learn about the many living and nonliving things that make up soil, and they record information about this as they read. The book allows students to begin to make sense of the role of decomposers in an ecosystem and the ways in which decomposers can affect soil matter.

3. Discussing Decomposers (10 min)
The teacher uses the Science/Everyday Words chart and photographs from *Walk in the Woods* to highlight the importance of decomposers in the soil.

4. Synthesizing Ideas About What Makes Up Soil (10 min)
Students consider what they learned from reading to conclude that soil is made of many living and nonliving things. This activity includes an On-the-Fly Assessment to assess how students are engaging in synthesizing.

Ecosystem Restoration: Lesson 3.1

Materials	Digital Resources	Vocabulary
For the classroom wall • vocabulary: *decomposer, soil* • Partner Reading Guidelines • Science/Everyday Words chart • Matter chart **For the Class** • optional: Chapter 3 Home Investigation: Conduct a Soil Investigation copymaster • marker, wide tip* • masking tape* **For Each Pair of Students** • 1 copy of *Walk in the Woods* **For Each Student** • optional: 1 copy of the Chapter 3 Home Investigation: Conduct a Soil Investigation student sheets • *Ecosystem Restoration* Investigation Notebook (page 59–62) *teacher provided	• Projections: Lesson 3.2 • Science/Everyday Words chart • Matter chart • Optional: Chapter 3 Home Investigation: Conduct a Soil Investigation copymaster	• decomposer • ecosystem • environment • evidence • matter • nutrient • organism • soil

<table>
<tr><th colspan="3">Ecosystem Restoration Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 3.2: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 1: Asking Questions and Defining Problems
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Plants acquire their material for growth chiefly from air and water. (5-LS1-1)</td>
<td>Crosscutting Concepts
• Cause and Effect
• Energy and Matter
• Systems and System Models</td>
</tr>
</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 3.3: Differences in Soil (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activities 1-3 students partner read and reflect on *Walk in the Woods*.

Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** When mushrooms are removed from an ecosystem, nutrients disappear and plants look unhealthy. **Investigative Phenomenon:** Mushrooms take food matter from dead plants, rabbits, foxes, and other mushrooms to build their bodies.	**Students learn:** • Decomposers and nutrients are made of matter. • Decomposers release nutrients from dead plants and animals into the soil. • Animals, plants, and decomposers grow by changing food molecules into body molecules that can build their bodies. • Animals, plants, and decomposers use some food molecules to release energy for movement and growth.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 3, 4, 5, 6, 7, 8 **DCIs** LS1.C, LS2.A, LS2.B **CCCs** Cause and Effect, Energy and Matter, Systems and System Models

3-D statement: Students use a digital model to figure out what can cause soils to be different from one another (cause and effect). Students synthesize what they learned from the book with what they are figuring out in the digital model as they investigate the relationship between nutrients and decomposers (energy and matter).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Simulating Different Soils (25 min)
Observing and manipulating conditions in the Ecosystem Restoration Simulation allows students to investigate the role that decomposers play in the ecosystem.

2. Synthesizing Ideas About Differences in Soil (15 min)
Students use ideas from Walk in the Woods, their observations of two soil samples, and the *Ecosystem Restoration* Simulation to come to a new understanding about how soil matter can be different in different places. This activity includes an On-the-Fly Assessment to assess students' understanding of the relationship between nutrients and decomposers.

3. Writing About the Project Area (10 min)
Students demonstrate their understanding of the role of decomposers in an ecosystem through a short writing activity. Students apply what they have been learning about ecosystems in general to the rainforest project area.

4. Investigating How Decomposers Get Food Molecules (10 min)
Students revisit the Simulation to investigate what decomposers do with the matter they break down and release as nutrients. Students observe that decomposers change food molecules into body molecules and use some of those food molecules to release energy for movement and growth.

5th Grade Unit 4 Ecosystem Restoration

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Decomposers release nutrients from dead plants and animals into the soil.* • key concept: *Animals, plants, and decomposers grow by changing food molecules into body molecules that can build their bodies.* • key concept: *Animals, plants, and decomposers use some food molecules to release energy for movement and growth.* • Matter chart **For the Class** • 1 copy of *Walk in the Woods* • marker, wide tip* • masking tape* **For Each Pair of Students** • 1 digital device* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 63–66) *teacher provided	• Matter chart	• decomposer • ecosystem • environment • matter • nutrient • organism • soil

Ecosystem Restoration: Lesson 3.3

<table>
<tr><th colspan="3">Ecosystem Restoration Lesson Planning Guide</th></tr>
<tr><th colspan="3">Lesson 3.3: Alignment to NGSS and NYSSLS</th></tr>
<tr>
<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 3: Planning and Carrying Out Investigations
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)</td>
<td>Crosscutting Concepts
• Cause and Effect
• Energy and Matter
• Systems and System Models</td>
</tr>
</table>

Ecosystem Restoration Lesson Planning Guide
Lesson 3.4: Nutrients and Soil (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Students investigate in the *Ecosystem Restoration* Simulation.

Anchor Phenomenon:
The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.

Investigative Phenomenon:
When mushrooms are removed from an ecosystem, the plants become unhealthy.

Students learn:
- One way in which soils can be different is that they can be nutrient rich or nutrient poor.
- Plants do not make enough food molecules to grow and thrive when they don't have access to the nutrients they need.

Alignment to NGSS and NYSSLS
SEPs 1, 2, 3, 4, 5, 6, 7, 8
DCIs ESS3.C, LS1.C, LS2.A, LS2.B
CCCs Cause and Effect, Energy and Matter, Systems and System Model

3-D statement: Students analyze and interpret new quantitative data to figure out why plants need nutrients to grow and thrive (energy and matter, cause and effect).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. New Data About Plant Growth (20 min)
By analyzing and comparing data about the growth of plants in nutrient-rich soil versus nutrient-poor soil, students figure out that nutrients are essential to plants.

2. Investigating Plant Growth in the Simulation (30 min)
Students revisit the *Ecosystem Restoration* Simulation in order to figure out why nutrients are essential to plants. They observe what happens to plants growing in soil without nutrients versus those growing in soil that is nutrient rich – namely, that plants can't make as much food in nutrient-poor soil. This activity includes an On-the-Fly Assessment to assess how students are understanding the impact of nutrient-poor soil on plants in an ecosystem.

3. Making Sense of Nutrients and Ecosystems (10 min)
Students engage in the Shared Listening routine to further make sense of what they have learned and to begin to consider the effect of nutrients not just on plants but on an ecosystem.

Materials

For the classroom wall
- vocabulary: nutrient
- For the Class
- masking tape*

For Each Pair of Students
- 1 digital device*

For Each Student
- *Ecosystem Restoration* Investigation Notebook (page 67–69)

*teacher provided

Digital Resources

Vocabulary
- Cause and Effect
- Energy and Matter
- Systems and System Models

Ecosystem Restoration Lesson Planning Guide		
Lesson 3.4: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 1:** Asking Questions and Defining Problems • **Practice 2:** Developing and Using Models • **Practice 3:** Planning and Carrying Out Investigations • **Practice 4:** Analyzing and Interpreting Data • **Practice 5:** Using Mathematics and Computational Thinking • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Cause and Effect • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide Lesson 3.5: Decomposers, Nutrients, and Ecosystems (60 minutes)		
Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher. Students draw nanovision models of emulsifiers then explore in the *Modeling Matter* Simulation.		
Anchor Phenomenon: The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving. **Investigative Phenomenon:** Cordgrass in the salt marshes on Cape Cod dies off. A mining operation kills many organisms in the Alberta Forest and wetlands.	**Students learn:** • Plants need nutrients to help make food molecules for energy and body matter. • The health of the plant provides a clue about its growing conditions. • Scientific arguments are stronger when they have data and evidence linked together to support a claim. • Scientific arguments end with a conclusion.	**Alignment to NGSS and NYSSLS** **SEPs** 2, 4, 6, 7, 8 **DCIs** ESS3.C, LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Cause and Effect, Energy and Matter, Systems and System Models
3-D statement: Students read a section of the reference book *Restoration Case Studies* to obtain information about the role that decomposers play in healthy ecosystems (systems and system models, cause and effect). **Key:** Practices / Disciplinary Core Ideas / Crosscutting Concepts		
Lesson at-a-Glance **1. Using the Environments Model (20 min)** Engaging with the digital Environments Model allows students to demonstrate their understanding of what plants need to grow and to thrive. This activity includes an On-the-Fly Assessment to assess students' understanding of this content. **2. More Restoration Case Studies (20 min)** The case studies that students read provide them with a snapshot of how real scientists use nutrients to try to repair damaged ecosystems. These case studies demonstrate the importance of nutrients for the health of plants. **3. Critiquing an Argument About Soil (20 min)** Natural Resources Rescue asks students to help them make sense of a draft argument about a different ecosystem project. Students critique the argument based on the guidelines they have learned for writing scientific arguments.		

Ecosystem Restoration: Lesson 3.4

Materials	Digital Resources	Vocabulary
For the classroom wall • key concept: *Plants need nutrients to help make food molecules for energy and body matter.* **For the Class** • masking tape* **For Each Pair of Students** • 1 digital device* • 1 copy of *Restoration Case Studies* **For Each Student** • *Ecosystem Restoration* Investigation Notebook (page 70–73) *teacher provided	• Projections: Lesson 3.5	• argument • claim • data • decomposer • ecosystem • environment • evidence • matter • nutrient • organism • restoration • soil

Ecosystem Restoration Lesson Planning Guide		
Lesson 3.5: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 2:** Developing and Using Models • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)	**Crosscutting Concepts** • Cause and Effect • Energy and Matter • Systems and System Models

Ecosystem Restoration: Lesson 3.5

Ecosystem Restoration Lesson Planning Guide		
Lesson 3.5: Alignment to NGSS and NYSSLS		
	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems: • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **PS3.D: Energy in Chemical Processes and Everyday Life:** • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 3.6: Arguments About Soil in the Ecosystem (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 1 students discuss claims and evidence. In Activity 2 students write a scientific argument.

Anchor Phenomenon:	Students learn:	Alignment to NGSS and NYSSLS
The jaguars, sloths, and cecropia trees in a reforested section of a Costa Rican rainforest are not growing and thriving.	• Scientists apply their understanding to solve problems.	**SEPs** 4, 6, 7, 8 **DCIs** 3-5-ETS1-2, LS1.C, LS2.A, LS2.B, PS3.D, ESS3.C **CCCs** Cause and Effect, Energy and Matter, Systems and System Models

3-D statement: Students use evidence to construct written arguments about why the cecropia trees in the rainforest ecosystem project area aren't growing and thriving (energy and matter, systems and system models). They then design revised restoration plans for the project area.

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Evidence Circles (25 min)
In small groups, students review the evidence and consider which data and scientific ideas best support a proposed claim about the soil in the project area. Working in small groups to review and discuss the evidence prepares students to write their own scientific arguments.

2 Critical Juncture: Writing a Scientific Argument (25 min)
Students are reminded that they must write their arguments for an audience, Natural Resources Rescue, for the purpose of convincing them that they have sound evidence about the problem in the ecosystem. Students are also prompted to end their arguments with a concluding sentence. This activity serves as the third and final Critical Juncture in the unit. It is an opportunity to assess students' understanding of key content.

3 Action Steps for Restoring the Rainforest (10 min)
After discussing the purpose of action steps as a class, students independently write an action step as part of their third Rainforest Restoration Plan.

Ecosystem Restoration: Lesson 3.5

<table>
<tr>
<td>
Materials
For the classroom wall
Rainforest Restoration Plan 1: Action Steps chart
For the Class

sets of Evidence Cards: Decomposers
1 copy of Restoration Case Studies
optional: Rainforest Restoration Plan 3 Version B copymaster
paper clips*
stapler*

For Each Group of 4 Students
1 set of Evidence Cards: Decomposers, clipped together (6 cards/ set)
For Each Student

optional: 1 copy of the Rainforest Restoration Plan 3 Version B student sheets
Ecosystem Restoration Investigation Notebook (page 74–80)

*teacher provided
</td>
<td>
Digital Resources

Projections: Lesson 3.6
Optional: Rainforest Restoration Plan 3 Version B copymaster

</td>
<td>
Vocabulary

argument
claim
data
decomposer
ecosystem
evidence
matter
nutrient
organism
restoration
soil

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</tr>
</table>

Ecosystem Restoration Lesson Planning Guide		
Lesson 3.6: Alignment to NGSS and NYSSLS		
Science and Engineering Practices • **Practice 4:** Analyzing and Interpreting Data • **Practice 6:** Constructing Explanations and Designing Solutions • **Practice 7:** Engaging in Argument from Evidence • **Practice 8:** Obtaining, Evaluating, and Communicating Information	**Disciplinary Core Ideas** **3-5-ETS1-2: Developing Possible Solutions:** • Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. **LS1.C: Organization for Matter and Energy Flow in Organisms:** • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems:** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Crosscutting Concepts** • Cause and Effect • Energy and Matter • Systems and System Models

Ecosystem Restoration Lesson Planning Guide		
Lesson 3.6: Alignment to NGSS and NYSSLS		
	PS3.D: Energy in Chemical Processes and Everyday Life: • The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **ESS3.C: Human Impacts on Earth Systems:** • Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)	

Ecosystem Restoration Lesson Planning Guide
Lesson 3.7: End-of-Unit Assessment (60 minutes)

Guidance for cluster teachers and classroom teachers: Lesson can be taught by either teacher.

Literacy: In Activity 2 students write their final scientific arguments.

Investigative Phenomenon:	**Students learn:**	**Alignment to NGSS and NYSSLS**
Snakes are not growing and thriving in a forest ecosystem.	• While the organisms in ecosystems may vary, there are basic relationships that can be found in any ecosystem.	**SEPs** 2, 4, 5, 6, 7, 8 **DCIs** LS1.C, LS2.A, LS2.B, PS3.D **CCCs** Cause and Effect, Energy and Matter, Systems and System Models

3-D statement: Students apply what they have learned about ecosystems and use evidence to construct written arguments about why the snakes in a forest ecosystem aren't growing and thriving (energy and matter, systems and system models).

Key: Practices / Disciplinary Core Ideas / Crosscutting Concepts

Lesson at-a-Glance

1. Modeling an Ecosystem Without Decomposers (20 min)
Students demonstrate their understanding of the flow of matter through an ecosystem as they use the digital Ecosystem Modeling Tool to model the impact of removing decomposers from an ecosystem.

2. Writing Final Arguments (35 min)
Students complete and label a food-web diagram and write a final argument about why the snakes in a forest ecosystem aren't growing and thriving. Students' diagrams and arguments serve as an End-of-Unit Assessment.

3. Concluding the Unit (5 min)
The class reflects on all they have done and learned during the *Ecosystem Restoration* unit.

Ecosystem Restoration: Lesson 3.7

Materials	Digital Resources	Vocabulary
For the classroom • End-of-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving Version A copymaster (optional: Version B) • stapler* **For Each Pair of Students** • 1 digital device* **For Each Student** • 1 copy of the End-of-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving Version A student sheets (optional: Version B) • *Ecosystem Restoration* Investigation Notebook (page 81–82) *teacher provided	• Projection: Lesson 3.7 • End-of-Unit Writing: Arguing Why a Forest Ecosystem Is Not Thriving Version A copymaster	• argument • claim • data • decomposer • ecologist • ecosystem • energy • evidence • matter • soil

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<tr>
<td>Science and Engineering Practices
• Practice 2: Developing and Using Models
• Practice 4: Analyzing and Interpreting Data
• Practice 5: Using Mathematics and Computational Thinking
• Practice 6: Constructing Explanations and Designing Solutions
• Practice 7: Engaging in Argument from Evidence
• Practice 8: Obtaining, Evaluating, and Communicating Information</td>
<td>Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.
LS1.C: Organization for Matter and Energy Flow in Organisms:
• Plants acquire their material for growth chiefly from air and water. (5-LS1-1)
LS2.A: Interdependent Relationships in Ecosystems:
• The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems:
• Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)
PS3.D: Energy in Chemical Processes and Everyday Life:
• The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)</td>
<td>Crosscutting Concepts
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• Energy and Matter
• Systems and System Models</td>
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