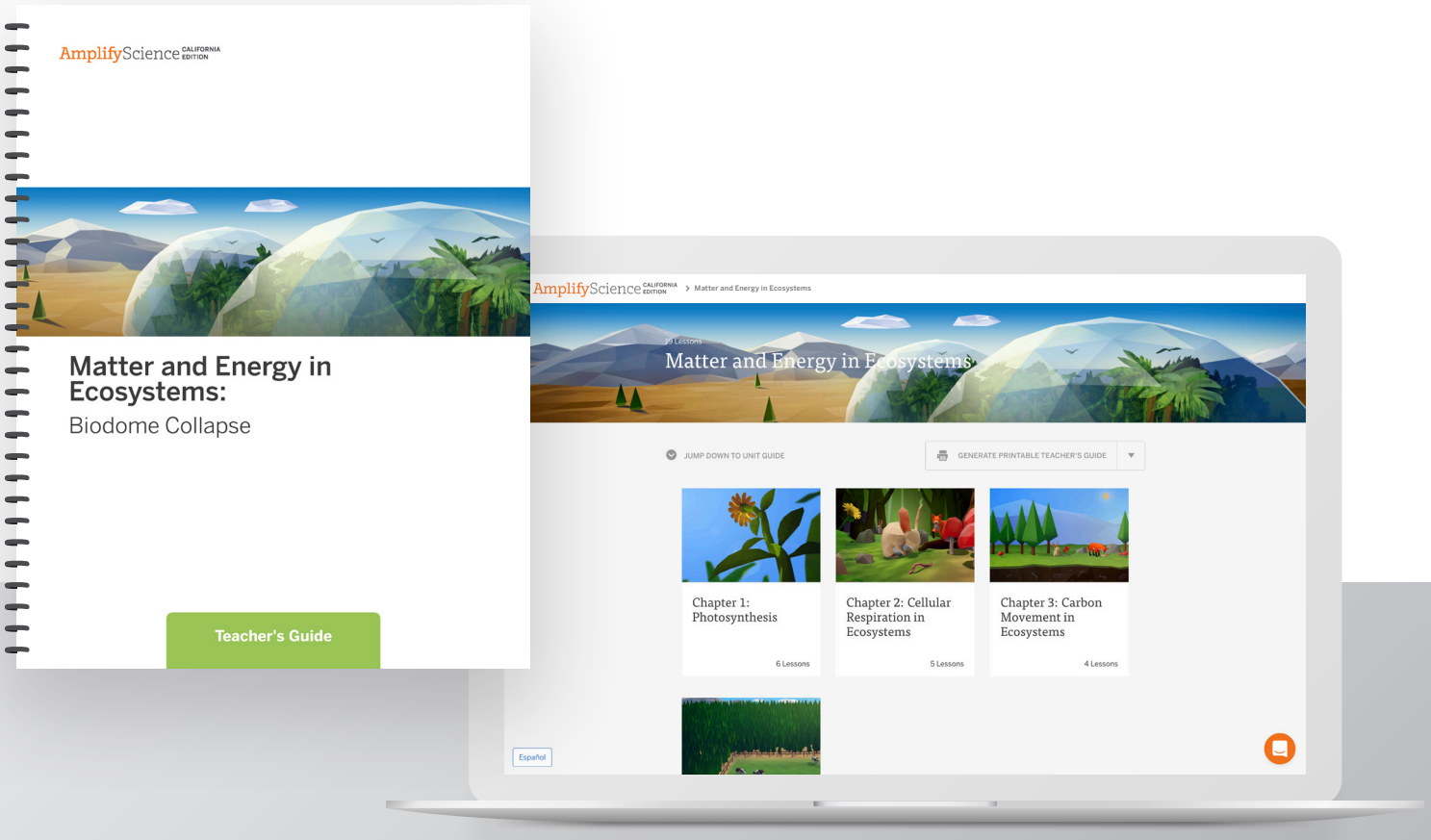
Amplify Science
CALIFORNIA

UNIT GUIDE

Matter and Energy in Ecosystems



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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Welcome to Matter and Energy in Ecosystems

The Matter and Energy in Ecosystems unit builds on the understanding of ecosystems developed in the Populations and Resources unit. While the previous unit focused on consumers, this unit expands students' understanding of ecosystems by considering both living and nonliving components—how an ecosystem's producers, consumers, and decomposers meet their energy needs through the processes of photosynthesis and cellular respiration; how carbon, a key component of those processes, moves between nonliving and living matter; and how sunlight and the atmosphere function within the overall system.

> Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of ecologists. Their job is to investigate a fictional failed biodome constructed by a local group of individuals. Working together, students figure out why the sealed ecosystem mysteriously crashed despite the Econauts following the advice of hired experts. The unit concludes with a Science Seminar in which students use what they have learned to analyze evidence and participate in a discussion about how deforestation is contributing to the increase of carbon dioxide in Earth's atmosphere.

Unit Type: Core

Student Role: Ecologists

Phenomenon: The biodome ecosystem has collapsed.

Core Concepts: Understanding how matter, carbon in particular, flows through biotic and abiotic components of an ecosystem

Target Performance Expectations:

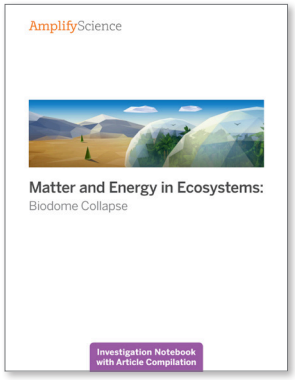
- LS1-6: Photosynthesis
- LS1-7: Cellular Respiration
- LS2-2: Ecosystem Relationships
- LS2-3: Flow of Energy and Cycling of Matter
- LS2-4: Changes Affect Populations
- ESS2-1: Earth's Materials

Related Performance Expectations:

- PS1-1: Atomic Theory/Molecules
- PS1-6: Thermal Energy and Chemical Processes
- LS1-1: Living Things Made of Cells
- LS1-2: Cell Parts
- ESS3-5: Factors for Global Temperature

Students figure out the unit phenomenon through the use of a variety of resources.

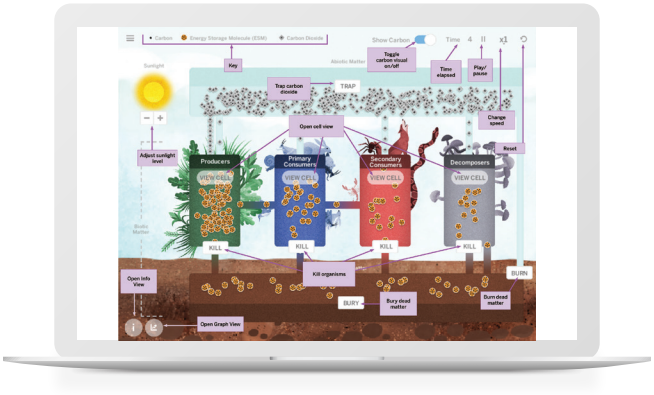
Student Books



Hands-On Kit

Videos

Digital Tools



About technology in this unit:
All Amplify Science California lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In this grade, student-facing technology includes Practice Tools and digital Simulations. When the use of a digital tool is called for in a lesson, teachers have several implementation options:

If limited student devices are available—teachers can have students do activities in pairs or small groups.

If no student devices are available—teachers can project the digital tool to the class and either "drive" the digital tool themself or invite students to "drive" by using their device.

If internet access is unavailable—teachers can "pre-load" the digital tool on their device for use offline.

Chapter 1:
The storyline begins

What students investigate:

Why didn't the plants and animals in the biodome have enough energy storage molecules?

What students figure out:

Producers make all of the energy storage molecules for an ecosystem through the process of photosynthesis, using carbon dioxide from abiotic matter. The organisms in the biodome did not have enough energy storage molecules because there was not enough carbon in the abiotic matter.

How they figure it out:

- Reading articles about photosynthesis and how energy storage molecules are made by producers and passed through food webs, as exemplified in three different settings: the Arctic, coral reefs, and rain forests
- Investigating photosynthesis, energy storage molecules, and carbon in the Sim
- Observing a photosynthesis experiment
- Analyzing data about the biodome and model

KEY

- CLASS
- HANDS-ON
- HOMEWORK
- MODELING
- VIDEO
- READING
- SIM
- SORTING
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WARM-UP
- WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Investigating a Biodome

- Introducing Biosphere 2
- Warm-Up (5 min)
- Introducing the Biodome (5 min)
- Examining the Biodome Files (20 min)
- Introducing the Simulation (15 min)

DAY 3 | LESSON 1.3

"Sunlight and Life"

- Warm-Up (5 min)
- Reading "Sunlight and Life" (25 min)
- Discussing Annotations (15 min)
- Homework

On-the-Fly Assessment

DAY 4 | LESSON 1.4

How Energy Storage Molecules Are Made

- Warm-Up (10 min)
- Rereading "Sunlight and Life" (20 min)
- Observing Photosynthesis Close Up (15 min)
- Homework

DAY 5 | LESSON 1.5

Photosynthesis in Ecosystems

- Warm-Up (5 min)
- Modeling Energy Storage Molecules (20 min)
- Decreasing Energy Storage Molecules (20 min)
- Homework

On-the-Fly Assessment
Optional Flextensions: *Plant Growth Investigations*

DAY 6 | LESSON 1.6

Examining Data from the Biodome

- Warm-Up (5 min)
- A New Message from Dr. Corry (5 min)
- Examining Data from the Biodome (10 min)
- Reasoning About Data from the Biodome (15 min)
- A Model for the Econauts (10 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

What caused carbon dioxide to decrease in the air (abiotic matter) of the biodome?

What students figure out:

As organisms release energy during cellular respiration, carbon dioxide is produced from the carbon in energy storage molecules. This process moves carbon from biotic to abiotic matter. Carbon dioxide in the biodome decreased because decomposers decreased, which means there was a decrease in cellular respiration overall.

How they figure it out:

- Gathering evidence from the Sim and from a video of an experiment to determine which organisms perform cellular respiration
- Reading articles about decomposers and their role in breaking down dead matter for use in ecosystems
- Modeling more complete ideas about the biodome collapse, using evidence about decomposers and dead matter

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


VIDEO


READING


SIM


SORTING


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 7 | LESSON 2.1

Carbon Dioxide in Ecosystems

- Warm-Up (5 min)
- Carbon Dioxide in Ecosystems (10 min)
- The Snail and Elodea Experiment (10 min)
- Snail and Elodea Experiment Video
- Introduction to "A Feast for Decomposers" Article Set (20 min)
- Homework

On-the-Fly Assessment

DAY 8 | LESSON 2.2

How Carbon Dioxide Enters the Air

- Warm-Up (5 min)
- Observing Cellular Respiration (20 min)
- Modeling How Organisms Give Off Carbon Dioxide (15 min)
- Sharing Models (5 min)
- Homework

On-the-Fly Assessment

DAY 9 | LESSON 2.3

An Explanation for the Econauts

- Warm-Up (5 min)
- Discussing the Data (10 min)
- Testing a Claim in the Sim (15 min)
- Word Relationships Routine (15 min)
- Homework

On-the-Fly Assessment

DAY 10 | LESSON 2.4

Critical Juncture Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)
- Homework

Critical Juncture Assessment

DAY 11 | LESSON 2.5

Investigating Econauts' Claims

- Warm-Up (5 min)
- Preparing to Investigate Claims (3 min)
- Investigating Ecosystem Claims (22 min)
- Word Relationships Routine (15 min)
- Homework
- Self-Assessment (Optional)

Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

What happened to the carbon that used to be in the air (abiotic matter) of the biodome?

What students figure out:

Since carbon cannot be produced or used up, the total amount of carbon in a closed ecosystem does not change. The decrease in carbon in the abiotic matter and in living things in the biodome means there was an increase somewhere in the system—in this case, in dead matter that had failed to decompose.

How they figure it out:

- Reading an article about how carbon dioxide gets into the atmosphere and how it affects our planet
- Using a game-like physical model to investigate carbon cycling
- Creating a visual model
- Writing their final explanation of the biodome collapse

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


VIDEO


READING


SIM


SORTING


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 12 | LESSON 3.1

"Carbon in the Global Ecosystem"

- Warm-Up (5 min)
- Focusing on Carbon (5 min)
- Reading "Carbon in the Global Ecosystem" (25 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 13 | LESSON 3.2

Total Carbon in an Ecosystem

- Warm-Up (5 min)
- Rereading "Carbon in the Global Ecosystem" (15 min)
- The Carbon Game (25 min)
- Homework

On-the-Fly Assessment

DAY 14 | LESSON 3.3

Looking for the Missing Carbon

- Warm-Up (5 min)
- Finding the Missing Carbon (20 min)
- Researching with the "Biodome Files" Article Set (15 min)
- Homework

DAY 15 | LESSON 3.4

Explaining What Happened in the Biodome

- Warm-Up (5 min)
- Cause and Effect in the Biodome (20 min)
- Biodome Model (15 min)
- What's New at Biosphere 2 (5 min)
- Homework
- Family Homework Experience (Optional)
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment
Optional Flextension: *Biodome Design Challenge*

Chapter 4:
Application to a new storyline

What students investigate:

After clearing a forest to create farmland, a group of farmers noticed that the amount of carbon dioxide in the air increased. Was deforestation to blame?

What students figure out:

Scientists must communicate how their claims and evidence are supported with reasoning in a convincing scientific argument. A written scientific argument needs to state a claim, describe specific evidence, and explain how the evidence supports the claim to convince its reader. A claim can sometimes be supported more effectively if you consider the combination of several different pieces of evidence.

How they figure it out:

- Analyzing and sorting evidence about temperature, mass, and energy transfer
- Reviewing available evidence to make an argument
- Engaging in oral argumentation in a student-led discourse routine called a Science Seminar
- Writing final arguments

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


VIDEO


READING


SIM


SORTING


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 16 | LESSON 4.1

Pasteurizing Water in an Emergency

- Warm-Up (5 min)
- Water Emergency on Louis Island (10 min)
- Analyzing Evidence (15 min)
- Sorting Evidence (15 min)

DAY 17 | LESSON 4.2

Science Seminar

- Warm-Up (5 min)
- Preparing for the Science Seminar (15 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (20 min)
- Homework

DAY 18 | LESSON 4.3

Writing a Scientific Argument

- Warm-Up (5 min)
- Using the Reasoning Tool (15 min)
- Organizing Ideas in the Reasoning Tool (10 min)
- Writing a Scientific Argument (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

DAY 19 | LESSON 4.4

End-of-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

End-of-Unit Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

Matter and Energy in Ecosystems Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of how matter and energy flow in an ecosystem.

Progress Build Level 1:

Producers make energy storage molecules using the carbon from carbon dioxide.

Progress Build Level 2:

All organisms give off carbon dioxide when they release energy from energy storage molecules.

Progress Build Level 3:

Carbon cannot be produced or used up, so in a closed ecosystem there is a fixed amount.

Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

For English learners:

Vocabulary scaffold (Example from Lesson 2.3)
This lesson asks students to focus on the specific vocabulary introduced so far in this unit so they can derive maximum benefit from a peer discussion and apply it to a writing activity. You may want to set aside a few minutes before Word Relationships begins in order to go over the vocabulary in an active way, which could include making use of images from the Sim or the articles. Ask students to point to relevant images as they explain how words are related. Be sure to use the vocabulary purposefully while guiding the demonstration and require that students who are talking or aiding in the demonstration do the same. This activity can help to ensure that more students understand how to discuss the decrease in carbon dioxide in the biodome in their small groups. Participation in this small-group routine will help students to internalize the vocabulary necessary for understanding and explaining the concepts they are learning in this unit.

For students needing more support:

More reflection time (Example from Lesson 2.5)
Some students may benefit from more time to reflect on each activity in this lesson. Before moving on to another activity, ask a fairly open-ended question, such as "What is something you can conclude from what you observed?" or "What could you say about carbon dioxide in ecosystems, based on what you just observed?" Have students think silently to themselves for a minute or two and then discuss with a partner.

For students ready for a challenge:

Considering and addressing refutable evidence (Example from Lesson 4.3)
Sophisticated argumentation includes not only supporting a claim with the strongest, most convincing evidence available, but also explaining why some evidence eliminates other possible claims. It can be quite challenging to consider both supports and refutation at the same time, but if some or all of your students are ready for the challenge, you may want to ask them to explain, orally or in writing, whether any pieces of evidence work against a claim.

3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

Matter and Energy in Ecosystems 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students investigate how photosynthesis and cellular respiration move energy and matter (energy and matter) through the biotic and abiotic parts of an ecosystem. They analyze and interpret evidence from a digital model, texts, and experiments and use systems analysis to construct explanations (systems and system models) for a fictional biodome's collapse.

Chapter Level

Chapter 1: Photosynthesis

Students obtain information from text and from a video of an experiment in order to investigate how producers make energy storage molecules through photosynthesis. Students use a digital model to test how the amount of energy and matter, including sunlight and carbon dioxide, affect the rate of photosynthesis (cause and effect). They create a visual system model (systems and system models) to explain why the plants and animals in the biodome were not getting enough energy storage molecules.

Chapter 2: Cellular Respiration in Ecosystems

Students analyze and interpret evidence from a digital model, a video of an experiment, and several articles in order to investigate how living organisms release energy and give off carbon dioxide through the process of cellular respiration (energy and matter). Students use what they have learned to revise their claims about what caused a decrease in carbon dioxide in the air of the biodome (systems and system models).

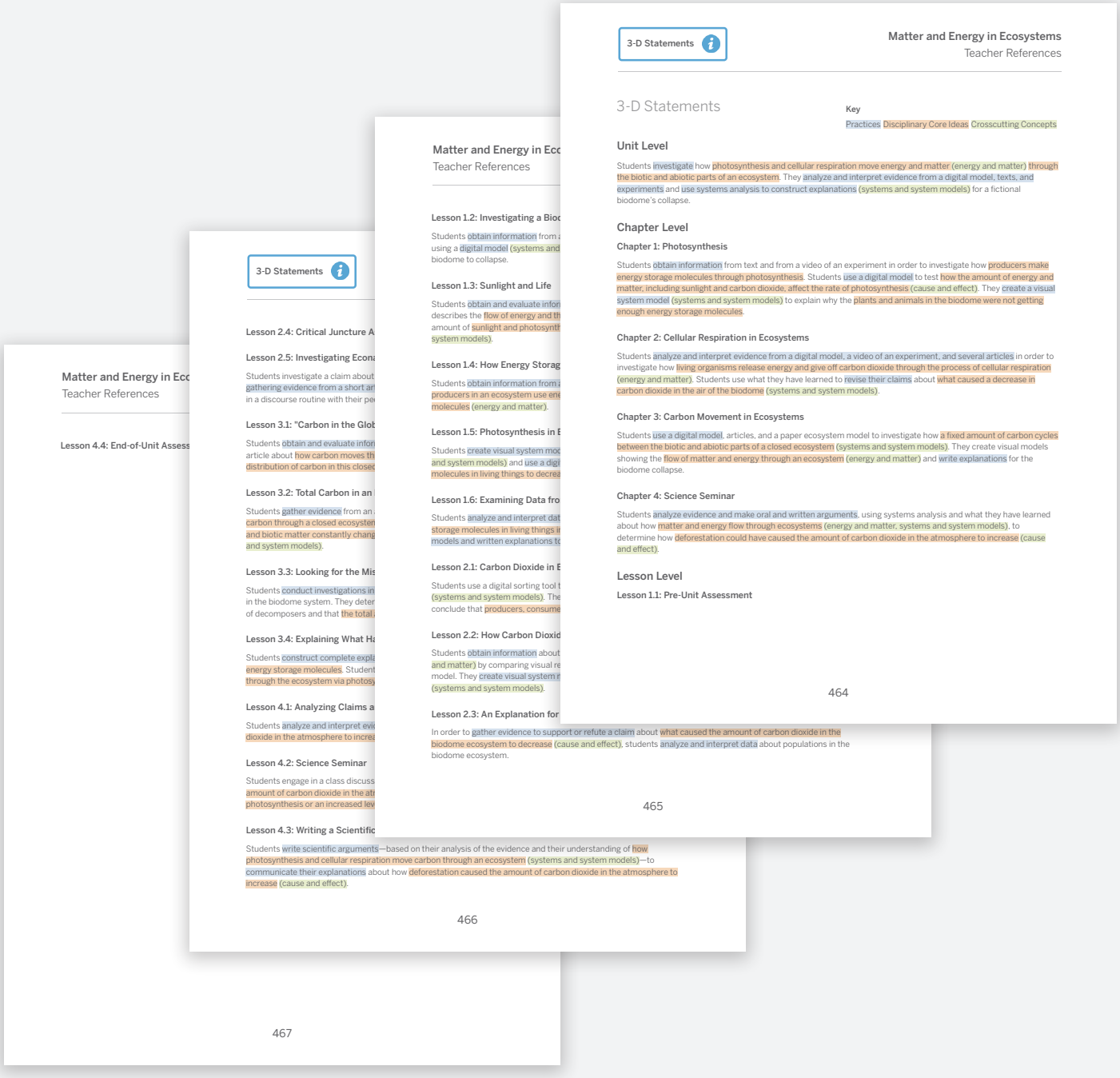
Chapter 3: Carbon Movement in Ecosystems

Students use a digital model, articles, and a paper ecosystem model to investigate how a fixed amount of carbon cycles between the biotic and abiotic parts of a closed ecosystem (systems and system models). They create visual models showing the flow of matter and energy through an ecosystem (energy and matter) and write explanations for the biodome collapse.

Chapter 4: Science Seminar

Students analyze evidence and make oral and written arguments, using systems analysis and what they have learned about how matter and energy flow through ecosystems (energy and matter, systems and system models), to determine how deforestation could have caused the amount of carbon dioxide in the atmosphere to increase (cause and effect).

To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.



3-D Statements

Matter and Energy in Ecosystems
Teacher References

3-D Statements

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

Unit Level

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Lesson Level

Lesson 1.1: Pre-Unit Assessment

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Matter and Energy in Ecosystems
Teacher References

Lesson 1.2: Investigating a Biod

Students obtain information from a
using a digital model (systems and
biodome to collapse.

Lesson 1.3: Sunlight and Life

Students obtain and evaluate infor
describes the flow of energy and th
amount of sunlight and photosynth
system models).

Lesson 1.4: How Energy Storag

Students obtain information from a
producers in an ecosystem use ene
molecules (energy and matter).

Lesson 1.5: Photosynthesis in E

Students create visual system mod
and system models) and use a digi
molecules in living things to decrea

Lesson 1.6: Examining Data fro

Students analyze and interpret dat
storage molecules in living things i
models and written explanations to

Lesson 2.1: Carbon Dioxide in E

Students use a digital sorting tool t
(systems and system models). The
conclude that producers, consume

Lesson 2.2: How Carbon Dioxid

Students obtain information about
and matter) by comparing visual re
model. They create visual system r
(systems and system models).

Lesson 2.3: An Explanation for

In order to gather evidence to support or refute a claim about what caused the amount of carbon dioxide in the biodome ecosystem to decrease (cause and effect), students analyze and interpret data about populations in the biodome ecosystem.

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3-D Statements

Lesson 2.4: Critical Juncture A

Lesson 2.5: Investigating Econ

Students investigate a claim about
gathering evidence from a short ar
in a discourse routine with their pe

Lesson 3.1: "Carbon in the Glob

Students obtain and evaluate infor
article about how carbon moves th
distribution of carbon in this closed

Lesson 3.2: Total Carbon in an

Students gather evidence from an
carbon through a closed ecosysten
and biotic matter constantly chang
and system models).

Lesson 3.3: Looking for the Mis

Students conduct investigations in
in the biodome system. They deter
of decomposers and that the total

Lesson 3.4: Explaining What Ha

Students construct complete expla
energy storage molecules. Student
through the ecosystem via photosy

Lesson 4.1: Analyzing Claims a

Students analyze and interpret evi
dioxide in the atmosphere to increa

Lesson 4.2: Science Seminar

Students engage in a class discuss
amount of carbon dioxide in the at
photosynthesis or an increased lev

Lesson 4.3: Writing a Scientific

Students write scientific arguments—based on their analysis of the evidence and their understanding of how photosynthesis and cellular respiration move carbon through an ecosystem (systems and system models)—to communicate their explanations about how deforestation caused the amount of carbon dioxide in the atmosphere to increase (cause and effect).

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Matter and Energy in Ecosystems
Teacher References

Lesson 4.4: End-of-Unit Assess

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Notes

Notes

For more information on Amplify Science, visit **amplify.com/science/california**.

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