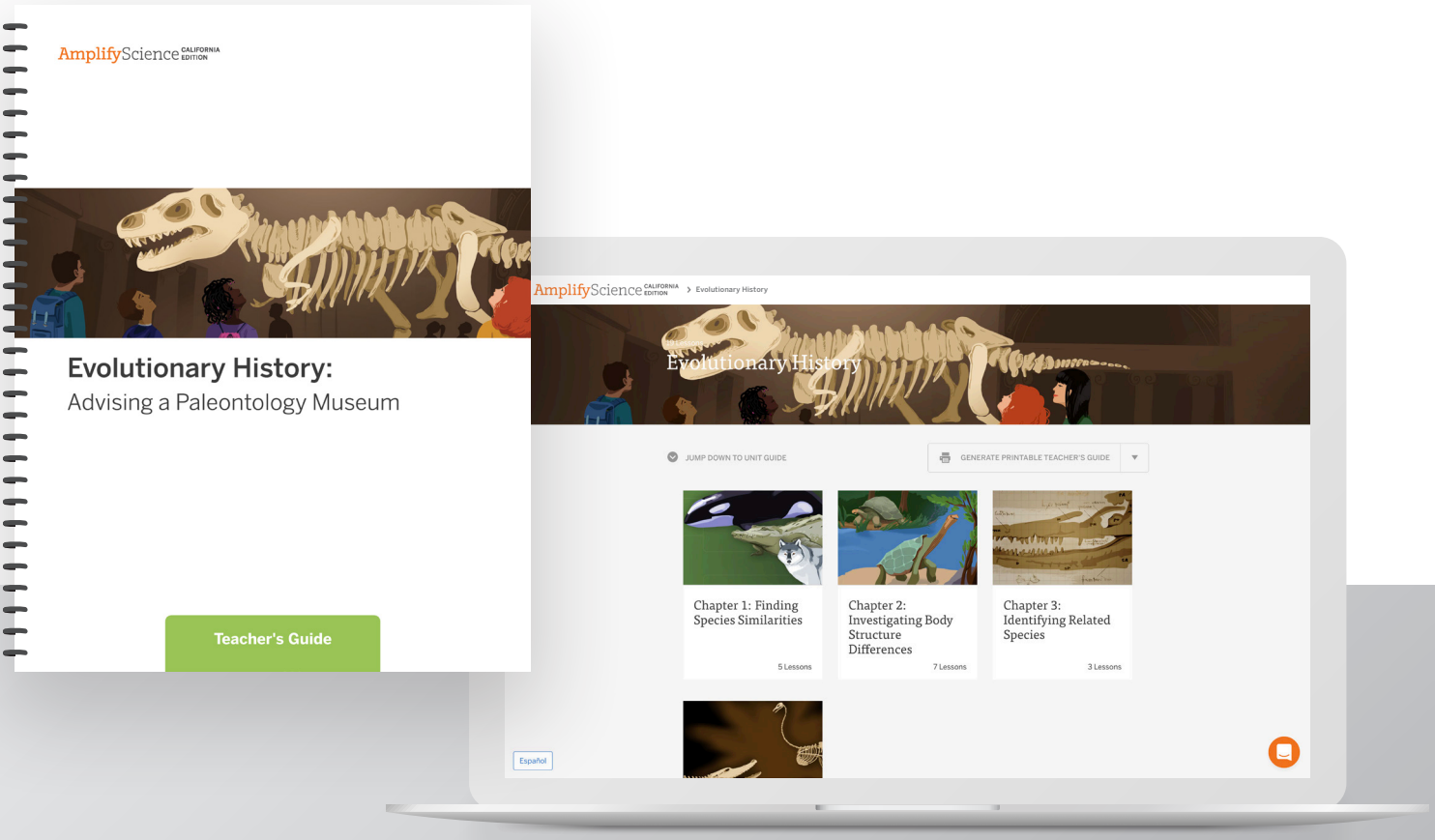
Amplify Science
CALIFORNIA

UNIT GUIDE

Evolutionary History



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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Welcome to Evolutionary History

Evolution is a complex and dynamic topic. Single-celled life formed in the ocean over 3.5 billion years ago. Over time, life diversified (forming algae, sea sponges, jellyfish, and sharks) and moved to land (forming amphibians, reptiles, birds, fungi, and plants). Some land animals eventually evolved characteristics that brought them back into the ocean (e.g., whales). Unlike other programs that simply scratch the surface, Amplify Science California helps students think deeply about the unity and diversity of life and how structural similarities and differences among fossils provide evidence for evolution.

> 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 paleontologists. Their job is to help determine the evolutionary history of a Mystery Fossil at the Natural History Museum. Working together, students determine the best placement for the Mystery Fossil within the museum exhibit, according to what type of organism the evidence shows it to be most closely related to—whales or wolves. The unit concludes with a Science Seminar in which students use what they have learned to analyze evidence and participate in a discussion about the possible relationship between the Tometti fossil, ostriches, and crocodiles.

Unit Type: Core

Student Role: Paleontologists

Phenomenon: A mystery fossil at the Natural History Museum has similarities with both wolves and whales.

Core Concept: Understanding of how anatomical structures are inherited and change over evolutionary time, and how similarities and differences can be used to interpret evolutionary relationships

Target Performance Expectations:

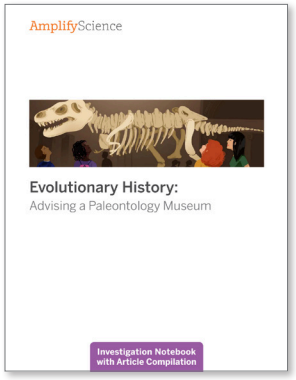
- LS4-1: Fossils
- LS4-2: Comparative Anatomy
- LS4-3: Embryonic Development
- ESS1-4: Strata and Earth Age

Related Performance Expectations:

- LS4-6: Natural Selection

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

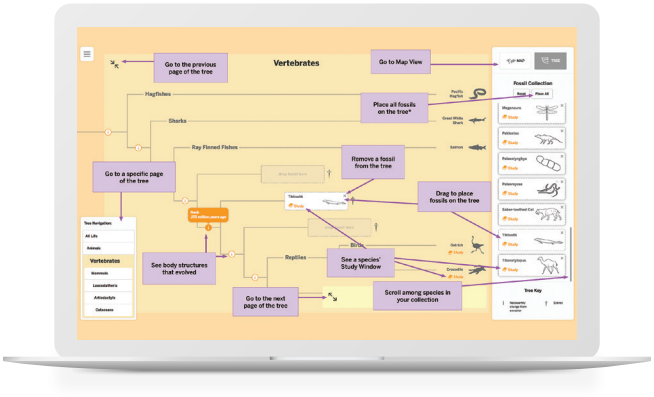
Student Investigation Notebook



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:

Where in the museum does this new fossil belong?

What students figure out:

The Mystery Fossil likely shares a common ancestor with both wolves and whales. A species is a group of the same kind of living thing that can reproduce with each other. Species that look very different can share similar structures. Traits, such as structures, are passed down from parents to offspring. When two species have many similar structures, this is evidence that both species descended from a common ancestor with those structures.

How they figure it out:

- Sorting species using similarities and differences
- Reading an article about related species and common ancestors
- Tracing similar structures back to common ancestors using the Sim
- Analyzing similarities among the Mystery Fossil, wolves, and whales
- Creating a visual model

KEY


CLASS


HANDS-ON


HOMEWORK


MODELING


READING


SIM


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

Welcome to the Natural History Museum

- Warm-Up (5 min)
- Video: Placing the Mystery Fossil in the Museum (5 min)
- Discussing the Student Paleontologist Role (5 min)
- Finding Similarities Between Species (20 min)
- How Paleontologists Make Observations (10 min)
- Homework

Optional Flextension: *Reconstructing Owl Pellet Skeletons*

DAY 3 | LESSON 1.3

"How You Are Like a Blue Whale"

- Warm-Up (10 min)
- Reading "How You Are Like a Blue Whale" (20 min)
- Discussing Annotations (10 min)
- Introducing the Evolutionary History Simulation (5 min)
- Homework

On-the-Fly Assessment

DAY 4 | LESSON 1.4

Interpreting Evolutionary Trees

- Warm-Up (7 min)
- Rereading "How You Are Like a Blue Whale" (18 min)
- Tracing Structures in an Evolutionary Tree (20 min)
- Homework

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Finding Similarities with the Mystery Fossil

- Warm-Up (5 min)
- What Can We Learn from the Baby Mystery Fossil? (10 min)
- Comparing the Mystery Fossil to Whales and Wolves (15 min)
- Predicting Body Structures of a Common Ancestor (15 min)
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

How did wolves, whales, and the Mystery Fossil become so different from their common ancestor population?

What they figure out:

These three species could have been separated into different environments. Populations can become separated in different environments, with different selection pressures. Mutations can introduce different changes to existing structures in each population. Due to natural selection, small changes that are helpful for survival in each population are more likely to get passed down to offspring. Over generations, two populations of the same species can begin to differ more from each other. When the two populations become so different that they no longer reproduce with each other, they become different species.

How they figure it out:

- Reading an article about examples of speciation
- Creating a model of speciation using the Sim
- Exploring evolution and deep time through a card sort activity and using the Sim
- Creating models to show how small changes can add up to larger changes over deep time

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TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 6 | LESSON 2.1

How Body Structures Differ

- Warm-Up (10 min)
- Observing Organisms to Consider Differences (25 min)
- Discussing Differences (10 min)
- Homework

DAY 7 | LESSON 2.2

"Where Do Species Come From?"

- Warm-Up (10 min)
- Reading "Where Do Species Come From?" (25 min)
- Discussing Annotations (10 min)

On-the-Fly Assessment

DAY 8 | LESSON 2.3

Investigating Speciation

- Warm-Up (5 min)
- Rereading "Where Do Species Come From?" (20 min)
- How One Population Becomes Two Species (20 min)
- Homework

On-the-Fly Assessment

Optional Flextension: ***Comparing Modern and Ancient Cephalopods***

DAY 9 | LESSON 2.4

How Differences Build Up Over Time

- Warm-Up (5 min)
- Warm-Up Debrief (10 min)
- Structure Change Card Sort (15 min)
- Evolutionary Time in the Sim (15 min)
- Homework

DAY 10 | LESSON 2.5

Reflecting on Differences in Body Structure

- Warm-Up (5 min)
- Modeling Changes Over Evolutionary Time (15 min)
- Word Relationships (20 min)
- Considering Whale and Wolf Claims (5 min)

On-the-Fly Assessment

DAY 11 | LESSON 2.6

Critical Juncture Assessment

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

Critical Juncture Assessment

DAY 12 | LESSON 2.7

Reviewing Ideas About How Species Change

- Warm-Up (5 min)
- Ostrilope Changes Over Time (20 min)
- Understanding Evolution from Fossils (15 min)
- Reviewing Ideas as a Class (5 min)
- Family Homework Experience (Optional)
- Self-Assessment (Optional)

Self-Assessment

Chapter 3:
The storyline goes deeper

What students investigate:

How can we tell if the Mystery Fossil is more closely related to wolves or to whales?

What they figure out:

Because the Mystery Fossil shares key features that are common to cetaceans and not found in other organisms, the Mystery Fossil is more closely related to whales. Life has been evolving on Earth for over 3 billion years. Small changes introduced by mutations add up to larger changes over geologic time. Populations continue to become separated in different environments, and speciation continues to happen again over geologic time. This makes it possible for descendants of the same common ancestor population to have very different structures.

How they figure it out:

- Investigating evolutionary relationships using a physical model
- Exploring the key common features of whales and wolves using the Sim
- Analyzing evidence about the Mystery Fossil to draw a final conclusion about the Mystery Fossil

KEY


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HANDS-ON


HOMEWORK


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READING


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TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 13 | LESSON 3.1

Exploring Relatedness

- Warm-Up (10 min)
- Modeling Evolutionary Relationships with K'NEX (20 min)
- Modeling Shared Structures in Common Ancestors (15 min)
- Homework

On-the-Fly Assessment

DAY 14 | LESSON 3.2

Determining Species Relatedness

- Warm-Up (5 min)
- Video: How Paleontologists Determine Relatedness (5 min)
- Investigating the Relatedness of Extinct Whales (20 min)
- Word Relationships (15 min)
- Homework

On-the-Fly Assessment

DAY 15 | LESSON 3.3

Placing the Mystery Fossil

- Warm-Up (5 min)
- Considering Similar Structures (15 min)
- Examining Diagnostic Structures (20 min)
- Placing the Mystery Fossil on the Evolutionary Tree (5 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 4:
Application to a new storyline

What students investigate:

The Tometti fossil is based on the Sinosauropteryx fossil found in China. But is it more closely related to ostriches or crocodiles? And what, if any, relationship exists between these three species?

What they 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:

- 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


READING


SIM


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TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 16 | LESSON 4.1

Investigating the Tometti Fossil

- Warm-Up (5 min)
- Introducing the Tometti Fossil Mystery (15 min)
- Sorting Evidence About the Tometti Fossil (20 min)
- Homework

DAY 17 | LESSON 4.2

Considering Evidence from the Museum

- Warm-Up (5 min)
- Examining Evidence (20 min)
- Discussing Evidence and Claims (20 min)

On-the-Fly Assessment

DAY 18 | LESSON 4.3

Science Seminar

- Warm-Up (10 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (20 min)
- Introducing the Homework Assignment (5 min)
- Homework
- Self-Assessment (Optional)

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.

Evolutionary History 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 anatomical structures are inherited and change over evolutionary time, and how similarities and differences can be used to interpret evolutionary relationships.

Progress Build Level 1:

Body structures shared between species are evidence that these two species inherited the shared structures from a common ancestor population.

Progress Build Level 2:

Species that share structures can have differences because they have been in separate environments, and have changed in different ways over time.

Progress Build Level 3:

Because populations separate and begin evolving differences at different points in time, similarities and differences in body structures can be used to interpret evolutionary relationships.

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:

Extended teacher modeling with pairs or small groups (Example from Lesson 2.2)
Extended modeling of Active Reading with a small group of English learners can help them surface their questions and confusions about the text within a supportive environment. Before students read, continue reading the article set introduction with a small group of English learners and model what to do when you don't understand any part of what you've read. Think aloud as you model how to notice a break in your understanding and then reread this section slowly. For example, you might express confusion as you grapple with the definitions of *consumer* and *resource populations*. Think aloud as you focus on the diagram, clarifying the meaning of each of these terms and checking how it goes together with the text. Encourage students to use these strategies as they read and provide time for them to try out the strategies on their own. After reading, you can provide additional time for the class or the smaller group you met with to share and discuss parts of the text they found confusing.

For students needing more support:

Provide more time to work on an activity (Example from Lesson 4.1)
Today's lesson introduces a new species (represented by the Tometti fossil) and considers how the species might be related to others, illustrating this relationship on a new branch of the evolutionary tree. If you feel that some of your students would benefit from receiving additional time to transition and explore the new topic in the Sim or with Tometti Fossil Mystery Evidence Cards: Set 1, you may want to increase the allotted time or provide an opportunity to preview the evidence cards or Sim with students before the lesson.

For students ready for a challenge:

Create a Venn diagram of shared (and not shared) structures (Example from Lesson 1.4)
For students who need more challenge, you may want to ask them to think about the similarities and differences between blue whales and humans. Students can create a Venn diagram (or fill in a blank diagram that you provide) showing structures that both species share, as well as structures that are unique to each.

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.

Evolutionary History 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students obtain information from science texts and analyze and interpret data from digital and physical models as they investigate the body structures of both extinct and living species (structure and function). Students identify similarities and differences, figure out how common body structures are evidence of common ancestry, and how natural selection can lead to changes in body structures and the evolution of new species over time (stability and change).

Chapter Level

Chapter 1: Finding Species Similarities

Students ask questions and make observations about a mystery fossil, use the digital model, and obtain and interpret information from science texts to discover how similar patterns in body structures of organisms are evidence of common ancestry (patterns).

Chapter 2: Investigating Body Structure Differences

Students gather evidence from science texts and a digital model to investigate how different body structures with different functions can be adaptive in different environments (structure and function) and how small changes can accumulate over evolutionary time, resulting in speciation and large differences in body structures between species (stability and change).

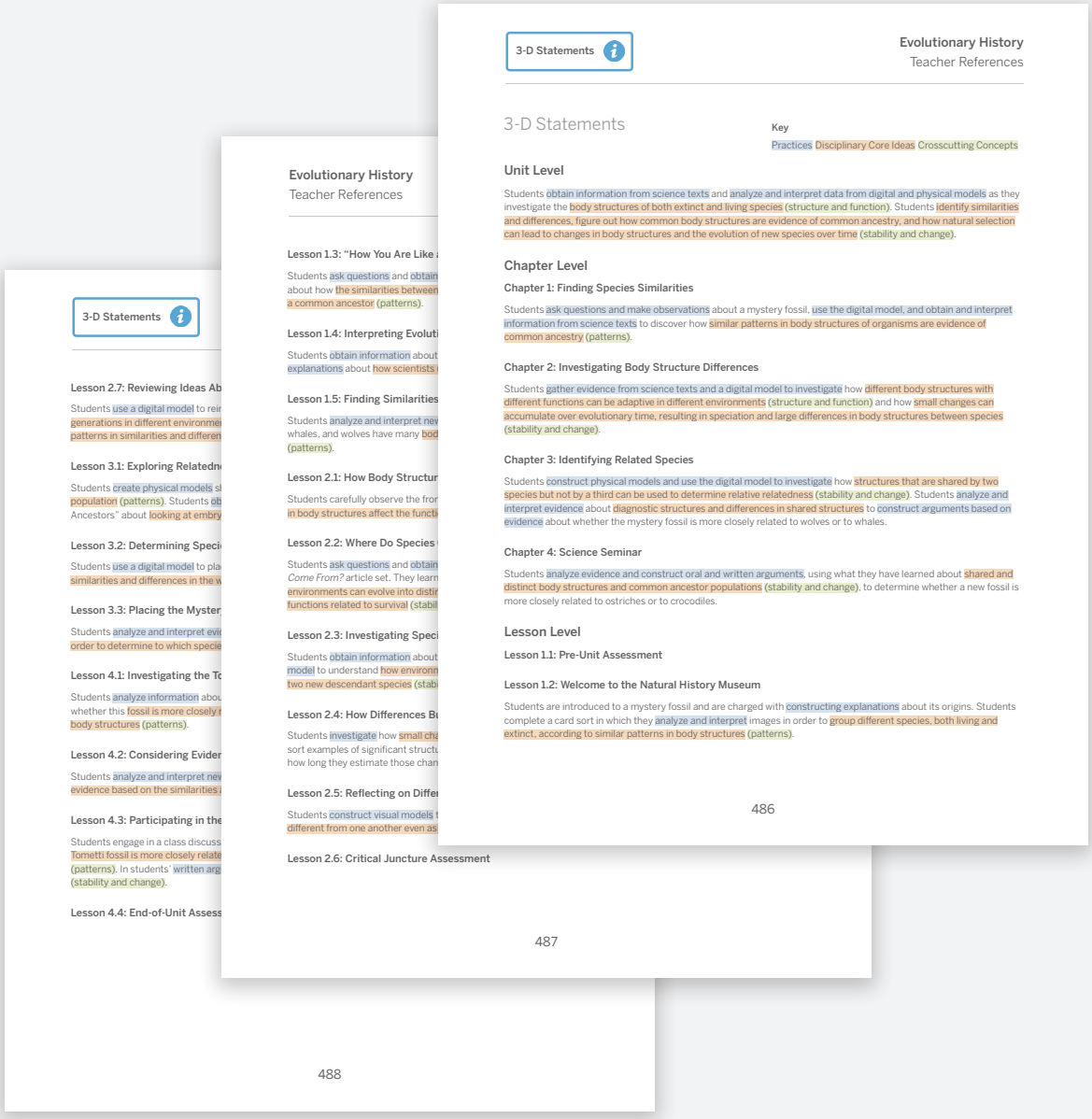
Chapter 3: Identifying Related Species

Students construct physical models and use the digital model to investigate how structures that are shared by two species but not by a third can be used to determine relative relatedness (stability and change). Students analyze and interpret evidence about diagnostic structures and differences in shared structures to construct arguments based on evidence about whether the mystery fossil is more closely related to wolves or to whales.

Chapter 4: Science Seminar

Students analyze evidence and construct oral and written arguments, using what they have learned about shared and distinct body structures and common ancestor populations (stability and change), to determine whether a new fossil is more closely related to ostriches or to crocodiles.

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



Notes

Notes

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

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