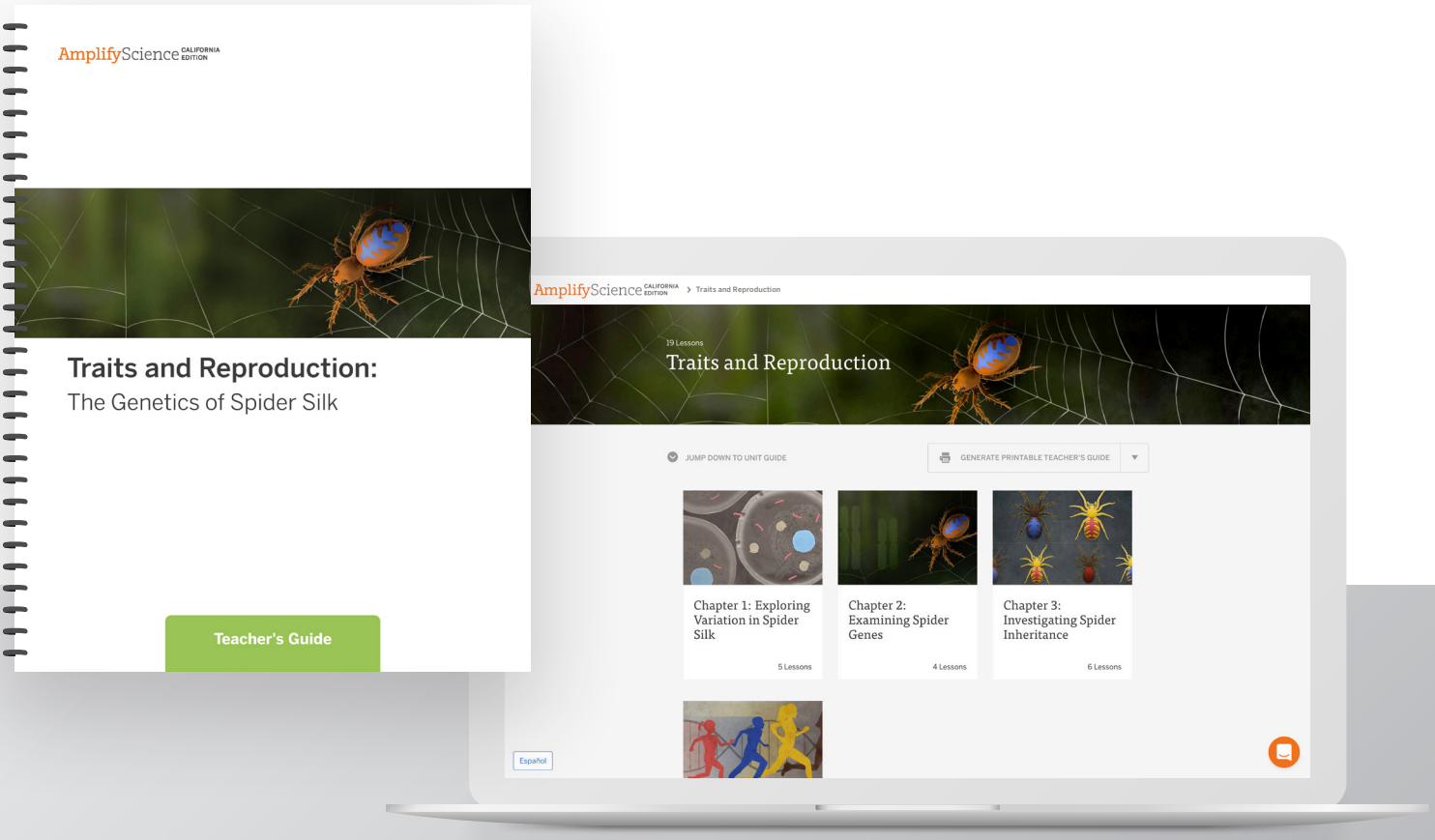
Amplify Science
CALIFORNIA

UNIT GUIDE

Traits and Reproduction



Amplify.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Table of contents

Welcome to Traits and Reproduction

An organism inherits its genes from its parent or parents, but different combinations of genes can lead to striking variation even among closely related organisms. Understanding the role of genes and the process of inheritance has allowed researchers to explain variation in life on Earth, breed plants and animals with new traits, and develop cures for devastating diseases. That's why Amplify Science California gives students opportunities to delve deeply into ideas about genes, proteins, traits, and sexual reproduction. In addition to considering intriguing examples of variations from human contexts (e.g., athletic ability, fraternal and identical twins, and genetic diseases such as hemophilia), student also explore nonhuman contexts, particularly spider silk flexibility, as they construct an understanding of the causes of variation.

> 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 biomedical scientists. Their job is to help a fictional bioengineering firm, Bay Medical Company, breed the right types of spiders in order to harvest silk that can be used for medical applications (e.g., to create artificial tendons). Working together, they are faced with the challenge of explaining how the silk flexibility traits of closely related spiders vary. 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 reasons for a difference in traits among members of a human family.

Unit Type: Core

Student Role: Biomedical Scientists

Phenomenon: Darwin's bark spider offspring have different silk flexibility traits, even though they have the same parents.

Core Concept: Understanding of why traits vary

Target Performance Expectations:

- LS1-2: Cell Parts
- LS1-4: Behaviors and Structures: Reproduction
- LS1-5: Growth
- LS3-2: Sexual vs. Asexual Reproduction

Related Performance Expectations:

- LS1-3: Body Systems
- LS3-1: Gene, Protein, Trait, and Mutations
- LS4-5: Artificial Selection and Genetic Engineering

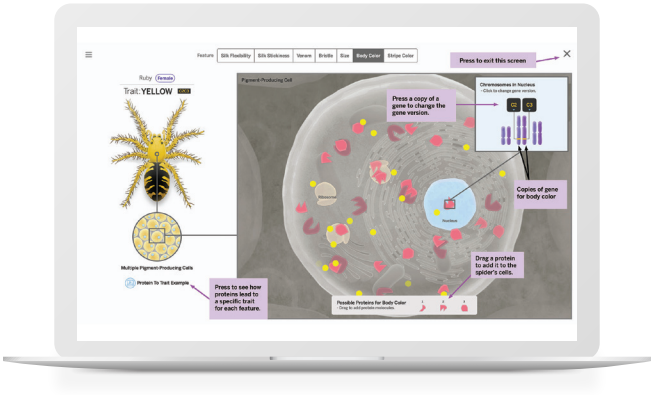
Students figure out the unit phenomenon through the use of a variety of resources.

Student Investigation Notebook

Hands-On Kit

Videos

Simulations



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 do traits for silk flexibility vary within this family of Darwin's bark spiders?

What students figure out:

The spiders in this family must have different proteins for silk flexibility in their cells. Variation in traits can be caused by variation in protein molecules within individuals' cells. Protein molecules' structures affect their function and the way they connect to other molecules. Spider silk is made of proteins, and connections between these molecules affect the silk flexibility.

How they figure it out:

- Exploring traits and proteins and testing the effects of changing protein molecules using the Sim
- Reading an article about different kinds of spiders and how their still traits are related to the protein molecules that make up the silk
- Building physical models of connected protein molecules to make silk with different levels of flexibility

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

Introducing Spider Silk Research

- Warm-Up (5 min)
- Video: Studying Spider Silk (10 min)
- Introducing Darwin's Bark Spiders (10 min)
- Exploring in the Simulation (20 min)
- Homework
- Family Homework Experience

DAY 3 | LESSON 1.3

"Surprising Spider Silk"

- Warm-Up (2 min)
- Playing Spiders in the Lab (3 min)
- Reading "Surprising Spider Silk" (15 min)
- Building Physical Models of Proteins (25 min)

DAY 4 | LESSON 1.4

Observing Proteins and Variation

- Warm-Up (5 min)
- Observing Proteins in the Sim (25 min)
- Modeling Silk Flexibility (15 min)
- Homework

On-the-Fly Assessment

DAY 5 | LESSON 1.5

Investigating Proteins and Traits

- Warm-Up (5 min)
- Revisiting Darwin's Bark Spider Claims (5 min)
- Testing Protein to Trait Predictions (20 min)
- Write and Share: Human Muscle Protein (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 2:
The storyline builds

What students investigate:

Why do Darwin's bark spiders make different proteins for silk flexibility?

What they figure out:

Genes are instructions for proteins; each gene version provides an instruction to make a specific protein molecule. An organism has two copies of a gene for each feature; these can be the same version (homozygous) or different (heterozygous). The spiders in the family have different gene versions for silk flexibility; some are homozygous and some are heterozygous.

How they figure it out:

- Reading an article about the genes and proteins involved in hemophilia
- Investigating genes and their outcomes by making changes to genes and observing the effect on proteins and traits using the Sim
- Constructing a physical model that highlights genes as instructions and introduces mutations
- Creating visual models showing their explanations for how the spider offspring have different traits

KEY

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

DAY 6 | LESSON 2.1

"Hemophilia, Proteins, and Genes"

- Warm-Up (5 min)
- Reading "Hemophilia, Proteins, and Genes" (30 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 7 | LESSON 2.2

Gathering Evidence About Genes

- Warm-Up (5 min)
- Modeling the Role of Genes (25 min)
- Introducing Mutations (15 min)
- Homework

On-the-Fly Assessment

DAY 8 | LESSON 2.3

Investigating Gene Copies

- Warm-Up (2 min)
- Playing Mutations and New Traits (3 min)
- Investigating Gene Copies in the Sim (20 min)
- Rereading "Hemophilia, Proteins, and Genes" (20 min)
- Homework

DAY 9 | LESSON 2.4

Applying Ideas About Genes

- Warm-Up (5 min)
- Modeling Variation in Spider Offspring (20 min)
- Write and Share: ACTN3 Proteins (20 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 3:
The storyline gets more complex

What students investigate:

Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?

What they figure out:

In sexual reproduction, each parent randomly passes on one of its two copies of each gene to its offspring. Each offspring receives two copies of each gene, one from each parent. Each offspring can inherit a different combination of gene versions, so siblings can have different traits from each other and from their parents. This random recombination of genes accounts for the variation in silk flexibility among the spider offspring. Each gene version present in the offspring is also present in the parents, meaning no mutations took place.

How they figure it out:

- Reading an article about identical and fraternal twins to learn how genes are passed on in sexual reproduction
- Investigating how genes are passed on when spiders in the Sim reproduce, and testing the effects of random mutations during reproduction
- Modeling their understanding of how genes were passed on in the Darwin's bark spider family

KEY


CLASS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TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 10 | LESSON 3.1

"Why Are Identical Twins Rare?"

- Warm-Up (5 min)
- Introducing the Chapter 3 Question (10 min)
- Reading "Why Are Identical Twins Rare?" (20 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 11 | LESSON 3.2

Gathering Evidence About Inheritance

- Warm-Up (5 min)
- Rereading "Why Are Identical Twins Rare?" (15 min)
- Gathering Evidence from the Sim (15 min)
- Revisiting the Claim (10 min)
- Homework

Optional Flextension: *Plant Structures for Reproduction*

DAY 12 | LESSON 3.3

Analyzing Variation and Reproduction

- Warm-Up (5 min)
- Testing Predictions About Inheritance (20 min)
- Modeling Venom Inheritance (20 min)
- Homework

On-the-Fly Assessment

DAY 13 | LESSON 3.4

Critical Juncture Assessment

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

Critical Juncture Assessment

DAY 14 | LESSON 3.5

Revisiting Key Concepts

- Warm-Up (5 min)
- Preparing for the Sim Activities (5 min)
- Completing the Sim Activity (15 min)
- Preparing for the Reading Activity (2 min)
- Reading About Diseases (13 min)
- Sharing Ideas (5 min)
- Homework

DAY 15 | LESSON 3.6

Reproduction in Darwin's Bark Spiders

- Warm-Up (5 min)
- Reasoning About Spider Traits (10 min)
- Writing an Argument (15 min)
- Breeding Spiders (15 min)
- Homework
- Self-Assessment (Optional)

Self-Assessment

Chapter 4:
Application to a new context

What students investigate:

Jackie is an elite distance runner while other members of her family are sprinters or not serious runners. Is this due to Jackie's experience, a mutation in Jackie's genes, or just the combination of genes passed on by her parents?

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:

- Analyzing evidence about the family's ACTN3 proteins, levels of ACTN3 proteins in Olympic sprinters and long-distance runners, and family members' experience and training
- 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


STUDENT-TO-STUDENT DISCUSSION


TEACHER


TEACHER-LED DISCUSSION


WARM-UP


WRITING

DAY 16 | LESSON 4.1

Analyzing Evidence

- Warm-Up (5 min)
- Introducing the Science Seminar (10 min)
- Analyzing Evidence (10 min)
- Sorting Evidence (20 min)
- Homework

On-the-Fly Assessment

DAY 17 | LESSON 4.2

Science Seminar

- Warm-Up (5 min)
- Preparing for the Science Seminar (10 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 (8 min)
- Using the Reasoning Tool (15 min)
- Preparing to Write (7 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.

Traits and Reproduction 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 why traits vary.

Progress Build Level 1:

The traits of an organism are determined by the structure of protein molecules and the interactions of those protein molecules in cells.

Progress Build Level 2:

Genes are instructions for producing proteins.

Progress Build Level 3:

Through sexual reproduction, an organism inherits a random combination of gene versions from its parents.

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:

Using visuals to depict claims (Example from Lesson 2.2)
In this lesson, visuals are provided to clarify each claim. These visuals can be especially supportive for English learners. Consider projecting and referring back to the visuals that correspond with the claims more often than this lesson explicitly suggests, especially as students evaluate the claims at the end of the hands-on activity.

For students needing more support:

Whole-class instead of partner work (Example from Lesson 1.5)
You may want to support students by completing part of the Simulation activity as a whole group. For example, you might work together as a class to complete the observations and tests for Ruby and Otis. We recommend students complete the second part of the observations and tests for Greg more independently, however, as students' discussions about silk flexibility provide an opportunity for the On-the-Fly Assessment of ideas about structure and function.

For students ready for a challenge:

Create offspring with traits not found in either parent (Example from Lesson 3.2)
Students who need more challenge can benefit from going further with the content by using the Sim to investigate how sexual reproduction can result in an offspring that has a trait not present in either parent. The following scenario is an example in which an offspring has a trait not present in either of its parents:

- Two parents with a heterozygous gene combination can produce an offspring with a homozygous gene combination that results in the expression of a recessive trait. For example, Leo (F1F2) and Ruby (F1F2) both have heterozygous gene combinations for silk flexibility and have the trait for medium silk flexibility. They can produce offspring that are homozygous and have either low (F1F1) or high (F2F2) silk flexibility.

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.

Traits and Reproduction 3-D Coverage

SEPs
Science and Engineering Practices

DCIs
Disciplinary Core Ideas

CCCs
Cross-Cutting Concepts

Unit Level

Students create physical and visual models, read articles, and observe genetics in action in a digital model as they investigate the structure and function of protein molecules. They construct explanations about the cause-and-effect relationships of gene combinations and inheritance, proteins, and traits (cause and effect), and they engage in argumentation about how the traits of silk flexibility of closely related spiders can vary.

Chapter Level

Chapter 1: Exploring Variation in Spider Silk

Students begin their investigation of variation in traits of spider silk—obtaining evidence from science texts and digital and physical models—in order to construct visual models and explanations of how the structures at the molecular scale of protein molecules produced in cells function to cause different traits at the macroscale (structure and function; scale, proportion, and quantity).

Chapter 2: Examining Spider Genes

Students investigate by using a physical model, a digital model and by gathering evidence from science texts in order to explain what causes the Darwin's bark spider offspring to make different silk proteins (cause and effect). Students construct visual models to show how gene variations affect the protein types that are made, which results in different traits such as variation in spider silk flexibility (structure and function).

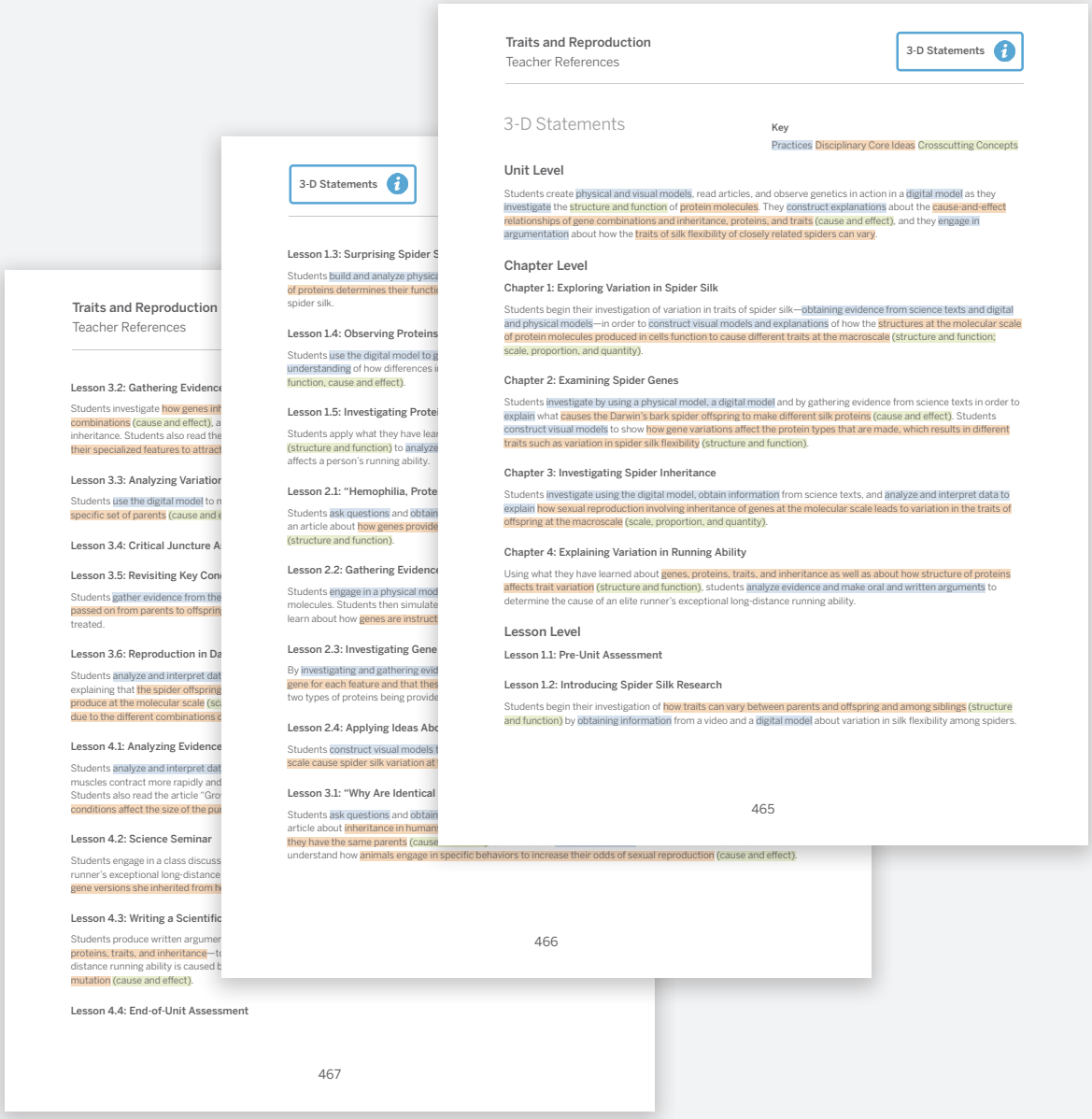
Chapter 3: Investigating Spider Inheritance

Students investigate using the digital model, obtain information from science texts, and analyze and interpret data to explain how sexual reproduction involving inheritance of genes at the molecular scale leads to variation in the traits of offspring at the macroscale (scale, proportion, and quantity).

Chapter 4: Explaining Variation in Running Ability

Using what they have learned about genes, proteins, traits, and inheritance as well as about how structure of proteins affects trait variation (structure and function), students analyze evidence and make oral and written arguments to determine the cause of an elite runner's exceptional long-distance running ability.

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



Traits and Reproduction
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

Lesson 1.2: Introducing Spider Silk Research

Students begin their investigation of how traits can vary between parents and offspring and among siblings (structure and function) by obtaining information from a video and a digital model about variation in silk flexibility among spiders.

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3-D Statements

Lesson 1.3: Surprising Spider S

Students build and analyze physica
of proteins determines their functi
spider silk.

Lesson 1.4: Observing Proteins

Students use the digital model to g
understanding of how differences i
function, cause and effect).

Lesson 1.5: Investigating Protei

Students apply what they have lea
(structure and function) to analyze
affects a person's running ability.

Lesson 2.1: "Hemophilia, Prote

Students ask questions and obtain
an article about how genes provide
(structure and function).

Lesson 2.2: Gathering Evidenc

Students engage in a physical mod
molecules. Students then simulate
learn about how genes are instruct

Lesson 2.3: Investigating Gene

By investigating and gathering evid
gene for each feature and that thes
two types of proteins being provide

Lesson 2.4: Applying Ideas Abo

Students construct visual models t
scale cause spider silk variation at

Lesson 3.1: "Why Are Identical

Students ask questions and obtain
article about inheritance in humans
they have the same parents (cause
understand how animals engage in specific behaviors to increase their odds of sexual reproduction (cause and effect).

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Traits and Reproduction
Teacher References

Lesson 3.2: Gathering Evidence

Students investigate how genes inf
combinations (cause and effect), a
inheritance. Students also read the
their specialized features to attract

Lesson 3.3: Analyzing Variation

Students use the digital model to n
specific set of parents (cause and e

Lesson 3.4: Critical Juncture A

Lesson 3.5: Revisiting Key Con

Students gather evidence from the
passed on from parents to offsprin
treated.

Lesson 3.6: Reproduction in Da

Students analyze and interpret dat
explaining that the spider offspring
produce at the molecular scale (sc
due to the different combinations o

Lesson 4.1: Analyzing Evidence

Students analyze and interpret dat
muscles contract more rapidly and
Students also read the article "Gro
conditions affect the size of the pu

Lesson 4.2: Science Seminar

Students engage in a class discuss
runner's exceptional long-distance
gene versions she inherited from h

Lesson 4.3: Writing a Scientific

Students produce written argumen
proteins, traits, and inheritance—t
distance running ability is caused b
mutation (cause and effect).

Lesson 4.4: End-of-Unit Assessment

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Notes

Notes

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

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