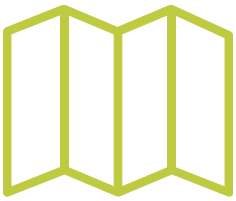


Lesson 3.1

“Why Are Identical Twins Rare?”

Lesson Overview

In this lesson, students are introduced to the Chapter 3 Question: *Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?* To answer this question, students read, annotate, and discuss the article "Why Are Identical Twins Rare?" This article introduces ideas about inheritance in humans, which students then use to explain the variation in silk flexibility among Darwin's bark spiders. At the end of the lesson, students share their annotations, identifying and discussing challenging or unfamiliar words from the reading. The purpose of this lesson is to help students build their understanding of how offspring inherit genes during the process of sexual reproduction.

Anchor Phenomenon: Darwin's bark spider offspring have different silk flexibility traits, even though they have the same parents.
Investigative Phenomenon: Sibling spiders have different gene combinations.
Everyday Phenomenon: Identical twins look the same.

Students learn:

- Each reproductive cell only has one copy of each gene.
- Identical twins have identical genes.

Lesson at a Glance

ACTIVITY

1 **Warm-Up** (5 min)
Students revisit the question of how two sisters could have different traits, activating prior knowledge about genes and inheritance.

WARM-UP

2 **Introducing the Chapter 3 Question** (10 min)
Students are given new data about the spider offsprings' gene versions, which helps introduce them to the Chapter 3 question.

STUDENT-TO-STUDENT DISCUSSION

3 **Reading: "Why Are Identical Twins Rare?"** (20 min)
Students read and annotate an article about how identical and fraternal twins inherit their genes. They focus on identifying challenging or unfamiliar words or phrases during reading. The teacher uses this opportunity as an On-the-Fly Assessment of students' abilities to engage with scientific texts and identify challenging words.

READING

4 **Discussing Annotations** (10 min)
Through a discussion of the reading, students address potential confusions about genetic inheritance. Students also discuss challenging words they identified during reading. Students' annotations provide an opportunity for an On-the-Fly Assessment of annotation skills, reading comprehension, and content understanding.

STUDENT-TO-STUDENT DISCUSSION

5 **Homework**
Students explore the outcomes of sexual reproduction by mating spiders in the Simulation and observing the offspring. Students also have an opportunity to read an article about current research on adaptive traits in animals.

HOMEWORK

Materials & Preparation

Materials

For the Classroom Wall

- Chapter 3 Question: *Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?*
- vocabulary: *inherit*, *sexual reproduction*

For the Class

- masking tape*
- Annotation Tracker*

For Each Student

- 1 copy of the Modeling Tool: Variation in Spider Offspring Model student sheet (from Lesson 2.4)
- optional: printed copy of the "Why Are Identical Twins Rare?" article*
- optional: printed copy of the "Invasion of the Periodical Cicada" article*
- optional: *Traits and Reproduction* Investigation Notebook, pages 63–68*

Digital Tools

- *Traits and Reproduction* Simulation
- "Why Are Identical Twins Rare?" article in the Amplify Library
- "Invasion of the Periodical Cicada" article in the Amplify Library

*teacher provided

Preparation

Before the Day of the Lesson

1. **Gather the following materials for the classroom wall:**

VOCABULARY

- feature
- function
- gene
- gene version
- heterozygous
- homozygous
- inherit
- mutation
- protein molecule
- sexual reprodution
- structure
- trait
- variation

UNPLUGGED?

Digital Devices Not Required

This lesson can be taught without devices. If students do not have devices, print copies of the article and Investigation Notebook pages for this lesson. (A PDF file can be found in the Digital Resources.)

If students do not have access to Amplify Science at home, adjust your schedule to make time for students to complete the Sim

- Chapter 3 Question: *Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?*
- vocabulary: *inherit*, *sexual reproduction*

2. **Print a copy of the Annotation Tracker for each class.** A PDF of the Annotation Tracker is in Digital Resources. Read the Annotation Tracker Instructions and view the Example Annotation Trackers in Digital Resources for more information.
3. **Preview "Why Are Identical Twins Rare?" article in the Amplify Library.** This article is also located in Digital Resources. Familiarizing yourself with the entire article will help you support students as they read and help you facilitate a conversation about the article at the end of class.
4. **Prepare to model Active Reading.** You can use the think-aloud script that is provided in Activity 3, or you can modify the script, modeling in a way that makes the most sense for your students. In the modeling script provided, we chose to focus on identifying challenging words or phrases.
5. **Familiarize yourself with the Simulation activity in this lesson.**
6. **Gather and prepare to distribute completed Modeling Tool: Variation in Spider Offspring Model student sheets from Lesson 2.4.** If needed for reference, you can distribute these completed sheets to students in Activity 2.
7. **Preview the "Invasion of the Periodical Cicada" article in the Amplify Library.** Locate and read the article in Digital Resources or the Amplify Library. Students will read the article for homework.
8. **Prepare for On-the-Fly Assessments.** There are two On-the-Fly Assessments included in this lesson. Activity 3 provides an opportunity to informally assess students' ability to engage with scientific texts and identify challenging words. In Activity 4, students' annotations provide an additional opportunity for informal assessment. Press the hummingbird icon and then select the ON-THE-FLY ASSESSMENT for details about what to look for and how you can use the information to maximize learning by all students.

activity in class. Alternatively, you can project the Sim at the beginning of the next lesson and use the homework instructions as a guide to investigate inheritance among spiders. You can also provide them with copies of pages 67–68 from the Investigation Notebook as well as printed copies of the "Invasion of the Periodical Cicada" article.

DIGITAL RESOURCES

Why Are Identical Twins Rare?

Printable Article: "Why Are Identical Twins Rare?"

Invasion of the Periodical Cicadas

Printable article: "Invasion of the Periodical Cicada"

Annotation Tracker Instructions

Annotation Tracker

Annotation Summary Sheet

Example Annotation Tracker and Summary Sheet

Traits and Reproduction Investigation Notebook, pages 63–68

Traits and Reproduction Glossary

Traits and Reproduction Multi-Language Glossary

Immediately Before the Lesson

1. **Post the following items on the wall:**
    - Chapter 3 Question: *Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?*
    - vocabulary: *inherit*, *sexual reproduction*
2. **Write the Investigation Question on the board:** "How do organisms get their genes?"
3. **Have on hand the following materials:**
    - Annotation Trackers
    - optional: digital devices
    - optional: printed copies of the "Why Are Identical Twins Rare?" article
    - optional: printed copies of the "Invasion of the Periodical Cicada" article
    - optional: *Traits and Reproduction* Investigation Notebook, pages 63–68

Between-Class Prep

1. **Locate a new Annotation Tracker for your next class.**
2. **Erase digital annotations.** Erase the digital annotations you made in the article in the Amplify Library before modeling for the next class.

At the End of the Day

1. **Print a copy of the Annotation Summary Sheet for each class.** A PDF of the Annotation Summary Sheet is in Digital Resources.
    - **Use the Annotation Trackers to review students' submitted articles.** If you have time to review students' submitted articles and annotations, continue to fill out each Annotation Tracker to identify questions, alternate conceptions, and exemplary annotations.
    - **Use the Annotation Summary Sheets to analyze students' annotations.** The Annotation Summary Sheet is intended to help you identify trends in student thinking, recurring questions students have about the text, and other issues that you might want to address. Use your Annotation Trackers to fill out the Annotation Summary Sheets.
    - **Collect exemplary annotations and recurring alternate conceptions to share with the class.** Exemplary annotations and recurring alternate conceptions can be shared in the subsequent lesson. Identify examples of student annotations that are thought provoking, exemplify the Active Reading approach, and/or target key science ideas.

Differentiation

Embedded Supports for Diverse Learners

Multimodal learning. Active Reading is one component of a multimodal approach to learning in which students encounter concepts through reading, talking, investigating, and writing. This multimodal approach has been shown to be a highly effective strategy for learning content.

Extended teacher modeling. The Active Reading approach includes many supports embedded in each lesson. This approach to reading is based on curiosity, inquiry, and the awareness that students learn more from reading when they are active participants and when they are provided with opportunities to share their own thinking about the text. Thus, the modeling provided in this lesson is a scaffold because it sets the tone for an approach to reading that is positive, inquiry-based, and supports all types of readers. Model the types of thinking you hope that your students will adopt while reading. The suggestions in the instructional guide for what to attend to during modeling are intended to provide a useful guide, but we also encourage you to use this think-aloud technique to model any other aspects of sophisticated reading and deeper thinking that you think will benefit your class.

Student-to-student discussion for making sense of the reading. The partner sharing and discussion following the independent reading provides students with an opportunity to deepen their understanding through a purposeful conversation with their peers. Through discussion, students have a chance to both share and expand on their understanding.

Potential Challenges in This Lesson

Reading-focused. This lesson requires that students actively engage with the text, both through reading and through annotation. You may recommend that some students work in pairs as they read aloud, annotating their own articles as they read. Alternatively, you could ask students to form small groups and work together during the first read. Finally, you might support students by having them read with you or another adult.

Specific Differentiation Strategies for English Learners

More practice identifying challenging words or phrases during reading. Just as they did in Lesson 2.1, in Activity 3 students practice identifying and asking questions about challenging words and phrases from the reading. Focusing on unfamiliar words, or familiar words used in unfamiliar ways or new contexts, can help students build their vocabulary and bolster their reading comprehension. However, this practice can be especially supportive for English learners. This is because idioms and words with multiple meanings often pose unique comprehension challenges for students whose first language is not English. Taking time to demonstrate how even familiar words can take on new meanings, depending on their context, can help cultivate an environment in which English learners feel comfortable asking questions about words that might be perceived as familiar or easy. Setting this precedent helps students learn not to pass over words that they might have heard before and to pay careful attention to how words are used in context.

Analyzing diagrams in science texts. Analyzing diagrams in scientific texts can benefit English learners in a number of ways. In the "Why Are Identical Twins Rare?" article, the diagrams represent models of sexual reproduction that are discussed in the text. For English learners who need additional reading support, a focus on the diagrams can provide an entry point into the scientific ideas found in the text and into class discussions around the text. The diagrams may offer more ways for English learners to use the content of the article in questions or to make observations before they read. The images and diagrams can help students grasp ideas while they read, solidifying their understanding. Learning to analyze diagrams is a sophisticated skill that can allow struggling readers to contribute to a text-based discussion in which they may otherwise have had difficulty participating.

Specific Differentiation Strategies for Students Who Need More Support

Creating a positive environment by setting attainable goals. Establishing expectations for Active Reading and building enthusiasm and excitement around this practice might take time. You might find that many students disengage during independent reading time. These students might feel overwhelmed by the length of the articles or the cognitive load involved in having to read an entire article and record questions and connections about it. For this reason, students might resist reading because they feel that they cannot be successful. Or, students might make a strong effort to read and annotate but run out of time before they are able to finish the first few paragraphs of the article. It is important that students who struggle or who are intimidated by reading have a strategy for feeling successful as they read, even if they do not finish the entire text. Assure them that the goal is to think of at least one question they have about the article as they annotate. They can focus on a single paragraph or a visual representation and do not need to read the entire article during class.

Specific Differentiation Strategies For Students Who Need More Challenge

Asking deeper questions and making broader connections. Students who need more challenge should be encouraged to push themselves to ask deeper questions and make broader connections while they read. Active Reading is a very sophisticated way to read, and many advanced learners who haven't used this practice before are surprised and pleased to see how much more they get out of reading when they take the time to slow down and interact with the text in this way. You can also ask students who need more challenge to write down the three most important things they learned from the text after reading or to write down what ideas and questions they have about identical twins and gene inheritance that weren't addressed in this text.

Standards

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students ask questions and obtain and evaluate information as they actively read "Why Are Identical Twins Rare?," an article about inheritance in humans and what can cause offspring to have different gene combinations even though they have the same parents (cause and effect). Students also obtain information from an article about cicadas to understand how animals engage in specific behaviors to increase their odds of sexual reproduction (cause and effect).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 1:** Asking Questions and Defining Problems
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **LS1.A: Structure and Function**:
  - Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- **LS1.B: Growth and Development of Organisms**:
  - Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)
- **LS1.B: Growth and Development of Organisms**:
  - Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
- **LS3.A: Inheritance of Traits**:
  - Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)

- **LS3.A: Inheritance of Traits**:
  - Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)
- **LS3.B: Variation of Traits**:
  - In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)

NGSS Crosscutting Concepts

- Structure and Function
- Cause and Effect

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.
- **CCSS.ELA-LITERACY.RST.6-8.4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics
- **CCSS.ELA-LITERACY.WHST.6-8.9:** Draw evidence from informational texts to support analysis, reflection, and research
- **CCSS.ELA-LITERACY.CCRA.SL.1:** Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- **CCSS.ELA-LITERACY.CCRA.SL.4:** Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience
- **CCSS.ELA-LITERACY.CCRA.L.4:** Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized references materials, as appropriate

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP5:** Use appropriate tools strategically.

1 WARM-UP
Warm-Up

Warm-Up

5 MIN

Students record their ideas about how two sisters could end up with different genes, resulting in different proteins and traits.

Instructional Guide

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 64 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

Possible Responses

How could these sisters have ended up with different genes, leading to their different proteins and traits? Explain your ideas below.
This prompt is intended to elicit students' initial ideas about inheritance. Answers will vary.

2 STUDENT-TO-STUDENT DISCUSSION
Introducing the Chapter 3 Question

Introducing the Chapter 3 Question

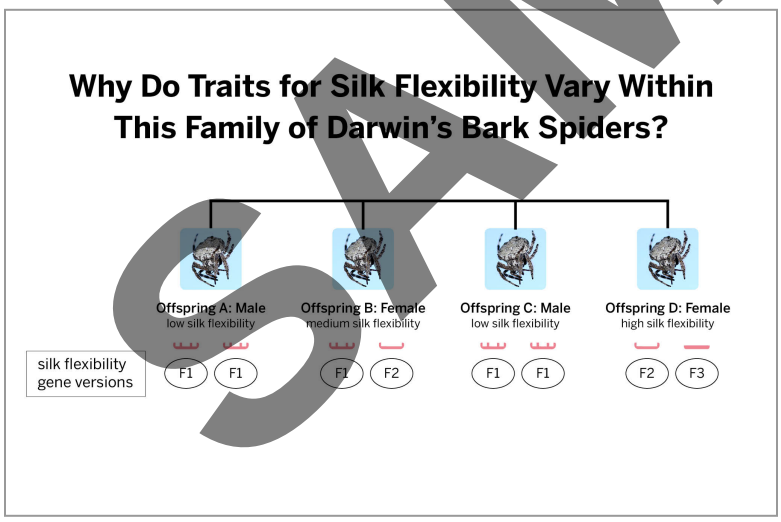
10 MIN

The teacher shares new evidence, reviews the claims, and introduces the Chapter 3 Question.

Instructional Guide

1. Project Why Do Traits for Silk Flexibility Vary Within This Family of Darwin's Bark Spiders?

- **Remind students of researchers' interest in spiders with medium silk flexibility.**



Remember, we are trying to help Bay Medical Company determine how to breed spiders that will produce offspring with the trait for medium silk flexibility. The lab needs silk with medium flexibility to use for medical purposes. In order to help the researchers, we need to determine why the Darwin's bark spiders' offspring have different traits for silk flexibility.

- **Discuss new data about the offsprings' gene versions.** Explain that the researchers at Bay Medical Company have sent new data about the offsprings' gene versions. Remind students that they created a model in the previous lesson that predicted these gene versions.
- **Ask students to recall their models from Lesson 2.4, comparing the data to their predictions.** Conclude the discussion by highlighting that the spiders have different combinations of gene versions. Note: If needed, you can distribute students' completed Modeling Tool: Variation in Spider Offspring Model student sheets from Lesson 2.4 or have students turn to page 53 in the notebook, so they can reference the model.

2. Point out the Chapter 3 Question on the classroom wall: *Why do the Darwin's bark spider offspring have different gene combinations even though they have the same parents?* Read (or ask a student to read) the question aloud.

We have learned that the spiders' traits vary because they have different proteins in their cells. We also know that *genes are instructions for proteins*. However, we still don't know why the Darwin's bark spider offspring have different gene combinations even though they have the same parents.

3. Project Darwin's Bark Spider Claims (revised). Point out that the terms *copies of genes* and *gene versions* have been added to claims 2 and 3, respectively, to reflect what students have learned so far.

Darwin's Bark Spider Claims

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

Claim 1: The offspring have **mutations** that affect their traits.

Claim 2: The offsprings' traits depend on **which parent the offspring received more copies of genes from.**

Claim 3: The offspring received **different combinations of gene versions from their parents.**

4. Prompt partners to discuss the claims. Collapse the instructional guide and project the student screen, or have students turn to page 65 in their Investigation Notebooks. Ask students to consider which claim or claims they find most convincing at this point. Also, ask students to brainstorm ideas about what else they need to know to support one of these claims.

5. Ask volunteers to share their ideas with the class. Highlight student responses that request more information about the spider parents' genes and proteins.

Teacher Support

Instructional Suggestion

Classroom Management: Discussing Sexual Reproduction
This lesson transitions into content related to sexual reproduction. This topic can be disruptive in a middle school classroom. You may wish to discuss expectations for student behavior while these topics are being introduced.

Instructional Suggestion

Going Further: The Effect of the F3 Gene Version
F3 is a nonfunctional protein, which means that the gene version instructs for a protein that does not connect to form spider silk. Nonfunctional proteins are mentioned but not emphasized in this unit. Students began to investigate this in Lesson 1.3, when they modeled the three different protein molecules and observed that some molecule models did not connect to form spider silk. In using the Sim, students may have noticed that F3F3 combinations of gene versions result in no spider silk. Although students can successfully learn the key concepts in the unit without developing an understanding of nonfunctional proteins, you might want to take time to discuss this concept. Understanding nonfunctional proteins will also help students realize why the F1F2 gene combination produces the trait for medium silk flexibility for spider offspring B. In Lesson 2.4, students may have incorrectly identified F2F2 or F1F3 as offspring B's gene combination. In fact, the F2F2 gene combination would have produced high silk flexibility while the F1F3 gene combination would have produced low silk flexibility.

Reading: "Why Are Identical Twins Rare?"

20 MIN

Students read and annotate "Why Are Identical Twins Rare?"

Instructional Guide

1. Introduce the Investigation Question. Point out the Investigation Question on the board and read (or ask a student to read) it aloud. Remind students that answering this question will help them explain variation in silk flexibility among the spider family.

2. Project and introduce the "Why Are Identical Twins Rare?" article. You can also access this article from Digital Resources, or project the printed article using a document camera.

3. Model Active Reading. As you model, emphasize the importance of identifying challenging words or phrases. As you model, you can use the following script, or you can model your own thinking.

- **Begin by reading the title of the article aloud.**
- **Ask a question about the word *rare* in the title.**

The title states that identical twins are *rare*. I know the word rare means not often, but I wonder if the word has a different meaning in this context. What are parents' chances of having identical twins? I am going to highlight this word and record my thinking about it.

- **Highlight "rare."** Press ADD NOTE and write "What are the chances of having identical twins?"
- **Read the first paragraph aloud.**
- **Ask a question about the word *instruct*.**

When I hear the word *instruct*, I think of a person teaching or providing directions. The way the word *instruct* is used here seems less familiar to me. I am going to read the sentence one more time to see if I can gain a better understanding of what the word means.

- **Read the fifth sentence aloud again.** (The sentence begins, "Genes instruct for proteins, . . .")

I think this sentence is an abbreviated way to summarize the idea that genes provide instructions for building proteins.

- **Highlight "instruct."** Press ADD NOTE and write "Genes provide instructions for building proteins."
- **Continue to make annotations.** If useful, add notes about vocabulary, questions, or connections.

4. Remind students how to identify a challenging word or phrase.

Remember to identify challenging words or phrases as you read. As a reminder, a challenging word or phrase can be something that is completely unfamiliar, such as a word or phrase that you have never seen before. Alternatively, it can be a word that you have seen or heard of before, but you are not sure exactly what it means.

Lastly, a challenging word can be one that you are familiar with but where it is used in a different context. The word might have a new meaning other than the one you are familiar with.

Emphasize that students will select different words as challenging or unfamiliar. There are no right answers.

5. Review Active Reading Guidelines. Remind students that these guidelines are posted in the classroom.

6. Instruct students to open "Why Are Identical Twins Rare?" Students can open the article using the link on their screens or from Digital Resources, or you can distribute a printed copy of the article to each student.

7. Prompt students to read and annotate. Circulate as students read, using the Annotation Tracker to record annotations that you would like to invite students to share during the class discussion.

8. On-the-Fly Assessment: Progress with Identifying Challenging Words and Phrases. For further suggestions on how to support students as they annotate, press the hummingbird icon and select ON-THE-FLY ASSESSMENT 8.

Embedded Formative Assessment

ON-THE-FLY ASSESSMENT 8: Progress with Identifying Challenging Words and Phrases

Look for: This reading activity is an opportunity to check students' progress identifying challenging or unfamiliar words or phrases, a process modeled in Lesson 2.1. As with all reading lessons, students should feel free to annotate in unique ways that are helpful to their individual learning and personal style. Look for students to be actively engaged in the reading and annotation process. Students may make a wide range of annotations that reflect their varying levels of science understanding. This variation is fine. You can review annotations, gauging students' attention to new or unfamiliar vocabulary, by asking yourself the following questions: Do students seem to be strategically highlighting challenging or unfamiliar words as they read? Are students taking time to think critically about what the word or phrase might mean in this context? Are they adding annotations that reflect what they already know, initial ideas, or questions they have about the words and phrases they highlight?

Now what? This reading experience is intended to give students the space to practice Active Reading strategies, including identifying unfamiliar or challenging words or phrases. However, some students may need support in developing this type of word awareness as they read. Consider periodically sharing words that multiple students have identified as problematic or unfamiliar. Provide positive, encouraging feedback about these choices. For example, you might note how a word that students identified as familiar in other contexts is used in an unfamiliar or interesting way in this article. You can also offer general prompts to support deeper engagement by pointing out specific words or phrases and asking students to record their ideas about what they mean. You might also notice that while some students need encouragement to identify a few words or phrases, other students might begin to quickly highlight a large number of words without stopping to look for clues about what the words or phrases might mean or to record their initial ideas. If this is the case, you can invite these students to record annotations each time they highlight a word or phrase, challenging them to think deeply and critically about what the word or phrase might mean in this context.

Teacher Support

Background

Science Note: About Twins

Twins may be fraternal or identical. Fraternal twins are as genetically similar as all other pairs of siblings. The same process of gamete creation and fertilization takes place for fraternal twins as for siblings who are not twins. The only difference between siblings and fraternal twins is that the two offspring for fraternal twins develop at the same time in the mother's womb. Identical twins are created by a different process. For identical twins, fertilization happens only once. A gamete from the father fertilizes a gamete from the mother to form a cell. This single cell then copies its chromosomes and splits, forming two identical cells—the first cells of identical twins. The cells of these twins inherit the same chromosomes with the same combinations of genes because they were produced from the same two gametes. As they have the same genes, identical twins will have virtually identical genetic traits.

Rationale

Pedagogical Goals: Why Twins?

We found that students are naturally curious about identical and fraternal twins, making this an accessible entry point to understanding gene inheritance. This natural engagement makes the topic a well-suited introduction to exploring variation in traits among closely related organisms, which is a focus of the *Traits and Reproduction* unit. Offering students opportunities to apply their understanding of genes, proteins, and traits to a human example serves as a reminder that the concepts they are learning about spiders are also true for humans.

Discussing Annotations

10 MIN

Students discuss their annotations from the "Why Are Identical Twins Rare?" article.

Instructional Guide

1. Project and review Discussing Annotations. Explain that students will review their annotations, choose a question or connection that is interesting to them and that they want to share with a partner, and edit the annotation by pressing EDIT and writing "#share." Remind students to focus on unfamiliar words or phrases.

Discussing Annotations

#share	Carefully choose an interesting annotation (comment, question, connection, vocabulary word) you'd like to share with your partner and add #share to this annotation.
#discussed	Add #discussed to your annotation if you feel that you and your partner have resolved a question OR if your discussion gave you a deeper understanding about something in the article.
#present	Add #present to your annotation to mark any unresolved questions or ideas you would like to present to the class.

2. Prompt partners to discuss annotations. Circulate as partners discuss, using the Annotation Tracker and listening for questions and connections that you would like to share during class discussion. Ask students to change the tags in their shared annotations to "#discussed" if they feel that their partner discussions gave them a deeper understanding of their annotations or if they answered their tagged questions.

3. Prompt partners to prepare for class discussion. Ask them to choose an interesting or unanswered question they would like to share. Explain that these can be the same annotations they shared with their partners if the questions are still unresolved. Ask students to tag the annotations they would like to share with the class by pressing EDIT and writing "#present."

4. Facilitate a brief class discussion about annotations. Invite students to share their tagged questions and connections. Encourage students to respond to one another and to look back at the article to answer their peers' questions.

5. Focus on the strategy of identifying unfamiliar or challenging words or phrases. If you noticed a good example of a word or phrase identified by one or more students, ask for a student to share this example. Help the class reflect on how identifying these phrases supports them in a deeper understanding of the science text.

6. Highlight exemplary or noteworthy annotations. Refer to your Annotation Tracker and invite students with annotations that you noted to share them with the class. Provide specific, positive feedback as students share, noting when annotations show evidence of Active Reading. Examples might include annotations that make a connection to science ideas, annotations that use vocabulary from the unit, or instances in which students were able to answer their own questions.

If using devices, ask students to press NEXT.

7. Introduce the vocabulary words *sexual reproduction* and *inherit*. Collapse the instructional guide and project the student screen. Read (or ask a student to read) the definitions aloud.

When something is inherited, it is passed down to a family's offspring from their parents. The article we read today explained how organisms inherit their genes through sexual reproduction. In an everyday sense, the word *inherit* does not only refer to genes; it is also used to describe the process of obtaining objects or possessions.

Ask students to press NEXT or to turn to page 66 in the Investigation Notebook.

8. Prompt students to review their annotations on their digital devices and submit their annotated articles. On each student's screen, the "Why Are Identical Twins Rare?" article and the annotations that each student made in the Amplify Library should be visible. Students should answer the reflection question on the screen or on page 66 in their Investigation Notebooks. Students using devices should then submit their articles and reflection question responses by pressing HAND IN.

9. On-the-Fly Assessment: Insight from Student Annotations. For further suggestions on how to review students' annotations, press the hummingbird icon and then select ON-THE-FLY ASSESSMENT 9.

10. Point out the homework assignment to students (Activity 5 or pages 67–68 in the Investigation Notebook). If students do not have access to Amplify Science at home, provide them with copies of pages 67–68 from the Investigation Notebook as well as printed copies of the "Invasion of the Periodical Cicada" article, and adjust your schedule to make time for students to complete the Sim activity in class. Alternatively, you can project the Sim at the beginning of the next lesson and use the homework instructions as a guide to investigate inheritance among spiders. Project the Sim and introduce homework. Explain that students will mate spiders and observe their offspring. They will also read an article about cicadas. If time permits, quickly model the Sim activity for students.

- Select a female spider. Drag her on top of a male spider so that the spiders reproduce.
- Press CREATE REPRODUCTIVE CELLS.

- Once the cells have been produced, press RANDOMLY FERTILIZE to observe fertilization.
- Compare the offspring with each other and with their parents. Pay careful attention to traits and combinations of gene versions. How are family members similar? How are they different?
- Pick one feature to observe closely (except for body size) and answer the questions included on the student screen.

Embedded Formative Assessment

ON-THE-FLY ASSESSMENT 9: Insight from Student Annotations

Look for: Review submitted student annotations after class. You can use these annotations to assess students' annotation skills, reading comprehension, and content understanding. Use the Annotation Tracker and Annotation Tracker Instructions for guidance.

Now what? See the Annotation Tracker Instructions for suggestions on how to further support students.

Teacher Support

Rationale

Science Reading: Value of Sharing Student Annotations
Much of students' success with Active Reading comes from teacher modeling and encouragement to engage with the approach, expanding on skills and techniques. Offering examples of interesting student annotations is one way to support Active Reading as a classroom norm. Simultaneously, sharing annotations provides students with new ways to think about the activity itself.

Instructional Suggestion

Student Thinking: Traits and the Environment
The examples about identical and fraternal twins may bring up questions about the influence of environment on traits. While it is fine to spend some time thinking about this idea, do not spend too much time on it. Chapter 3 focuses on sexual reproduction. Explain that students will discuss environment to a further degree in Chapter 4.

Background

Science Note: About Sexual Reproduction
Sexual reproduction occurs when two parent organisms create an offspring that includes genes from both of the parents. Each parent creates gamete cells, or special cells for reproduction, that are haploid rather than diploid. In other words, each gamete has only one of each pair of chromosomes and so only one copy of each gene. For all animals and all land plants, the gamete from a female parent is called an egg, and the gamete from a male parent is called a sperm. Gametes are produced through a process called meiosis. (This process is not described in this unit.) In meiosis, the

chromosomes in a diploid parent cell are duplicated. During this duplication, crossing-over occurs. (Each pair of chromosomes is rearranged, exchanging analogous sections.) This process allows for even more variation within the possible gene combinations that can be passed on to each gamete.

An offspring inherits one gene copy from its male parent, and one from its female parent. A common misconception is that an offspring may have more copies of the gene for a feature from one parent than the other. This likely arises when there is confusion between the words *traits* and *genes*. An offspring's traits may be shared with one parent more than the other if the gene received from that parent is dominant over the gene received from the other. This can happen even though one gene copy came from each parent.

Homework

Students mate spiders in the Simulation to learn more about inheritance and read an article about adaptive traits in cicadas.

Instructional Guide

1. If needed, make additional time to explain homework. If students do not have access to Amplify Science at home, adjust your schedule to make time for students to complete the Sim activity in class. Alternatively, you can project the Sim at the beginning of the next lesson and use the homework instructions as a guide to investigate inheritance among spiders. You can also provide them with copies of pages 67–68 from the Investigation Notebook as well as printed copies of the "Invasion of the Periodical Cicada" article.

2. If needed, make additional time to explain the second part of the homework. If students do not have access to Amplify Science at home, provide them with copies of pages 67–68 from the Investigation Notebook as well as printed copies of the "Invasion of the Periodical Cicada" article.

Teacher Support

Rationale

Pedagogical Goals: Additional Reading About Cicadas
Students read an article for homework that presents information about current research on adaptive traits in organisms. In this engaging article, students are introduced to the periodical cicada, which emerges from the ground in 13- to 17-year cycles to mate. These organisms come above ground all at once to find a mate, reproduce, and die.

Assessment

Assessment Opportunity: Student Understanding of How Animal Behaviors Affect the Odds of Reproduction
This activity can be used to assess whether students understand that the cicadas' behavior contributes to the probability of their successful survival and reproduction. Look for whether students can describe that the cicadas' emergence all at once increases their chances of finding a mate and also protects them from predators. If students do not seem to understand these ideas, consider spending some time in class going over the article as a group. Ask students to work in pairs to read paragraphs 4 and 5 and find two reasons that emerging all at once helps the cicadas to survive and reproduce. Then ask some students to explain these ideas to the class. If students struggle with these ideas, draw two large boxes on the board. In the first box, draw about 10 dots that represent cicadas, spaced far apart,

and a circle that represents a bird. In the second box, draw about 50 dots and a circle. Ask students if it is more likely that cicadas will be able to find each other in the first box or the second box [the second box]. Tell them that the bird will eat 5 cicadas, and cross out 5 of the dots in each box. Point out that now half of the cicadas in the first box are gone, but most of the cicadas in the second box survived. Ask if it is more likely that each cicada will be eaten in the first box or the second box [the first one]. Help students construct the understanding that when there are more cicadas all at once, they are each more likely to find each other and mate, and they are also each less likely to be eaten by a predator.

Possible Responses

What students should do and notice in the Sim:
In this activity, students mate spiders. They will notice that each parent contributes only one copy of each gene to each reproductive cell. Once the cells are fertilized, therefore, the offspring will inherit only one gene copy from each parent. Depending on the combination of gene versions, the offspring may have the same or different combinations as their parents. One possible response is shown below.

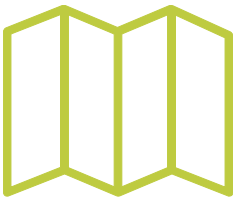
I mated **Zora** with **Greg** and focused on **body color**.

How did the offsprings' traits compare to their parents' traits?
All of the offspring had the same trait as their mother and were brown in color.

Greg had homozygous gene copies (C2C2) for the feature of body color. Zora also had homozygous gene copies (C1C1). All the offspring had heterozygous gene copies (C1C2).

What are two reasons why arriving above ground all at once increases the cicadas' chances of surviving and reproducing?
Coming above ground all at once increases the cicadas' chances of surviving and reproducing because they are all looking for mates in the same place at the same time so they are more likely to find a mate, and they are also more protected from predators.

Why do scientists think it is helpful to the periodical cicadas to emerge every 13 to 17 years?
Scientists think the cicadas emerge every 13 to 17 years because they can avoid predators with shorter and more regular life cycles.



Lesson 3.2

Gathering Evidence About Inheritance

Lesson Overview

Students continue to gather information about the Investigation Question: *How do organisms get their genes?* First, students return to an excerpt from the article "Why Are Identical Twins Rare?" to build on their understanding of how organisms inherit genes from both parents during sexual reproduction. To deepen their understanding of gene inheritance, students then use the Sim to investigate claim 2: The offsprings' traits depend on which parent the offspring inherited more gene copies from. (Note: The word *inherited* has been added to claim 2 and 3 in this lesson.) The Sim allows students to observe how the combinations of gene versions are separated during the formation of reproductive cells (egg and sperm) and are passed on when the reproductive cells from each parent come together during fertilization. The purpose of this lesson is for students to develop a robust understanding of how genes are inherited through sexual reproduction. Students will also counter the common misconception that organisms can get more of their genes from one parent.

Anchor Phenomenon: Darwin's bark spider offspring have different silk flexibility traits, even though they have the same parents.
Investigative Phenomenon: Sibling spiders have different gene combinations.

Students learn:

- Organisms inherit their genes through sexual reproduction.
- Each parent randomly passes on one of its two copies of each gene to its offspring. Each offspring, therefore, receives two copies of each gene, one from each parent.

Lesson at a Glance

ACTIVITY		
1	**Warm-Up** (5 min) Students prepare to investigate claim 2, sharing their current thinking.	WARM-UP
2	**Second Read of Twins Article** (15 min) Students return to an excerpt from the "Why Are Identical Twins Rare?" article. They build on their understanding of how organisms inherit their genes during sexual reproduction.	READING
3	**Gathering Evidence from the Sim** (15 min) Students use the Sim to debunk the idea that offspring can inherit more genes from one parent over the other.	SIM
4	**Revisiting the Claim** (10 min) Students reflect on evidence from the Sim and the article, eliminating claim 2 of the Darwin's bark spider claims.	TEACHER-LED DISCUSSION
5	**Homework** Students read about a unique plant adaptation.	HOMEWORK

Materials & Preparation

Materials

For the Classroom Wall

- key concept: *Organisms inherit their genes through sexual reproduction.*
- key concept: *Each parent randomly passes on one of its two copies of each gene to its offspring. Each offspring, therefore, receives two copies of each gene, one from each parent.*

For the Class

- masking tape*

For Each Student

- optional: printed copy of the Why Are Identical Twins Rare?" article*
- optional: printed copy of the "Why the Corpse Flower Smells So Bad" article*
- optional: *Traits and Reproduction* Investigation Notebook, pages 69–74*

Digital Tools

- *Traits and Reproduction* Simulation
- "Why Are Identical Twins Rare?" article in the Amplify Library
- "Why the Corpse Flower Smells So Bad" article in the Amplify Library

*teacher provided

VOCABULARY

- claim
- evidence
- feature
- gene
- gene version
- heterozygous
- homozygous
- inherit
- protein molecule
- sexual reproduction
- trait
- variation

UNPLUGGED?

Digital Devices Optional (with Modifications)

Students can complete most of the lesson without the use of digital devices. If students do not have devices, project the Simulation during Activity 2 and have students observe the projected Sim. Print copies of the Investigation Notebook pages for this lesson. (A PDF can be found in Digital Resources.)

Preparation

Before the Day of the Lesson

1. **Choose student annotations to share.** Use your completed Annotation Trackers and Annotation Summary Sheets from Lesson 3.1 to identify one or two exemplary annotations to share. You may also wish to identify any alternate conceptions, revealed in students' annotations, that you would like to discuss.
2. **Familiarize yourself with the Simulation activity in this lesson.**
3. **Familiarize yourself with the Offspring Data Table found in Digital Resources.** In Activity 3, you will use the Sim to mate two spiders, recording data about the offsprings' gene versions.
4. **Preview the "Why the Corpse Flower Smells So Bad" article in the Amplify Library.** Locate and read the article in Digital Resources or the Amplify Library. Students will read the article for homework.
5. **Review the optional Hands-On Flextension: Plant Structures for Reproduction and decide if you will teach it after this lesson.** The Flextension lesson guide and Flextension copymaster are available in Digital Resources.

Immediately Before the Lesson

1. **Draw the Offspring Data Table on the board.** The data table should be large enough for all students to see the information you record during Activity 3.
2. **Make sure the Investigation Question is still written on the board:** "How do organisms get their genes?"
3. **Have on hand the following materials:**
   - digital devices
   - optional: printed copy of the Why Are Identical Twins Rare?" article
   - optional: printed copies of the "Why the Corpse Flower Smells So Bad" article
   - optional: *Traits and Reproduction* Investigation Notebook, pages 69–74

If students do not have access to Amplify Science at home, provide them with copies of page 74 from the Investigation Notebook as well as printed copies of the "Why the Corpse Flower Smells So Bad" article.

DIGITAL RESOURCES

Why Are Identical Twins Rare?

Printable Article: "Why Are Identical Twins Rare?"

Why the Corpse Flower Smells So Bad

Printable article: "Why the Corpse Flower Smells So Bad"

Offspring Data Table

Traits and Reproduction Investigation Notebook, pages 69–74

Hands-On Flextension lesson guide: Plant Structures for Reproduction

Hands-On Flextension copymaster: Plant Structures for Reproduction

Traits and Reproduction Glossary

Traits and Reproduction Multi-Language Glossary

Between Class Prep

1. **Gather the next class's annotations.** If you chose annotations to share that were specific to the next class, make sure you have these annotations on hand.

At the End of the Day

1. **Gather and post the following items on the wall:**
    - key concept: *Organisms inherit their genes through sexual reproduction.*
    - key concept: *Each parent randomly passes on one of its two copies of each gene to its offspring. Each offspring, therefore, receives two copies of each gene, one from each parent.*

Differentiation

Embedded Supports for Diverse Learners

Explicit attention to a common misconception. This lesson intentionally confronts the common misconception that organisms can inherit more genes from one parent over the other. Addressing this misconception helps students build a scientifically accurate understanding of how genes are inherited during sexual reproduction.

Multiple modalities with the same topic. Students consider gene inheritance by completing a Simulation activity, rereading excerpts from an article, and participating in partner and whole-class discussions. Engaging with the same ideas in many ways provides students multiple opportunities to make sense of complex concepts and provides access points for different types of learners.

Potential Challenges in This Lesson

Visual interpretation. Students will be reading, analyzing, and discussing several complex diagrams from the Simulation and the "Why Are Identical Twins Rare?" article. If any of your students have difficulty with visual representations, you may want to take more time to work with these students during the activities of this lesson where these visuals are central to learning. In addition, students who have trouble distinguishing different colors may need more support in interpreting the chromosomes.

Specific Differentiation Strategies for English Learners

Additional sentence starters. English learners may benefit from the support of sentence starters in order to participate more fully in the partner discussions. These sentence starters might be especially helpful in Activity 3, when students are making observations in the Sim, and in Activity 4, when students are discussing how the evidence they gathered relates to claim 2. You could write the following prompts on the board or distribute them on paper to students you think would benefit from having them.

- I notice . . .

- I observe . . .
- I think that this is ___, and my evidence is ____.

Students summarize. Detailed instructions (such as the instructions for using the Simulation and for analyzing the data) and extended class discussions (such as the discussion about the claim) may be challenging for some English learners to follow. Having a few students summarize the main points of instructions or a discussion in their own words can help. If many English learners in the class have the same primary language, you could invite a student to summarize in that language.

Specific Differentiation Strategies for Students Who Need More Support

More time. As this lesson requires students to synthesize complex information across several different learning modalities, you may want to give students more time for processing each modality by spreading the lesson across two days. You can then provide time for students to write about what they learned after each activity and discuss their conclusions after independent writing. Building in more time to process and reflect can help some students better understand what they are being asked to do and can also offer time for you to check in more closely with these students.

Specific Differentiation Strategies for Students Who Need More Challenge

Create offspring with traits not found in either parent. 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 are two scenarios 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.
- Alternatively, two parents with homozygous gene combinations that are different from each other can produce an offspring with a heterozygous gene combination, resulting in a trait that is a combination of the two parents' traits. For example, Anne (R1R1) has a homozygous gene combination for the bristle feature and has dense bristles. Greg (R2R2) has a homozygous gene combination for the bristle feature and has no bristles. Both spiders can produce offspring that are heterozygous (R1R2) and have sparse bristles.

Standards

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students investigate how genes inherited during sexual reproduction cause offspring to have different gene combinations (cause and effect), and they use the digital model to gather evidence to support or refute a claim about inheritance. Students also read the article "Why the Corpse Flower Smells So Bad" to investigate how plants can use their specialized features to attract insects who assist them in reproduction (structure and function).

Next Generation Science Standards (NGSS)

NGSS Practices

- **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

NGSS Disciplinary Core Ideas

- **LS1.A: Structure and Function**:
  - Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)
- **LS1.B: Growth and Development of Organisms**:
  - Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)
- **LS1.B: Growth and Development of Organisms**:
  - Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)

- **LS3.A: Inheritance of Traits**:
  - Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- **LS3.A: Inheritance of Traits**:
  - Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)
- **LS3.B: Variation of Traits**:
  - In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)

NGSS Crosscutting Concepts

- Cause and Effect
- Structure and Function

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.
- **CCSS.ELA-LITERACY.RST.6-8.2:** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
- **CCSS.ELA-LITERACY.WHST.6-8.9:** Draw evidence from informational texts to support analysis, reflection, and research.

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP3:** Construct viable arguments and critique the reasoning of others.
- **CCSS.MATH.PRACTICE.MP5:** Use appropriate tools strategically.
- **CCSS.MATH.PRACTICE.MP7:** Look for and make use of structure.

1 WARM-UP
Warm-Up

Warm-Up

5 MIN

Students explain why they either agree or disagree with claim 2.

Instructional Guide

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 70 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

2. Read Claim 2 and direct students to indicate whether they agree or disagree with the claim. Students can select their choices on their devices or by raising their hands. If students are raising their hands, tally up the votes for agreement or disagreement with the claim and record the tally on the board.

Possible Responses

Answers will vary.

2 READING
Second Read of Twins Article

Second Read of Twins Article

15 MIN

Students gather evidence from the "Why Are Identical Twins Rare?" article to answer to the Investigation Question.

Instructional Guide

1. Make a connection to the Investigation Question: *How do organisms get their genes?* Remind students that the Investigation Question is written on the board.

We know that an organism's genes provide instructions for making proteins, which determine an organism's traits. In the previous lesson, we read an article about twins, which helped us understand how organisms get their genes.

2. Prompt partners to share their ideas in response to the Investigation Question. Collapse the instructional guide and project the student screen.

3. Ask students to share ideas with the class.

How do you think organisms get their genes? Highlight responses that refer to organisms inheriting their genes through sexual reproduction.

4. Project and introduce the key concept: *Organisms inherit their genes through sexual reproduction.* Read (or ask a student to read) the key concept aloud. Summarize the class discussion, connecting student comments to this concept.

Key Concept

Organisms inherit their genes through sexual reproduction.

Ask students to press NEXT or turn to page 71 in the Investigation Notebook.

5. Discuss the purpose of reading the article a second time.

Understanding how organisms inherit their genes through sexual reproduction can be challenging. Today, you will reread a part of the "Why Are Identical Twins Rare?" article with the intention of further examining the Investigation Question.

Reading a text multiple times is something that sophisticated readers do in order to better understand difficult ideas.

6. Review exemplary annotations from Lesson 3.1. From the analysis you did with the Annotation Tracker, share exemplary annotations that demonstrate thoughtfulness or creativity. You may also want to review and discuss any alternate conceptions that were revealed in students' annotations.

7. Prompt students to reread the article excerpt and review the diagram. Collapse the instructional guide and project the student screen or have students turn to page 71 in the Investigation Notebook. Remind students to highlight important sentences or phrases as they reread. Circulate and offer support as needed.

8. Ask students to share evidence from the article. Ask students to share important information from the article, encouraging them to explain how the information helps them answer the Investigation Question. If students do not bring it up on their own, highlight the following points:

- Both parents create reproductive cells.

- Reproductive cells have half of the genetic material of a normal cell. In other words, reproductive cells only contain one copy of each gene.
- During fertilization, the reproductive cells combine to form a new offspring. The new offspring will have two copies of each gene, one from each parent.

3 SIM
Gathering Evidence from the Sim

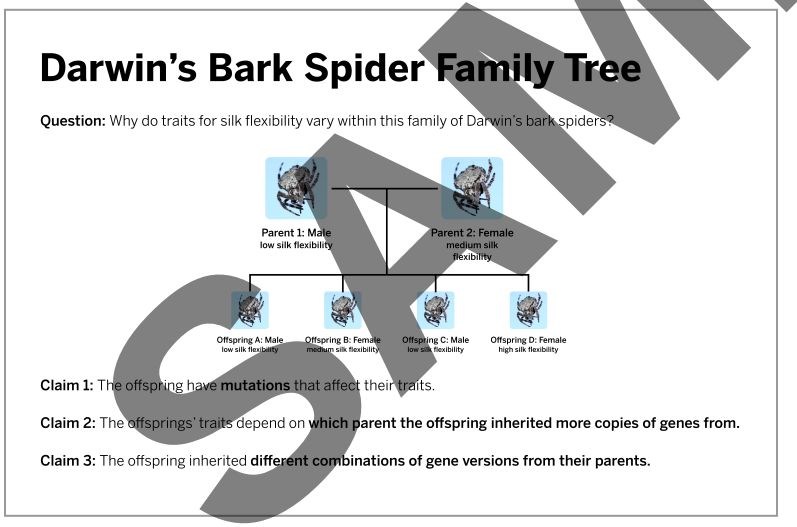
Gathering Evidence from the Sim

15 MIN

Students use the Sim to determine that both parents pass on one gene copy for each feature to their offspring.

Instructional Guide

1. Project Darwin's Bark Spider Family Tree (with claims). Review the claims with students.



Remember that we are investigating how organisms get their genes, so we can explain why traits for silk flexibility vary within the spider family. Now that we know a little more about how organisms inherit their genes, we will take a closer look at claim 2.

- Read (or ask a student to read) claim 2 aloud.
- Show how this claim applies to humans.

People often think that an offspring looks more like one parent because that offspring received more genes from one parent over the other. Is this true? Can organisms inherit a greater number of genes from one parent? You will use the Sim to see if you can either support or refute this claim.

2. Project the Sim. Introduce the activity, informing students that they will use the Sim to examine how offspring inherit genes through the process of reproduction. Students can open the Sim activity via their digital devices, following along as you model. If students are using their Investigation Notebooks, have them turn to pages 72–73.

- First, you will model the activity for students, focusing on evidence about genes and traits for the bristle feature.
- Students will then complete the same steps for the body color feature.

3. Examine Otis's and Anne's genes and traits.

In a moment, we will use the Sim to mate Otis and Anne. We will then make observations about their offspring. As we are trying to determine if offspring can inherit more genes from one of their parents over the other, we need to carefully observe both Otis's and Anne's genes.

- Select the bristle feature.
- Prompt students to compare Otis's and Anne's traits and gene versions for the bristle feature.
- Record Otis's and Anne's traits and gene versions underneath the Offspring Data Table written on the board. Otis's and Anne's traits and gene versions are also included on the student card.
- Write: "Otis: Sparse (R1R2)" and "Anne: Dense (R1R1)."

4. Model creating reproductive cells in the Sim.

- Select the spider named Anne. Drag the spider on top of Otis and hold until a dotted circle appears. Let go, allowing the two spiders to mate.
- Press CREATE REPRODUCTIVE CELLS. Point out that the genes are color coded to indicate which is the sperm cell and which is the egg. (The male reproductive cell is green, and the female cell is purple.)
- Focusing on Otis, point out that each sperm cell has only one copy of Otis's genes. Some cells received a copy of the R2 gene version, and some received a copy of the R1 gene version.
- Press RANDOMLY FERTILIZE. Ask students to observe the offspring, noting which gene versions and traits the offspring inherited.

5. Demonstrate how to record information about the offsprings' bristle traits. Record the information for each offspring by completing the Offspring Data Table. Note: In the Sim, the order of the offsprings' gene combinations shows which parent they inherited the gene from. In this scenario, for example, the first gene comes from Otis and the second from Anne. You may want to point this out to students.

Ask students to press NEXT or to turn to page 73 in the Investigation Notebook.

6. Prompt pairs to gather more evidence in the Sim. Collapse the instructional guide and project the student screen, or have students turn to page 73 in their Investigation Notebooks. Explain that students will breed Otis with Anne again, this time focusing on body color. If partners are sharing one device, have one student drive the Sim while the other records data in the data table. Circulate and offer support as needed.

7. Project Discussion Questions. When most students have completed their data tables, ask them to discuss the projected questions with their partner.

Discussion Questions

With your partner, discuss these questions about the evidence you gathered in the Sim.

1. Are the offsprings' traits the same as or different from the parents' traits?
2. Do any of the offspring have a gene version that is not present in either parent?
3. For each offspring, where do the copies of each gene come from?

8. Prompt students to share ideas in response to the discussion questions. Use student responses to show that each offspring received one gene copy from Otis and one from Anne.

Teacher Support

Instructional Suggestion

Student Thinking: Surfacing Common Alternate Conceptions
In order to help students connect the spider content to their own lives, and to reveal existing ideas and misconceptions, you might start this activity by asking students who they think they look like in their biological family. Remind students that genes determine the proteins that influence our traits. Then, ask students how they think they inherited their genes and traits. Point out that sometimes people look like both parents. In other cases, people may think they do not look like either parent and instead resemble a grandparent. Remember to be respectful of adopted students or students who do not know who their birth parents are.

Rationale

Pedagogical Goals: Addressing Confusion About the Inheritance of Traits Versus the Inheritance of Genes
While an offspring may share a trait with just one parent, every offspring receives one copy of each gene from each parent. Even if a girl has hair just like her father's, she still has an equal number of genes that provide instructions for hair color: one from her mother, and one from her father. These Sim activities help students address this concept.

Instructional Suggestion

Going Further: Comparing Different Results
If students are following along on their own devices, they may find that the offspring they get from mating Otis with Anne are not the same as the teacher's. You may want to ask students to compare trials and then discuss why the results are different. (The fertilization and reproduction process is random.)

Instructional Suggestion

Promoting Deeper Thinking: Extended Discussion of Resemblance Among Parents and Children
The purpose of investigating claim 2 is to provide students with an opportunity to evaluate and reject the common misconception that a person looks more like one of their parents because they inherited more genes from that parent. Students might readily accept the general idea that offspring receive one copy of each gene from each parent. However, they might be reluctant to let go of the misconception about the number of genes an offspring receives, especially when pressed to explain why some children look very similar to either their mother or their father. If you think your students might benefit from having more time to apply their findings about claim 2 to humans, consider making time for this during the lesson.

Possible Responses

What students should do and notice in the Sim:
Students watch as the teacher models in the Sim. They observe both Otis's and Anne's traits as well as their offsprings' traits for the bristle feature. Students will notice that each offspring received one copy of a gene from each parent. As a result, the offspring have different gene combinations and traits (either sparse or dense bristles).

What students should do and notice:
Students will observe Otis's and Anne's gene versions and traits. They will then mate the two spiders, recording the gene versions and traits of their offspring. Students should observe that some offspring have the C1C3 gene combination and are brown while other offspring have the C3C3 gene combination and are colorless.

1 2 3 **4** TEACHER-LED DISCUSSION **Revisiting the Claim** 5

Revisiting the Claim

10 MIN

By reviewing the evidence gathered in the Sim and article, the class eliminates claim 2 and discusses a key concept.

Instructional Guide

1. Discuss the poll results from the Warm-Up. Project the results, using the Graph icon or direct students' attention to the tally on the board from the beginning of class, and think about whether or not their ideas about claim 2 have changed. You can ask the class to raise their hands (or put thumbs up, down, or to the side) to signify whether they still agree or disagree with claim 2 or if they are unsure.

2. Prompt partners to discuss the evidence related to claim 2. Point out that students gathered evidence from both the Sim and the "Why Are Identical Twins Rare?" excerpt. Prompt partners to discuss claim 2 with this evidence in mind.

3. Facilitate a class discussion. Ask volunteers to share evidence that relates to claim 2.

4. Guide students in eliminating claim 2. If students have not already eliminated claim 2, highlight evidence that refutes this claim. You can build on students' ideas or use evidence from the list below.

- The "Why Are Identical Twins Rare?" article stated that each offspring inherits two copies of each gene, one from each parent.
- The article stated many possible gene combinations can be passed on, resulting in variation.
- In the Sim, one gene version from each parent was present in either the sperm or egg cell. This created the combinations of gene versions seen in the offspring.

5. Project and introduce the key concept. Read (or ask a student to read) the key concept aloud. Explain that this statement captures the main ideas from this lesson.

Key Concept

Each parent randomly passes on one of its two copies of each gene to its offspring. Each offspring, therefore, receives two copies of each gene, one from each parent.

Through sexual reproduction, an offspring inherits two copies of each gene, one from each parent. These genes are instructions for making protein molecules, which interact to determine the offspring's trait.

6. Point out the homework assignment to students (Activity 5 or page 74 in the Investigation Notebook). If students do not have access to Amplify Science at home, provide them with copies of page 74 from the Investigation Notebook as well as printed copies of the "Why the Corpse Flower Smells So Bad" article. Explain that students will read about a unique organism called the corpse flower.

Teacher Support

Instructional Suggestion

Argumentation: Using Sentence Starters in Discussion
If students need more support for partner and class discussions about how the evidence either supports or refutes claim 2, refer to the Argumentation Sentence Starters on the scientific argumentation wall.

5 HOMEWORK
Homework

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Students read about a unique plant adaptation.

Instructional Guide

1. If needed, make additional time to explain the homework. If students do not have access to Amplify Science at home, provide them with copies of page 74 from the Investigation Notebook as well as printed copies of the "Why the Corpse Flower Smells So Bad" article.

Teacher Support

Rationale

Pedagogical Goals: Additional Reading About the Corpse Flower
Students read an article for homework that introduces the concept of how adaptations help a plant reproduce and therefore help pass along its genetic material. In this engaging article, students are introduced to the corpse flower, a unique organism that smells like rotting meat when it flowers. Students learn that this smell helps the corpse flower attract insects and increases the flower's odds of reproducing successfully. Students also learn that pollination needs to happen in order for the plant to reproduce.

Assessment

Assessment Opportunity: Student Understanding of Plant Structures Used for Reproduction
This activity can be used to assess students' understanding that plants have specialized features and structures that contribute to their successful reproduction. Look for whether students can explain that the corpse flower smells bad because this smell attracts the insects that it needs to pollinate it. Also look for whether students can name other adaptations in plants that help them reproduce, such as scents and colors that attract pollinators or seeds that catch the wind or stick to animals. If students are not able to explain the reason for these plant adaptations, consider spending some time in class showing students some additional visual examples. Useful images can be found using the search term "pollinators." You might show students an image of a bee covered in pollen, and point out that the bee eats the nectar of the flower, not the pollen. Ask students what might happen when a bee covered in pollen from one flower lands on a new flower [some of the pollen might rub off on that flower]. Point out that this pollen is the way that plants reproduce; pollen needs to be carried from one flower to another so that the flower can make seeds. Ask students how the plant might have evolved structures that would help its pollen be more likely to stick to a bee [answers will vary; for example, the pollen might become more sticky, or the plant might have a shape that ensures that the bee will touch the

pollen when it lands on the flower, or the plant might make a lot of pollen to stick to many bees]. Point out to the class that plants often rely on insects and animals to pollinate them, and different plants have many different adapted structures and features that help them reproduce this way and increase their probability of successful reproduction.

Possible Responses

Why does the corpse flower smell so bad?
The corpse flower smells so bad because the insects that pollinate it feed on decaying meat.

Why does the corpse flower need to attract insects to reproduce?
The corpse flower cannot reproduce on its own. In order to reproduce, an insect has to pollinate it.

What is another plant adaptation that helps a plant reproduce?
Another plant adaptation is having seeds that catch the wind or stick to a passing animal to bring the seed to a new environment.