Traits and Reproduction

Chapter 3: Investigating Spider Inheritance

3 | 3.3: Analyzing Variation and Reproduction

Lesson Overview

Students further investigate how sexual reproduction can result in variation among offspring. They use the Sim to examine reproduction, making and testing predictions about the gene versions offspring could inherit when given a specific set of parents. Students observe that offspring inherit different gene combinations from their parents, resulting in trait variation. Students then use the Modeling Tool, applying what they have learned to the feature of venom; they show how sexual reproduction can result in different combinations of gene versions. The lesson concludes with an introduction of Punnett Squares and a chance for students to use this tool to calculate the probabilities of certain traits being passed to offspring from given parents. The purpose of this lesson is for students to solidify their understanding of how sexual reproduction leads to variation in offsprings' gene versions and traits.

Students learn:

- Through sexual reproduction, each offspring can inherit a different combination of gene versions. Therefore, siblings can have different traits from each other and even from their parents.

Lesson at a Glance

1: Warm-Up (5 min)

Students reinforce their understanding that, for each feature, an offspring receives one gene copy from each parent.

2: Testing Predictions About Inheritance (20 min)

Students make and test predictions about the gene versions that offspring inherit from their parents, building an understanding of how sexual reproduction results in variation.

3: Modeling Venom Inheritance (20 min)

Students use the Modeling Tool to create a model that explains how spider offspring can have different gene versions both from each other and from their parents. The teacher uses this opportunity as an On-the-Fly Assessment of students' ability to model how offspring can have different gene versions from each other and their parents.

4: Predicting Probabilities with Punnett Squares (20 min)

Using Punnett Squares allows students to reinforce their understanding of how genes are inherited and provides a tool for calculating probabilities for genotypes and phenotypes of offspring.

5: Homework

Students reflect on what they learned by revisiting a statement from the Anticipation Guide. Students also read a short article to learn more about asexual reproduction.

We'd love to hear from you! Submit your feedback here.

Materials & Preparation

Materials

For the Classroom Wall

- key concept: *Through sexual reproduction, each offspring can inherit a different combination of gene versions. Therefore, siblings can have different traits from each other and even from their parents.*

For the Class

- masking tape*

For Each Student

- Modeling Tool: Venom Inheritance Model student sheet*
- optional: Predictions with Punnett Squares student sheet*
- optional: printed copy of the "Sea Anemones: Two Ways to Reproduce" article*
- optional: *Traits and Reproduction* Investigation Notebook, pages 75–82*

Digital Tools

- *Traits and Reproduction* Simulation
- "Sea Anemones: Two Ways to Reproduce" article in the Amplify Library

*teacher provided

Preparation

Before the Day of the Lesson

1. **Familiarize yourself with the Simulation activities in this lesson.** Decide if you will make copies of the Predictions with Punnett Squares student sheet that students could use with the Sim if they do not have individual digital devices in Activity 4 of this lesson.

2. **Make copies of the Modeling Tool: Venom Inheritance Model copymaster.** Locate the copymaster in Digital Resources and make one copy for each student. This student sheet is also included on page 80 of the Investigation Notebook.

3. **Familiarize yourself with the Modeling Tool activity: Venom Inheritance Model.** You will introduce the Modeling Tool activity: Venom Inheritance Model, using a projection. Students will individually complete the Modeling Tool activity: Venom Inheritance Model on their student sheets or in the notebook. In each lesson where the Modeling Tool is used, there is information about expected student responses in the Possible Responses tab associated with that activity.

4. **Preview the "Sea Anemones: Two Ways to Reproduce" 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. **Prepare for the On-the-Fly Assessment.** Included in Activity 3 of this lesson is an On-the-Fly Assessment. Activity 3 provides an opportunity to informally assess students' understanding of the idea that, compared to each other, offspring can have different combinations of gene versions for a particular feature. Offspring can also have different combinations of gene versions compared to their parents. 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.

Immediately Before the Lesson

1. **Draw data tables on the board.** Draw two data tables on the board: Silk Stickiness Inheritance Predictions and Silk Stickiness Inheritance Results. You will use these two data tables to record student predictions and results during the Sim modeling in Activity 2.
   - For the Silk Stickiness Inheritance Predictions data table, copy the rows and columns exactly as they appear on the first student screen in Activity 2.
   - For the Silk Stickiness Inheritance Results data table, use the Body Color Inheritance Results: Test 1 data table on the second student screen in Activity 2 as a reference. Copy the rows and columns exactly. (One column should read "Combinations of Gene Versions," and one should read "Trait." Each row will then be labeled with the resulting, numbered offspring.) Write "Silk Stickiness Inheritance Results" (instead of "Body Color Inheritance Results") for the title.
2. **Draw a blank Punnett Square on the board.** To do this, draw a large two-by-two table.
3. **Write the Investigation Question on the board:** "How does sexual reproduction result in variation among offspring?"
4. **Have on hand the following materials:**
   - Modeling Tool: Venom Inheritance Model student sheets
   - digital devices
   - optional: printed copies of the "Sea Anemones: Two Ways to Reproduce" article
   - optional: Predictions with Punnett Squares student sheet
   - optional: *Traits and Reproduction* Investigation Notebook, pages 75–82

Between-Class Prep

1. **Erase the data in the tables on the board.** You will need to record new results for the next class.

At the End of the Day

1. **Gather and post the key concept on the wall.**
2. **Review student models for the On-the-Fly Assessment included in Activity 3.**

Digital Resources

Modeling Tool: Venom Inheritance Model copymaster

Sea Anemones: Two Ways to Reproduce
1 - Sea Anemones: Two Ways to Reproduce

Printed article: "Sea Anemones: Two Ways to Reproduce"

Projections: Lesson 3.3

Predictions with Punnett Squares copymaster

Traits and Reproduction Investigation Notebook, pages 75–82

Traits and Reproduction Glossary
1 - Traits and Reproduction Glossary

Traits and Reproduction Multi-Language Glossary
1 - Traits and Reproduction Multi-Language Glossary

Vocabulary

- feature
- gene
- gene version
- heterozygous
- homogeneous
- inherit
- protein molecule
- sexual reproduction
- trait
- variation

Differentiation

Embedded Supports for Diverse Learners

Multiple modalities with the same topic. Students consider gene inheritance using the Simulation, completing a diagram, and through student-to-student discussions. These experiences provide multiple access points for diverse learners.

Potential Challenges in This Lesson

Extended whole-class discussion. In Activity 2, students refer to the projected Sim to make predictions about inheritance. They also share these predictions and discuss the results as a class. If you think this extended whole-class discussion will be challenging for your students, or if you think some students will not be able to see the projected Sim well enough to make predictions and observations, consider modifying this activity. You might have students launch the Sim on their own devices to observe Greg's and Anne's gene combinations and traits for silk stickiness and then have students test their predictions on their own. Note: Students will have different results if they run the test on individual devices.

Specific Differentiation Strategies for English Learners

Extended teacher modeling. Today's Modeling Tool activity allows students to show what they have learned so far, not just in Chapter 3, but over the course of the *Traits and Reproduction* unit. The Modeling Tool can provide an opportunity for English learners to demonstrate their understanding, reducing the language demands involved with explaining concepts in writing or in discussion. To ensure that English learners have the opportunity to demonstrate what they have learned, you might consider extending your modeling with a small group of English learners. You could work with students to surface their ideas about the different possible proteins and gene combinations. Then, think aloud about how you would show their ideas in the Modeling Tool, using one offspring as an example. Students could then complete the diagram for the other offspring on their own.

Specific Differentiation Strategies for Students Who Need More Support

Using cards to map out possible gene combinations. Some students might benefit from additional support predicting the possible combinations of gene versions in Activities 2 and 3. Consider providing sticky notes or index cards to represent the gene versions that would be present in the reproductive cells of each parent. (If a parent has the C1C3 gene combination, then you would write "C1" on one card and “C3” on the other. Repeat this process for the gene combination of the second parent.) Students could use the cards to create all possible gene combinations for the offspring. Having a physical manipulative could provide additional support to students during the Sim and Modeling Tool activities.

Specific Differentiation Strategies For Students Who Need More Challenge

Selective breeding in the Sim. Students who need more challenge can use the Sim to investigate how to choose parents with a combination of gene versions that will produce offspring with a desired trait. This is possible when you identify the combinations of gene versions needed to produce the desired trait, selecting parents that each have one or both of the desired genes. For example, if I want to produce a spider with brown body color, I could mate Zora (C1C1) with Greg (C2C2) to get offspring that are all brown (C1C2).

Standards

Science Florida Standards

- **SC.6.L.14.2: Investigate and explain the components of the scientific theory of cells (cell theory):** all organisms are composed of cells (single-celled or multi-cellular), all cells come from pre-existing cells, and cells are the basic unit of life
- **SC.6.L.14.3:** Recognize and explore how cells of all organisms undergo similar processes to maintain homeostasis, including extracting energy from food, getting rid of waste, and reproducing
- **SC.7.L.16.1:** Understand and explain that every organism requires a set of instructions that specifies its traits, that this hereditary information (DNA) contains genes located in the chromosomes of each cell, and that heredity is the passage of these instructions from one generation to another
- **SC.7.L.16.3:** Compare and contrast the general processes of sexual reproduction requiring meiosis and asexual reproduction requiring mitosis.
- **SC.6.N.1.1:** Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions
- **SC.6.N.3.4:** Identify the role of models in the context of the sixth grade science benchmarks.
- **SC.7.N.1.1:** Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions
- **SC.7.N.1.2:** Differentiate replication (by others) from repetition (multiple trials).
- **SC.8.N.1.1:** Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions
- **SC.8.N.1.3:** Use phrases such as ""results support"" or ""fail to support"" in science, understanding that science does not offer conclusive 'proof' of a knowledge claim
- **SC.8.N.1.6:** Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence
- **SC.8.N.3.1:** Select models useful in relating the results of their own investigations.

- **SC.7.L.16.2:** Determine the probabilities for genotype and phenotype combinations using Punnett Squares and pedigrees.

English Language Arts Florida Standards

- **LAFS.68.RST.2.4:** 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
- **LAFS.68.WHST.1.1b:** Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources
- **LAFS.6.SL.1.1:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others ideas and expressing their own clearly.
- **LAFS.7.SL.1.1:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others ideas and expressing their own clearly.

Mathematics Florida Standards

- **MAFS.K12.MP.1.1:** Make sense of problems and persevere in solving them.
- **MAFS.K12.MP.4.1:** Model with mathematics.
- **MAFS.K12.MP.5.1:** Use appropriate tools strategically.
- **MAFS.K12.MP.7.1:** Look for and make use of structure.
- **MAFS.7.SP.3.5:** Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event
- **MAFS.7.SP.3.7a:** Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events.
- **MAFS.7.SP.3.8a:** Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs

English Language Development Florida Standards

- **ELD.K12.ELL.SC.1:** English language learners communicate information, ideas and concepts necessary for academic success in the content area of Science
- **ELD.K12.ELL.SI.1:** English language learners communicate for social and instructional purposes within the school setting.

Unplugged?

Print fidelity to digital lesson: low

It is highly recommended that students have access to digital devices for this lesson. If students do not have individual devices, print copies of the Investigation Notebook pages for this lesson and have students complete the Simulation activity in pairs.

If students do not have access to Amplify Science at home, provide them with copies of pages 81–82 from the Investigation Notebook as well as printed copies of the "Sea Anemones: Two Ways to Reproduce" article.

Instructional Guide

Lesson at a Glance

1.	**WARM-UP** Students use a diagram from the "Why Are Identical Twins Rare?" article to explain why offspring have two copies of each gene. (5 min.)
2.	**TESTING PREDICTIONS ABOUT INHERITANCE** Students predict the traits of two spiders' offspring. They use the Sim to test their predictions. (20 min.)
3.	**MODELING VENOM INHERITANCE** Students show how spider offspring can have different combinations of gene versions, leading to variation in venom. (20 min.)
4.	**PREDICTING PROBABILITIES WITH PUNNETT SQUARES** Students use Punnett Squares to predict probabilities of genotypes and phenotypes among offspring, then test results in the Sim. (20 min.)
5.	**HOMEWORK** Students revisit the Anticipation Guide, reflecting on their learning thus far, and read an article about asexual reproduction.

WARM UP

1. Warm-Up

Students use a diagram from the "Why Are Identical Twins Rare?" article to explain why offspring have two copies of each gene. (5 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Project Warm-Up; students work independently. Collapse the instructional guide and project the student screen, or have students turn to page 76 in their Investigation Notebooks. Allow a few minutes for students to individually respond to the Warm-Up.

SOLUTIONS

- **Use the diagram to explain how the offspring receives two copies of each gene.**
  The offspring receives two copies of each gene because it inherits one copy from each of its parents.

SIM

2. Testing Predictions About Inheritance

Students predict the traits of two spiders' offspring. They use the Sim to test their predictions. (20 min.)

CARD 1

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.

Now that we understand how organisms inherit their genes from their parents, we will focus on investigating why the spider offspring have different traits for silk flexibility even though they have the same parents.

2. Project the Sim. Introduce the activity to students.

Today, you will mate spiders and predict the gene versions the spider offspring will have. You will then use the Sim to test your predictions.

3. Introduce the Sim activity. As a class, students will make and test predictions about two spiders' offspring. After you have finished modeling, students will then make predictions about a different pair of spiders.

I am going to use Greg and Anne to model how to make a prediction about the gene versions their offspring will have for silk stickiness.

After I have completed the modeling activity, you will then mate a different pair of spiders, making predictions about their offsprings' body color.

4. Model how to observe and record Greg's and Anne’s traits for silk stickiness.

- Select the silk stickiness feature. Explain that you will compare Greg's and Anne’s traits and gene combinations for this feature.

What traits and gene versions do Greg and Anne have for silk stickiness?

- Record Greg's and Anne’s traits and gene versions underneath the Silk Stickiness Inheritance Predictions data table written on the board.
- Write: “Greg: Sticky (S1S2)” and “Anne: Sticky (S1S2).”

5. Ask partners to make predictions. Collapse the instructional guide and project the student screen, or have students turn to page 77 in their Investigation Notebooks. Review the Silk Stickiness Inheritance Predictions data table with students, prompting them to first record Greg's and Anne’s gene versions in the space provided. Partners should then work together to make and record predictions about Greg's and Anne’s offspring.

6. Prompt students to share their predictions with the class. As students share, record predictions in the Silk Stickiness Inheritance Predictions data table.

7. Mate Greg and Anne in order to test student predictions.

- Mate Greg with Anne by moving Anne on top of Greg until a dotted circle appears.
- Press CREATE REPRODUCTIVE CELLS.
- Press RANDOMLY FERTILIZE, and observe the results.

8. Record the Sim results in the Silk Stickiness Inheritance Results data table written on the board.

9. Compare results with student predictions. Point out that the predictions students made were all possible combinations of gene versions. The actual set of offspring might not match the predictions exactly. Remind students that each time they mate the spiders, the offspring will inherit different combinations of gene versions.

10. Discuss variation in traits. Depending on your results, you may have offspring that all share the sticky traits with their parents. Alternatively, you may have some offspring with the not sticky trait, inheriting two copies of the S2 gene version from their parents.

- If traits do not vary among your offspring, ask students if they think the parents’ offspring will always have the sticky trait.
- After hearing student responses, repeat the fertilization process until you have offspring with the not sticky trait.

Ask students to press NEXT (or turn to pages 78-79 in their Investigation Notebooks).

SOLUTIONS

- **What students should do and notice in the Sim:**
  As the teacher models this activity, students will observe the spiders’ gene versions and traits for the feature of silk stickiness. They will make predictions about the combinations of gene versions the offspring will have. The teacher will then mate the two spiders, and the class will discuss the results. Possible responses are shown below.

  Greg’s gene versions for silk stickiness are: S1S2.
  Greg’s trait for silk stickiness is: sticky.
  Anne’s gene versions for silk stickiness are: S1S2.
  Anne’s trait for silk stickiness is: sticky.

Silk Stickiness Inheritance Predictions
Note: The order in which these possible gene combinations are listed on the table does not matter.

Gene combination A

- Gene Version from Greg: S1
- Gene Version from Anne: S1
- Offspring Gene Versions: S1S1

Gene combination B

- Gene Version from Greg: S1
- Gene Version from Anne: S2
- Offspring Gene Versions: S1S2

Gene combination C

- Gene Version from Greg: S2
- Gene Version from Anne S2
- Offspring Gene Versions: S2S2

Gene combination D

- Gene Version from Greg: S2
- Gene Version from Anne: S1
- Offspring Gene Versions: S2S1

The resulting offspring will vary, but if the spider has S1S1, S2S1, or S1S2, its trait will be sticky. Offspring that inherit two copies of the S2 gene version will have the not sticky trait.

CARD 2

INSTRUCTIONAL GUIDE

11. Prompt students to launch the Sim and make predictions about body color. Collapse the instructional guide and project the student screen, or have students turn to pages 78–79 in their Investigation Notebooks. Have students view Otis and Ruby's genes and traits for body color. Explain that students should make predictions for the gene versions of Otis and Ruby's offspring, but they should not test their predictions yet.

12. Ask students to discuss their predictions. Have partners compare their predictions and discuss why they made the choices they did.

13. Prompt students to mate spiders in the Sim and observe the spiders' offspring. Students should record all resulting gene version combinations. Remind students that they should mate the spiders at least twice, recording the new gene version combinations for the offspring.

14. Have students share results. Students will end up with different results. Ask if anyone ended up with an offspring that did not share its parents' traits for body color. [Otis is brown, and Ruby is yellow, but if an offspring inherits two copies of C3, it will be colorless.]

If using devices, ask students to press NEXT.

TEACHER SUPPORT

Instructional Suggestion

Going Further: Mathematical Thinking

This lesson provides an opportunity to go further with mathematical thinking by introducing probability. You can guide students in creating a Punnett square that is used as a probability model for the combinations of gene versions inherited by offspring. The Punnett square will allow students to visualize the different ways the parents' genes can combine. It will also help students determine the probability that an offspring will inherit a specific gene combination. Demonstrate how to create a Punnett square with the parent gene combinations from the Sim activity (C1C3 and C2C3).

- Create a Punnett square by drawing a 2 x 2 grid
- Write C1 and C3 on the left side of the grid and C2 and C3 on the top of the grid.
- Show the four ways the parent genes can combine within the grid. Each way the genes combine are equally probable.
- Point out the unique combinations: C1C2, C1C3, C3C2, and C3C3.
- Determine the probability an offspring will inherit each combination. Since there are four different possible gene combinations, the probability an offspring will inherit each is one-fourth.

After demonstrating how to determine probability using a Punnett square, students can practice with other combinations of parent genes.

Instructional Suggestion

Classroom Management: Provide Extensions for Early Finishers

Encourage students who finish early to choose two different spiders to mate. Have students pick another trait to focus on, such as venom, stripe color, or body size. Students can create the data tables on paper.

Rationale

Pedagogical Goals: Predicting Gene Versions But Not Traits

In this activity, students are only asked to predict the gene version combinations, not the traits, that will result from mating. This is because students are not expected to know, in advance, the relationship between the gene version combinations and the traits for silk stickiness or body color. However, since students are able to obtain some evidence in the Sim about these relationships, they may be interested in making predictions in terms of traits. If students are interested, you can encourage these predictions, prompting students to provide evidence to support their predictions.

SOLUTIONS

- **What students should do and notice in the Sim:**
  Students will observe two spiders' gene versions and traits for the feature of body color and make predictions about the combinations of gene versions the offspring will have. Then, they will mate the spiders, and the class will discuss the results. Possible responses are shown below.

  Otis's gene versions for body color are: C1C3.
  Otis's trait for body color is: brown.
  Ruby's gene versions for body color are: C2C3.
  Ruby's trait for body color is: yellow.

  Body Color Inheritance Predictions:
  Possible offspring gene versions are as follows: C1C2, C1C3, C3C2, C3C3. The order in which these possible gene combinations are listed on the table does not matter.

  Body Color Inheritance Results: Test 1 and Test 2:
  Results will vary; an example test result is shown below.

  Offspring 1
  Combinations of Gene Versions: C1C3; Trait: brown

Offspring 2
Combinations of Gene Versions: C1C2; Trait: brown

Offspring 3
Combinations of Gene Versions: C3C3; Trait: colorless

Offspring 4
Combinations of Gene Versions: C3C2; Trait: yellow

CARD 3

INSTRUCTIONAL GUIDE

15. Prompt students to review the Investigation Question. Prompt partners to review their results with each other, if needed. Partners should then discuss what caused the offsprings' traits to vary.

16. Facilitate a whole-class discussion. Invite students to share their thoughts about why sexual reproduction results in variation in offspring.

How did sexual reproduction lead to variation in body color in Otis and Ruby's offspring?
[Each parent randomly passed on one copy of the gene to the offspring, resulting in different combinations of genes. This, in turn, resulted in different traits among the offspring.]

17. Emphasize that each offspring inherits a random gene combination. Ask students if they noticed whether or not the resulting offspring had the same gene combinations each time the two spiders mated. Explain that the offspring produced will not always have the same set of gene combinations. Each spider offspring can inherit any of the possible combinations.

MODELING TOOL

3. Modeling Venom Inheritance

Students show how spider offspring can have different combinations of gene versions, leading to variation in venom. (20 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Project Venom Inheritance Model and introduce the Modeling Tool.

Now that you have investigated two examples of how sexual reproduction can lead to variation, we will study a new feature, venom, to apply what you have learned. You will explain why the spider offspring can have different gene versions for venom even though they have the same parents.

2. Use the projected Modeling Tool to explain the components of the model. Explain that students will need to fill in the possible gene versions and proteins for the offspring. In addition, students should annotate the diagram to explain how each offspring inherited their gene versions and proteins for venom and why there is variation among offspring. Highlight that there are multiple possible accurate responses. Students can make choices about which combinations the offspring might have, given the possibilities.

3. Distribute one copy of the Modeling Tool: Venom Inheritance Model sheet to each student, or have students turn to page 80 in their Investigation Notebooks. Collapse the instructional guide and project the student screen to review instructions.

4. Prompt students to individually complete the Modeling Tool activity. Circulate and assist if needed.

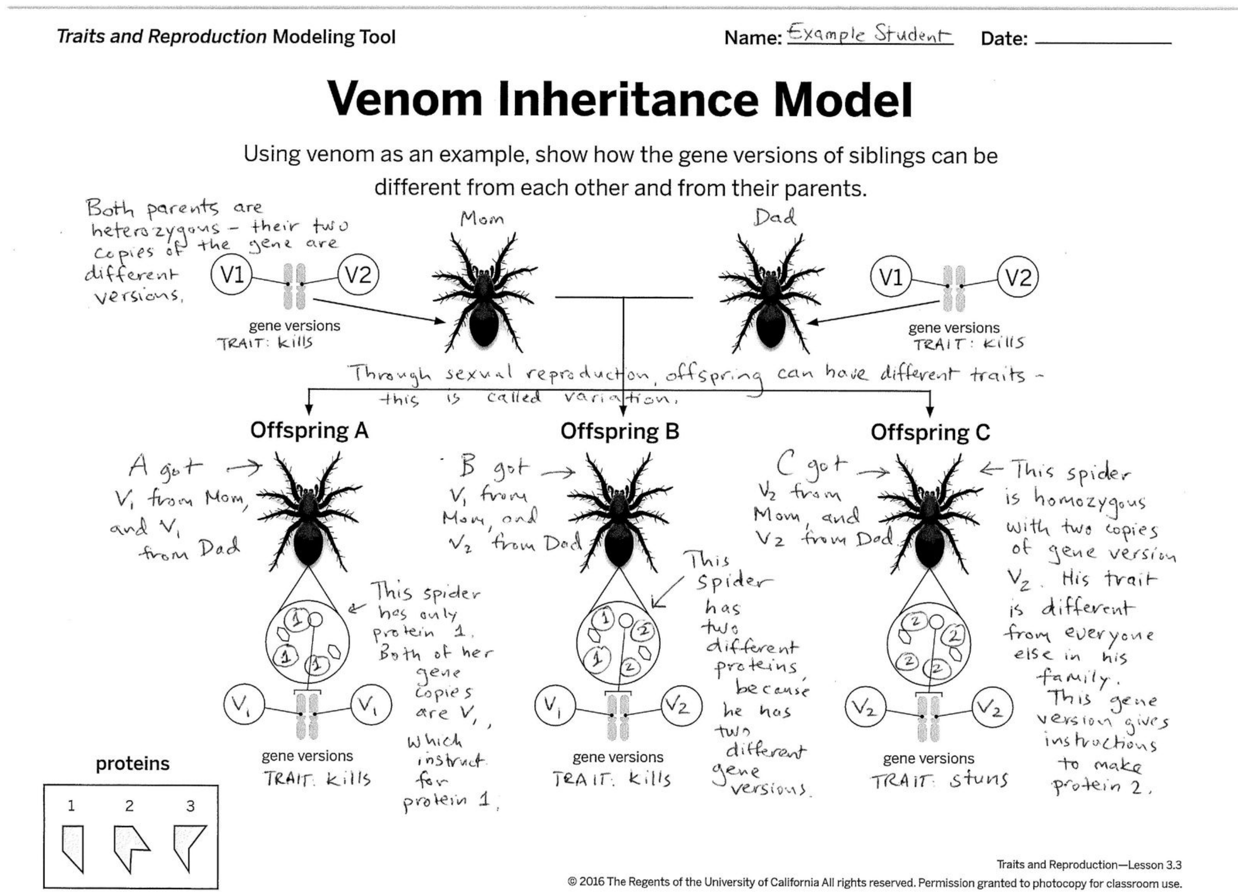
5. On-the-Fly Assessment: Modeling Inheritance. For further suggestions on what to look for when reviewing student models and how to support students in modeling the relationship between genes and proteins, press the hummingbird icon and then select ON-THE-FLY ASSESSMENT 10.

6. Partners discuss offsprings' gene combinations. Have partners share their models, explaining their choices about the gene versions and proteins they chose for the spider offspring.

7. Whole-class share. Invite groups to share how they determined the possible gene combinations for the offspring.

If using devices, ask students to press NEXT.

SOLUTIONS



Over-The-Shoulder-Conference:

ON THE FLY ASSESSMENT

ON-THE-FLY ASSESSMENT 10: Modeling Inheritance

Look for: Observe students as they complete their models by filling in the gene versions and proteins of the offspring. This activity allows students to apply their understanding of the relationship between gene versions and proteins to a new feature. By producing three combinations of gene versions in offspring (V1V1, V1V2, and V2V2), students demonstrate that they understand that each parent contributes only one copy of a gene to each offspring as neither parent has a homozygous gene combination (V1V1 or V2V2). In addition, by drawing and labeling the corresponding proteins (proteins 1, 2, or 3) produced in a cell, students will be able to fully demonstrate that a specific gene version instructs for a specific protein. Through this modeling activity, students show that there are different ways that parents' gene versions can combine, which results in offspring with random variation in the trait for venom.

Now what? If you notice students do not understand how offspring can inherit one of the multiple combinations of gene versions, ask them to recall the process of sexual reproduction that they just explored in the Simulation. Provide sticky notes or index cards to help students model the possible gene combinations for offspring. This will help support students' understanding of how the different combinations of gene versions in the offspring are formed. This can be done by having students write the individual gene versions for each parent on separate cards (There should be four cards in total, two for each parent). It may also be useful to color-code or mark the cards to highlight that only one gene can come from each parent. By manipulating the cards to make all four possible combinations of gene versions, students can see the gene versions of four possible offspring. Point out that since each version of a gene instructs for a specific protein, two of these combinations will instruct for the same proteins in a cell (V1V2 and V2V1) and thus will result in the same trait.

CARD 2

INSTRUCTIONAL GUIDE

8. Project Darwin's Bark Spider Claims (with eliminated claim). Remind students that they are investigating variation within this spider family. The spider offspring have different traits from each other, and some even have different traits from their parents. Point out that claim 2 can be eliminated, based on the investigations they have completed.

9. Prompt students to briefly discuss the remaining claims. Ask students whether the evidence they gathered today supports or refutes claim 1 or 3. If it does not come up, highlight how the evidence students gathered supports claim 3: Offspring inherit different combinations of gene versions from their parents.

10. Project and introduce the key concept. Read (or ask a student to read) the key concept aloud.

11. Collect student sheets.

TEACHER SUPPORT

Instructional Suggestion

Going Further: Identifying Traits

We chose to make it optional for students to identify the traits in their Modeling Tool: Venom Inheritance Model since we do not expect students to know the relationships between particular gene version combinations and the resulting traits for the venom feature. However, labeling the traits of the parents and offspring would make student models more complete. If you feel your students would enjoy the extra challenge, you can have them use the Sim to determine these relationships, or you can simply write the relationships on the board for students to refer to. As represented in the Sim, the relationships of gene version combinations to traits are as follows:

- V1V1, V1V2 and V1V3: kills
- V2V2 and V2V3: stuns
- V3V3: no venom

SIM

4. Predicting Probabilities with Punnett Squares

Students use Punnett Squares to predict probabilities of genotypes and phenotypes among offspring, then test results in the Sim. (20 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Discuss probabilities and offspring.

You have discovered how to predict which gene combinations and traits offspring can inherit from their parents. We will now use a tool that will help us figure out which of those gene combinations and traits are more likely. We will be able to predict how many offspring with each gene combination and trait there will likely be.

2. Introduce the Punnett Square. Draw students' attention to the blank Punnett Square you drew on the board. Explain that one parent's gene information will go in the column headers across the top, the other parent's gene information in the row headers along the left side. Possible gene combinations for offspring will go in each box.

3. Model setting up a Punnett Square for body color in the *Traits and Reproduction* Simulation. Select the body-color trait in the Sim. Say that you will use Anne and Otis as the parents for this example, and write "Parent 1: Anne" above the Punnett Square and "Parent 2: Otis" along the side. Fill in the genes for Anne (C3, C3) along the top of the Punnett Square and for Otis (C1, C3) along the side.

4. Model filling in the offspring genes in the boxes of the Punnett Square. Model filling out each offspring box, combining Anne's gene version from the row header and Otis's gene version from the column header. [Top row left C1, C3; top row right C1, C3; bottom row left C3, C3; bottom row right C3, C3.]

5. Have students help you predict the offspring traits and add them to the boxes. Call on students to help you fill in what body-color trait would result for the gene combination in each box, referring to the Sim as needed. [Top row left, brown; top row right, brown; bottom row left, colorless; bottom row right, colorless.]

This helps us predict that about ½ of the offspring from these parents would have colorless body color and about ½ of their offspring would have brown body color. We can use these fractions to record our predictions.

6. Review instructions for students' use of the Punnett Square and Sim. Explain that students will open the Sim and select the stripe-color trait. They will complete the Punnett Square for the stripe-color trait for Ruby and Leo and predict what fraction of their offspring will have each stripe-color trait. Next, students will mate these spiders three times and compare the actual results for their offspring's stripe-color traits to their own predictions.

7. Students complete Punnett Square for stripe color and make predictions. Encourage pairs to help each other as needed.

8. Students run tests in the Sim and compare results to their Punnett Square. Remind students to begin mating Leo and Ruby and recording results.

9. Tally results. Tally results for the three possible stripe-color traits. You will probably end up with twice as many black-stripe offspring as purple- or blue-stripe offspring.

A Punnett Square won't tell us exactly what will happen with any given set of offspring, but it tells us about probabilities—what is likely to happen in general.

10. Discuss repetition and replication of investigations.

11. Point out the homework assignment to students (Activity 5 or pages 81–82 in the Investigation Notebook). Students will reflect on their understanding by revisiting a statement from the Anticipation Guide, and will also read an article about sea anemones and asexual reproduction.

TEACHER SUPPORT

Rationale

Pedagogical Reasoning: Reasons for Introducing Punnett Squares Late in the Chapter
Punnett Squares are not introduced until students have quite a bit of experience reasoning through the possible offspring traits from given parental genes. The risk in introducing this tool earlier is that students may learn to complete the square by rote without really understanding that it represents one copy of each gene being passed on from each parent.

SOLUTIONS

- Punnett Square

    - Ruby's (T2) and Leo's (T2) Possible Offspring: T2T2, blue
    - Ruby's (T2) and Leo's (T1) Possible Offspring: T1T2, purple
    - Ruby's (T3) and Leo's (T2) Possible Offspring: T2T3, black
    - Ruby's (T3) and Leo's (T1) Possible Offspring: T1T3, black

    Predictions for offspring stripe-color traits

    - red: 0/4 or 0
    - blue: 1/4
    - purple: 1/4
    - black: 2/4 or 1/2

    Actual stripe-color traits in offspring

    Answers will vary, since the Punnett square predicts what is likely to happen, not what will actually happen for a given set of offspring.

HOMEWORK

5. Homework

Students revisit the Anticipation Guide, reflecting on their learning thus far, and read an article about asexual reproduction.

CARD 1

INSTRUCTIONAL GUIDE

1. If needed, make additional time to explain homework. If students do not have access to Amplify Science at home, provide them with copies of pages 81–82 from the Investigation Notebook as well as printed copies of the “Sea Anemones: Two Ways to Reproduce” article.

SOLUTIONS

- **Do you agree or disagree with this statement now? What evidence supports your ideas about the statement?**
  Disagree. It is possible for an offspring to have a trait that neither of its parents has because the offspring inherits one copy of a gene from each parent. That means the offspring could have a different combination of gene versions compared to its parents. This further means that the offspring could have a different trait from its parents.

CARD 2

INSTRUCTIONAL GUIDE

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 81–82 from the Investigation Notebook as well as printed copies of the "Sea Anemones: Two Ways to Reproduce" article.

TEACHER SUPPORT

Rationale

Pedagogical Goals: Additional Reading about Asexual Reproduction
Students read an article for homework that introduces the concept of asexual reproduction. In this engaging article, students are introduced to the sea anemone. These organisms reproduce asexually by splitting in half or when a small piece of the anemone breaks away from the rest of the body. Students use this information to consider the difference between asexual and sexual reproduction, and why asexual reproduction doesn't result in variation among offspring and parents.

SOLUTIONS

- **How is asexual reproduction different from sexual reproduction?**
  The difference between asexual and sexual reproduction is that asexual reproduction requires only one organism while sexual reproduction requires two organisms.

  How does a sea anemone reproduce asexually?
  A sea anemone reproduces asexually by splitting in half or when a small piece of the anemone breaks away from the body.

  Why doesn't asexual reproduction result in variation among offspring?
  There is no variation between offspring and parents in asexual reproduction because all the offspring have the same exact genes as the parents.