RESPeCT Summer Institute Professional Development Leader Guide (PDLG)

Grade Level	6	Day	4	STeLLA Strategy	STL Strategy 6: Use and Apply New Science Ideas	Subject Matter Focus	Genetics

Focus Questions	• Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts? • How will the Student Thinking Lens strategies help you teach the Genetics lessons? • Starting with Mendel's ideas about inheritance, how can we use mathematical simulation and statistical analysis to determine the *rules of expression* for simply-inherited traits? • What kinds of data sets characterize simply-inherited traits?
Main Learning Goals	Participants will understand the following: • In order to develop meaningful understandings of science ideas, students need multiple opportunities to try using and applying new science ideas in a variety of ways and contexts. • Based on Mendel's ideas about trait inheritance—that individuals receive one allele from each parent, and the particular allele a parent passes on to offspring is a matter of chance—16 possible rules (represented as zero-one tables) can be identified that may determine the way in which a trait is expressed. • Through mathematical modeling (simulation, statistical analysis, and data comparison), the range of possible ways a trait may be expressed can be narrowed to just two. • The difference between the two remaining rules of expression is simply the label assigned to the trait that is produced most frequently according to those rules. By defining the dominant trait as the one that occurs most frequently and choosing whether to label it 0 or 1, the rules of expression can then be determined. • A simply-inherited trait is a trait controlled by only one or a few genes. Simply-inherited traits are characterized by bimodal data sets in which one mode occurs approximately three times more often than the other. Traits (such as plant height) that exhibit more variation are likely not simply-inherited traits.

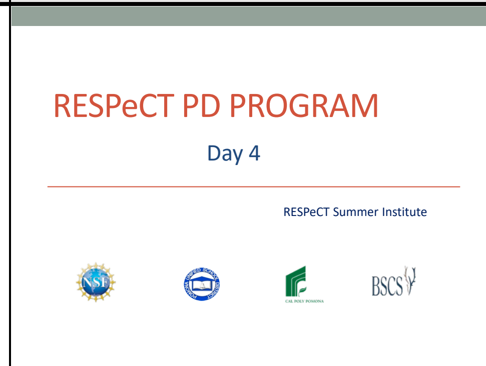
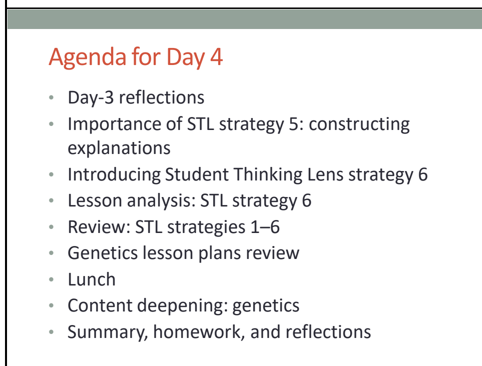
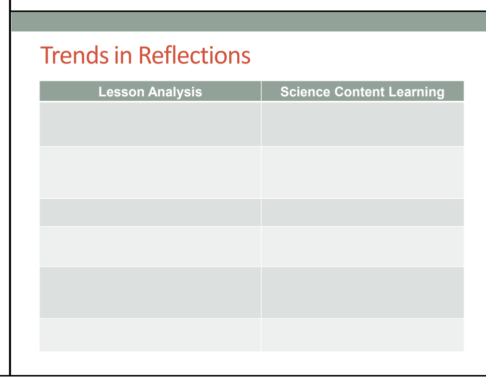
Preparation	Materials	Videos
Daily Setup Tasks • Check that video clips are correctly linked to PowerPoint (PPT) slides. • Set up PowerPoint. • Make sure video clips play correctly with good sound. • Arrange furniture and food. • Arrange participant materials. • Put up posters and charts. **Planning and Preparation Tasks** • Study the PDLG, PowerPoint slides (PPTs), video clips, and handouts. Make changes to	**Posters and Charts** • STeLLA Framework and Strategies poster • Day-4 Agenda (chart) • Day-4 Focus Questions (chart) • Norms for Working Together (chart) • Strategy charts from days 1–3 (STL strategies 1–5) • Chart of STL strategies highlighted in Genetics lesson plans (see PPT slide 24 for model) • Parking Lot poster **Handouts in RESPeCT PD Binder Front**	• Hershberger video clip, *Introducing the CER* (on companion DVD for Zembal-Saul book *What's Your Evidence?*) • Video Clip 4.1: Doggett classroom (use and apply, strategy 6); 4.1_stella_GEN_doggett_L5_c1 • Video Clip 4.2: Kawamura classroom (review Student Thinking Lens strategies); 4.2_stella_GEN_kawamura_L3_c4

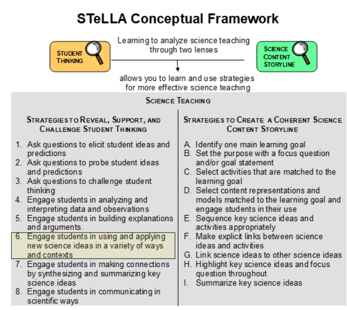
PPTs if needed. • Review the reflections from day 3 and create a summary slide. • Watch video clips and anticipate participant responses. • Prepare charts for the day's agenda and focus questions. • Using PPT slide 24 as a model, prepare a chart of the STL strategies highlighted in the Genetics lesson plans.	**Pocket** • Z-fold summary chart: Student Thinking Lens Strategies **Handouts in RESPeCT PD Binder, Day 4** • 4.1 Importance of Engaging Students in Constructing Scientific Explanations (task sheet) • 4.2 Student Work from Zembal-Saul Book *What's Your Evidence?* • 4.3 Benefits of Engaging Students in Constructing Scientific Explanations • 4.4 Transcript for Video Clip 4.1 • 4.5 Transcript for Video Clip 4.2 • 4.6 Identifying Student Thinking Lens Strategies • 4.7 Daily Reflections—Day 4 **Handouts in RESPeCT Lesson Plans Binder** • 2.1 Mendel's Ideas (from Genetics lesson 2b) **Supplies** • Science notebooks • Chart paper and markers • 1 coin per participant **PD Resources** • STeLLA strategies booklet • RESPeCT PD program binder • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Genetics Content Background Document • Common Student Ideas about Variation and Inheritance of Traits	

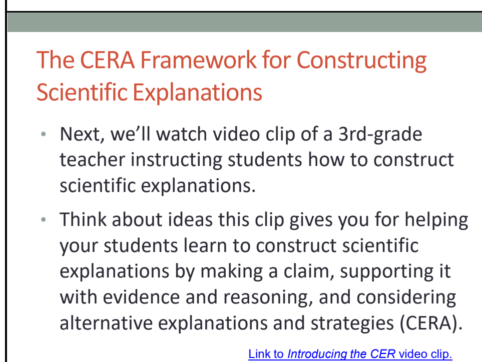
DAY 4 SESSION OUTLINE

Time	Activities	Purpose
8:00–8:15 15 min	**Getting Started: Housekeeping, Agenda, Day-3 Reflections, Focus Questions**	• Build community by sharing participants' reflections from day 3. • Set the stage for a day of learning.
8:15–8:50 35 min	**Importance of STL Strategy 5: Constructing Explanations**	• Develop an appreciation for the multiple ways in which engaging students in constructing scientific explanations can have an impact on student learning within and beyond science.
8:50–9:10 20 min	**Introducing Student Thinking Lens (STL) Strategy 6**	• Develop an initial understanding of the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts.
9:10–10:10 60 min	**Lesson Analysis: STL Strategy 6**	• Use lesson analysis of classroom videos to better understand strategy 6. • Deepen science-content knowledge of genetics through lesson analysis.
10:10–10:55 45 min (Includes 10-min break)	**Review: STL Strategies 1–6**	• Review and deepen understandings of key similarities and differences among STL strategies 1–6.
10:55–12:00 65 min	**Genetics Lesson Plans Review**	• Understand why the Genetics lesson plans are so scripted and how they should be used before and during the lessons. • Understand the conceptual flow within and across the Genetics lessons. • Understand the focus question, main learning goal, and main activity in each lesson. • Understand how STL strategies 1–6 are embedded in the lessons.
12:00–12:45 45 min	**LUNCH**	
12:45–3:15 150 min (Includes 10-min break)	**Math Content Deepening: Genetics**	• Understand how mathematical modeling (simulation, statistical analysis, and data comparison) can be used to determine rules of expression for simply-inherited traits.
3:15–3:30 15 min	**Wrap-Up: Summary, Homework, and Reflections**	• Summarize and reflect on key ideas from today's learning and preview the transition to the Science Content Storyline Lens (SCSL) strategies.

DAY 4

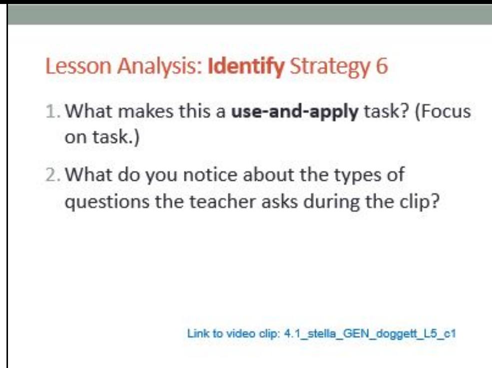
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
8:00–8:15 15 min **Getting Started** Slides 1–5	**Purpose** • Build community by sharing participants' reflections from day 3. • Set the stage for a day of learning. **What Participants Do** • Review the day's agenda. • Discuss the reflections from day 3. • Read today's focus questions. **Posters and Charts** • STeLLA Framework and Strategies poster • Day-4 Agenda (chart) • Day-4 Focus Questions (chart)		**Display Slide 1.** RESPeCT PD Program (5 min) a. Take care of any housekeeping issues.
			**Display Slide 2.** Agenda for Day 4 (3 min) a. Talk through the agenda for the day.
			**Display Slide 3.** Trends in Reflections (5 min) a. Invite participants to look at your feedback on their reflections from day 3 and offer reactions, comments, or follow-up questions.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Today's Focus Questions • Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts? • How will the Student Thinking Lens strategies help you teach the Genetics lessons? • Starting with Mendel's ideas about trait inheritance, how can we use mathematical simulation and statistical analysis to determine the **rules of expression** for simply-inherited traits? • What kinds of data sets characterize simply-inherited traits?	**Display Slide 4.** Today's Focus Questions (1 min) a. Introduce the focus questions that will guide today's work. b. "Like STeLLA strategies 4 and 5, the goal of strategy 6 is to move student thinking forward toward deeper understandings of science ideas."
			**Display Slide 5.** STeLLA Conceptual Framework (1 min) a. Draw participants' attention to the new strategy highlighted on the slide. b. "Strategy 6 is the third STL strategy that is a type of activity designed to move student thinking forward."
8:15–8:50 35 min **Importance of STL Strategy 5: Constructing Explanations** Slides 6–7	**Purpose** • Develop an appreciation for the multiple ways in which engaging students in constructing scientific explanations can have an impact on student learning within and beyond science. **Content** • Engaging students in constructing scientific explanations helps them develop meaningful understandings of science ideas and how scientists	**The Importance of Engaging Students in Constructing Scientific Explanations** Read handout 4.1 and your group-specific handout. Then complete the assigned task: **Group 1:** Analyze a student explanation (handout 4.2). **Group 2:** Summarize benefits for students of constructing scientific explanations (handout 4.3). **Group 3:** Summarize the benefits for teachers of engaging students in constructing scientific explanations (handout 4.3).	**Display Slide 6.** The Importance of Engaging Students in Constructing Scientific Explanations (25 min) **Note:** If you need some time to catch up on day-3 activities, you can skip this slide. However, this activity is beneficial for reviewing strategy 5 (constructing explanations) and helping participants understand why explanation building is such important work in science and beyond. **Timing note:** For this segment, allot 5 minutes for reading, 10 minutes to prepare for a group share-out, and 10 minutes for the share-out.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	work. **What Participants Do** • Review jigsaw-strategy readings about the importance of scientific explanations and examine a sample of student work. • Share key ideas about constructing scientific explanations. • Watch and discuss a lesson video in which the teacher explicitly teaches 3rd graders how to construct explanations that include a claim, evidence, and reasoning that connects to science ideas. **Posters and Charts** • STeLLA Framework and Strategies poster • Strategy charts from days 1–3 (STL strategies 1–5) **Videos** • Hershberger video clip, *Introducing the CER* **Handouts in PD Binder** • 4.1 Importance of Engaging Students in Constructing Scientific Explanations (task sheet) • 4.2 Student Work from Zembal-Saul Book *What's Your Evidence?* • 4.3 Benefits of Engaging Students in Constructing Scientific Explanations **PD Resources** • STeLLA strategies booklet		a. Divide participants into three groups or pairs. Assign each group a number (1, 2, 3). b. Direct participants to three handouts: 1. Importance of Engaging Students in Constructing Scientific Explanations (handout 4.1 in PD program binder) (This handout describes what groups are to do with the following two handouts.) 2. Student Work from Zembal-Saul Book *What's Your Evidence*? (handout 4.2 in PD binder) (Group 1's task is linked to this handout.) 3. Benefits of Engaging Students in Constructing Scientific Explanations (handout 4.3 in PD binder) (Tasks for Groups 2 and 3 are linked to this handout.) c. After participants have read the designated handouts for their groups and completed their assigned tasks, invite them to share out.
			**Display Slide 7.** The CERA Framework for Constructing Scientific Explanations (10 min) **Note:** This activity is optional but powerful. a. "Let's watch how one 3rd-grade teacher taught her students to construct scientific explanations. This is the teacher whose student writing Group 1 just read about. The class in this video clip has been studying simple machines (such as pulleys and levers)." b. "We're not going to analyze this video clip in terms of STeLLA strategies. Instead, think about ideas this clip gives you as to how you might introduce your students to the CERA framework for constructing scientific explanations, which involves making a claim, supporting it with evidence and reasoning, and considering alternative explanations and strategies."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			c. After watching the clip, discuss participants' reactions and any ideas it gave them about how they might help their students learn to construct strong scientific explanations. **Note:** Make sure participants are aware that in addition to using the CERA framework as a tool for teaching students how to develop scientific explanations and arguments (STeLLA strategy 5) in the classroom, they will be using the same framework for videocase-based lesson analysis of their science teaching in RESPeCT study groups throughout the school year.
8:50–9:10 20 min **Introducing Student Thinking Lens (STL) Strategy 6** Slide 8	**Purpose** • Develop an initial understanding of the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts. **Content** • After students encounter new science ideas, they need opportunities to practice them and see their usefulness in explaining a variety of phenomena. Activities that challenge students to use and apply new ideas give them the time and space to really make sense of the concepts. **What Participants Do** • Make and discuss charts highlighting the purpose and key features of strategy 6. **Supplies** • Chart paper and markers **PD Resources**	Introducing STL Strategy 6 Engage students in using and applying new science ideas in a variety of ways and contexts. 1. What are the purpose and key features of this strategy? 2. Why do you think use-and-apply questions or activities are often shortchanged in science teaching?	**Display Slide 8.** Introducing STL Strategy 6 (20 min) a. **Small groups (10 min):** Divide participants into two groups to make charts highlighting the purpose and key features of strategy 6: Engage students in using and applying new science ideas in a variety of ways and contexts. Encourage participants to refer to the STeLLA strategies booklet and STL Z-fold summary chart for this activity. b. **Whole group (10 min):** Have groups present their charts in a whole-group share-out and compare them. Ask participants, "What differences and similarities do you notice when you compare your charts with those of other groups?" **Key ideas:** • Strategy 6 is a time for "strategic telling" and making sure students are using science ideas accurately. • A use-and-apply question or activity is introduced *after* students have experienced/encountered a new science idea. It provides an opportunity for students to use and apply the idea in a new context or novel way and/or link two or more science ideas together. • A common misconception is that use-and-apply questions or activities *assess* student learning. Teachers often talk about asking these kinds of

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• STeLLA strategies booklet • STL Z-fold summary chart (front pocket of PD binder)		questions on tests. However, according to research findings published in *How People Learn* (National Academy of Sciences, 2000), *application* is part of the learning process, or developing a conceptual framework. If application is treated like assessment, students may encounter a use-and-apply question on a test without ever having had the opportunity to practice this way of thinking as part of their learning.
9:10–10:10 60 min **Lesson Analysis: STL Strategy 6** Slides 9–14	**Purpose** • Use lesson analysis of classroom videos to better understand strategy 6. • Deepen science-content knowledge of genetics through lesson analysis. **Content** • Strategy 6 involves engaging students in using and applying new science ideas in a variety of ways and contexts. **What Participants Do** • Watch a classroom video clip to identify strategy 6 and analyze student thinking that is revealed and challenged from using this strategy. • Check their understandings of strategy 6 by taking a quick multiple-choice quiz. **Videos** • Video Clip 4.1, Doggett classroom	Lesson Analysis: Focus Question 1 Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts?	**Display Slide 9.** Lesson Analysis: Focus Question 1 (Less than 1 min) a. Highlight the focus question that will guide the lesson analysis work during this phase.
		Lesson Analysis: **Review** Lesson Context Read the lesson context for this video clip at the top of the transcript (handout 4.4 in your PD program binder).	**Display Slide 10.** Lesson Analysis: Review Lesson Context (2 min) a. "Read the lesson context at the top of the video transcript (handout 4.4 in your PD program binders)." b. Make sure participants understand the science content and activity that are the focus of this video clip. **Note:** Refer to the Genetics Content Background Document as needed throughout the lesson analysis.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	Handouts in PD Binder • 4.4 Transcript for Video Clip 4.1 **PD Resources** • STeLLA strategies booklet **Resources in Lesson Plans Binder** *Resources section:* • Content background document		**Display Slide 11.** Lesson Analysis: Identify Strategy 6 (25 min) a. "As you watch the video, think about what makes the activity in this clip a use-and-apply task. What science ideas should students be using and applying in each scenario? Also notice what kinds of questions the teacher asks." b. Show the video clip. c. **Individuals:** "Think about the questions on the slide and mark the transcript as you identify the use of strategy 6." d. **Whole group:** Discuss participants' responses to the questions. **Ideal observations:** • This video clip should have included challenge questions, since the goal of strategy 6 is to move student thinking forward. • This video clip is not a good example of the use-and-apply strategy. Essentially, it's a nonexample. Students appear to have missed key science ideas from the previous lesson: Individuals have two alleles for each trait, and offspring receive one allele from each parent. Consequently, the video analysis should focus on alternatives, particularly the alternative use of questioning strategies to support students in making connections to previously learned concepts. • The teacher in this clip missed opportunities to refer students back to what they did in the previous lesson (e.g., video segments 0:02:04.1–0:03:03.1). There are also many missed opportunities to probe and challenge student thinking. One example is segment 0:02:22.7. When asked where the alleles come from, students talk about "empowering over dominant," and that "both parents would have to be recessive." The teacher could have asked a probe

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			question here, such as "What do you mean by 'empowering over dominant?'" The teacher also could have asked a challenge question at this point: "How does your idea connect with what we found in the Generation 2 duckos?" This question might have caused students to realize that their statements were incorrect, since some of the offspring of two black-billed duckos had brown bills.
		Lesson Analysis: **Analyze** Strategy 6 and **Reflect** **Analyze:** • What student thinking is revealed by engaging students in using and applying new science ideas? By providing a claim, evidence, and reasoning? **Reflect:** • What did you learn about strategy 6 from watching and analyzing this video clip?	**Display Slide 12.** Lesson Analysis: Analyze Strategy 6 and Reflect (25 min) a. **Individuals:** "For the analysis questions on the slide, study the video transcript and come up with a claim, evidence, and reasoning to support your claim." b. **Whole-group share-out:** As participants share their claims, evidence, and reasoning, encourage them to challenge one another by asking questions, disagreeing, and suggesting improvements or alternative explanations and arguments. (Refer to the norms at the heart of the RESPeCT program.) **Note:** You may also want to ask participants whether they noticed in the transcript any missed opportunities for engaging students in using and applying new science ideas. c. **Reflect (1 min):** Give participants time to think about the reflection question on the slide. d. **Whole-group discussion:** Discuss the reflection question as a group. Make sure participants note specifically what they learned about strategy 6 from watching and analyzing this video clip.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Check Your Understanding of Strategy 6 Jot down your responses to this multiple-choice quiz: 1. Use-and-apply tasks are used [before/during/after] new science ideas are introduced. 2. For difficult content ideas, students might need to practice applying new ideas in [one/two/many] different contexts. 3. [True/false]: Use-and-apply questions or activities are used primarily for student assessment at the end of a unit. 4. It's appropriate for teachers to ask [elicit/probe/challenge] questions during a use-and-apply activity. 5. Teachers should [never/judiciously/always] tell students about science ideas they are missing or stating inaccurately.	**Display Slide 13.** Check Your Understanding of Strategy 6 (5 min) **Note:** This activity is optional if time is running short. a. "To check your understanding of STL strategy 6, jot down your responses to this multiple-choice quiz." b. Have participants discuss their answers either in pairs or as a group. (If time is short, just read the answers aloud.) **Answer key:** 1. After 2. Many 3. False 4. Challenge (and probe) 5. Judiciously (defined as "good or discriminating judgment; wise, sensible, or well advised")
		Reflect: Lesson Analysis Focus Question 1 Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts?	**Display Slide 14.** Reflect: Lesson Analysis Focus Question 1 (3 min) a. **Individuals (1 min):** "Think for a moment about how you would answer the focus question on this slide." b. **Whole-group share-out (2 min):** Have a few participants share their ideas.

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr>
<td rowspan="3">10:10–10:55

45 min

(Includes 10-min break)

Review: STL Strategies 1–6

Slides 15–19</td>
<td rowspan="3">Purpose
• Review and deepen understandings of key similarities and differences among STL strategies 1–6.

Content
• STL strategies 1–6 reveal, support, and challenge student thinking.

What Participants Do
• Study the Summary of STeLLA Student Thinking Lens Strategies chart in the STeLLA strategies booklet.
• Discuss patterns, similarities, and differences among STL strategies 1–6.
• Watch a classroom video clip and identify any STL strategies used during the lesson. Discuss observations and missed opportunities.

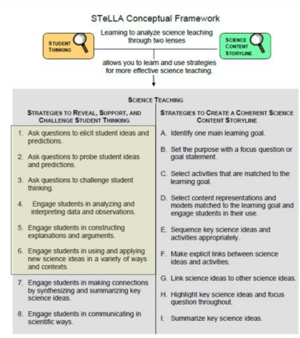
Posters and Charts
• Strategy charts from days 1–3 (STL strategies 1–5)

Videos
• Video Clip 4.2, Kawamura classroom

Handouts in PD Binder
• 4.5 Transcript for Video Clip 4.2
• 4.6 Identifying Student Thinking Lens Strategies

PD Resources
• STeLLA strategies booklet</td>
<td>Lesson Analysis: Focus Question 2

How will the Student Thinking Lens strategies help you teach the Genetics lessons?</td>
<td>Display Slide 15. Lesson Analysis: Focus Question 2 (Less than 1 min)

a. Transition: “Now we’ll shift our attention to the second lesson analysis focus question and spend some time summarizing what we’ve learned so far about Student Thinking Lens strategies 1–6. Then we’ll review the Genetics lesson plans and highlight how these strategies are used in the lessons you’ll start teaching in January.”</td>
</tr>
<tr>
<td>
</td>
<td>Display Slide 16. STeLLA Conceptual Framework (Less than 1 min)

a. “These are the Student Thinking Lens strategies we’ve explored so far. You’ll get practice using them as you teach the lessons on genetics and the Sun’s effect on climate next year.”</td>
</tr>
<tr>
<td>Review: Student Thinking Lens Strategies

Review the STL summary chart in the STeLLA strategies booklet and discuss these questions:
1. What pattern(s) do you see in this arrangement (organization) of the STL strategies?
2. How does this arrangement (organization) highlight the differences and similarities among the Student Thinking Lens strategies?</td>
<td>Display Slide 17. Review: Student Thinking Lens Strategies (3 min)

a. Individuals: Have participants review STL strategies 1–6 on the summary chart in the strategies booklet (Summary of STeLLA Student Thinking Lens Strategies).

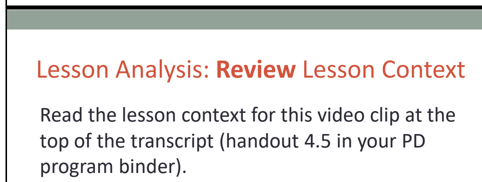
b. Whole group: Discuss the questions on the slide.

Key ideas:
• Strategies 1–3 are types of questions, and strategies 4–6 are activities designed to move student thinking forward toward more-scientific understandings.</td>
</tr>
</table>

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td></td><td></td><td></td><td>

- Some strategies are used at any time during the lesson (e.g., probe questions); others are used at specific times (e.g., elicit questions used *before* students have been introduced to new science ideas; use-and-apply activities used *after* students have been introduced to new science ideas).
- Each strategy has its own specific purpose(s), but the strategies are closely connected to one another. That is, these strategies aren't used in isolation; they're complementary.

</td></tr>
<tr><td></td><td></td><td>



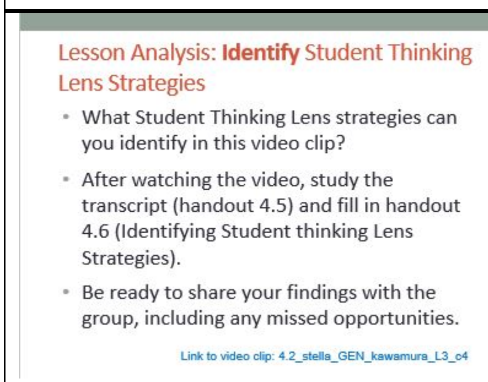
</td><td>

Display Slide 18. Lesson Analysis: Review Lesson Context (1 min)

a. "Read the lesson context at the top of the video transcript (handout 4.5 in your PD program binders)."

b. Make sure participants understand the science content and activity that are the focus of this video clip.

</td></tr>
<tr><td></td><td></td><td>



</td><td>

Display Slide 19. Lesson Analysis: Identify Student Thinking Lens Strategies (30 min)

Note: If absolutely necessary, you can skip this video analysis.

a. Orient participants to handout 4.6, Identifying Student Thinking Lens Strategies.

b. Make sure participants understand the context of the video clip (from the transcript).

c. Show the video clip.

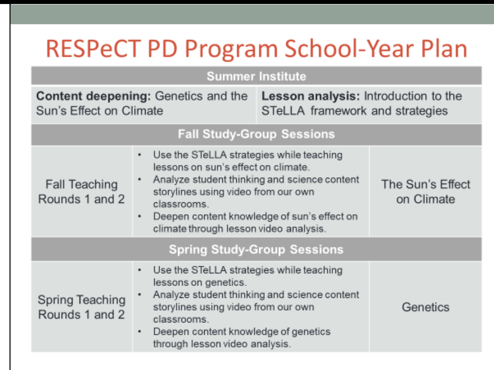
d. **Individuals:** "Study the video transcript and complete handout 4.6, Identifying Student Thinking Lens Strategies."

e. **Whole group:** "What STL strategies did you identify

</td></tr>
</table>

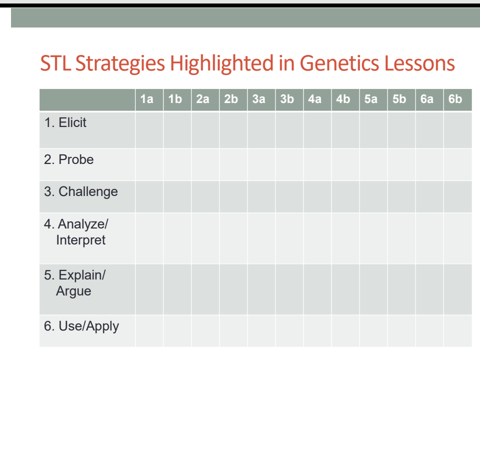
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			in the video transcript? Did you spot any missed opportunities?” **Observations:** • In this video clip, students are using and applying (strategy 6) key ideas about inheritance from previous lessons (offspring inherit one gene from each parent, and alleles can be dominant or recessive) to predict the bill color of second-generation duckos. In the process, the teacher asks probe questions (video segment 0:01:31.3; 0:01:36.6) and challenge questions (segments 0:02:25.1; 0:03:30.3–0:03:38.1). At segments 0:01:50.5 and 0:02:25.1, the teacher also asks students to support their ideas with evidence (strategy 5). • There are several missed opportunities to probe student thinking. At video segment 0:00:48.9, I wonder what Tessie means by a “fake one.” Does she equate a fake allele with a recessive allele? • At video segment 0:02:51.1, a student mentions that all of the black-bill alleles have been “used” to make offspring with black bills, so the brown bills will be present in the second generation. Does the student think that once a gene has provided instructions for a trait, it can’t be passed to the next generation? Could this student provide any evidence to support that idea?
10:45–10:55 10 min	**BREAK**		

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process

10:55–12:00
 	
65 min
 	
Genetics Lesson Plans Review
 	
Slides 20–24
	Purpose
	• Understand why the Genetics lesson plans are so scripted and how they should be used before and during the lessons.
	• Understand the conceptual flow within and across the Genetics lessons.
	• Understand the focus question, main learning goal, and main activity in each lesson.
	• Understand how STL strategies 1–6 are embedded in the lessons.
	
	Content
	• All lessons are designed to support the science content storyline within and across lessons. Each lesson contains a focus question, a main learning goal, and an activity.
	• The Student Thinking Lens strategies work together across lessons according to the following pattern:
	    • Elicit and probe strategies are very important in lesson 1.
	    • Probe and challenge strategies are used throughout all the lessons.
	    • Strategies 4 and 5 are highlighted in the middle lessons.
	    • Strategy 6 is highlighted toward the end of the lesson, after students encounter new science ideas but before final unit
			**Display Slide 20.** RESPeCT PD Program School-Year Plan (1 min)
			
			a. "Before we share our reports about each of the Genetics lesson plans and how they support you in practicing these Student Thinking Lens strategies, let's review the plan for the school year."
			b. "In the fall you'll teach the **Sun's Effect on Climate** lessons, and we'll meet in our study group to analyze video clips and student work from these lessons. This analysis will help us deepen our understandings of the STeLLA strategies, the science content, the lesson plans, and our students' thinking and learning."
			c. "Starting in January, you'll teach the **Genetics** lessons, and we'll meet in our study group to analyze video clips and student work from these lessons. Do you have any questions?"
			d. **Important reminder:** "Remember that we're analyzing video clips of our own classroom teaching to help us all learn, not to evaluate and critique one another. Everyone is learning to use both new strategies and new lesson plans, so it's predictable that our first attempts at teaching these lessons will have rough spots. We need to appreciate and acknowledge the courage each of us is demonstrating in sharing our initial efforts to teach these lessons. Please be assured that our analyses of the videos will focus on the strategies, the science content, and most importantly, how students are making sense of the lessons. We're not going to focus on rough spots or management problems. We're here to support one another and to learn and grow as science teachers."

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	assessments. **What Participants Do** • Review the plans for school-year study groups. • Listen to the PD leaders describe the lesson plans for the study groups and how they should be used/adapted. • Present a summary of an assigned lesson plan to help their peers understand the lesson. • Raise questions and concerns about the lesson plans and make suggestions. **Supplies** • Chart paper and markers **PD Resources** • RESPeCT lesson plans binder	The RESPeCT Lesson Plans as a Study Tool: Part 1 The RESPeCT lesson plans are **study tools** designed to support your learning and for our study group to analyze. This has two implications. 1. These lessons don't represent a complete unit. You may need to add lessons to help your students achieve all the learning goals, and …	**Display Slide 21.** The RESPeCT Lesson Plans as a Study Tool: Part 1 (2 min) a. Read through the information on this slide. b. Elicit and respond to any comments or questions from participants.
		The RESPeCT Lesson Plans as a Study Tool: Part 2 2. As a study tool, the lesson plans are highly scripted to model how they might be implemented. a. Study this script in your lesson planning. b. Adapt the plans and PowerPoint slides to make them work for you and your students (but don't add or drop main activities). c. You don't have to be tied to the script as you teach! Using the slides as a guide can help free you from the script.	**Display Slide 22.** The RESPeCT Lesson Plans as a Study Tool: Part 2 (2 min) a. Read through the information on this slide. b. Elicit and respond to any comments or questions from participants.
		Lesson Plan Conversation 1. **The science content storyline across lessons** • Review the main learning goal for each lesson sequentially. 2. **The science content storyline within lessons** (5–8 min for each two-part lesson) • How does this lesson fit into the arc of all the lessons? • What are the main learning goal and focus question? • What is the main activity (or activities)? • How will the activity help students better understand the learning goal for the day? • What STeLLA strategies are highlighted in the activity? • What concerns or suggestions do you have regarding the activity? 3. **Practical issues and questions**	**Display Slide 23.** Lesson Plan Conversation (60 min in conjunction with next slide). a. For step 1 on the slide, have participants describe the main learning goal for their assigned two-part lesson (parts A and B) and how it connects to the lessons that precede and follow it. (5 min) b. For steps 2 and 3, have participants report on their assigned two-part lesson. **Note:** Rather than walking through every step in the lesson plan, participants should present the *big picture* using the questions in step 2 on the slide. They should bring up details only when they

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			have some concern, question, or suggestion about a modification. c. As participants give their reports, mark on a chart the Student Thinking Lens strategies that are highlighted in each lesson. (Use the chart on the next slide as a model.) **Note:** Encourage participants to pick just one or two Student Thinking Lens strategies that are highlighted in the lesson. (Several strategies may be used in a lesson.) d. Highlight the following ideal pattern and how the STL strategies work together across lessons: • Elicit and probe strategies are very important in lesson 1. • Probe and challenge strategies are used throughout all the lessons. • Strategies 4 and 5 are highlighted in the middle lessons. • Strategy 6 is highlighted toward the end of a lesson, after students encounter new science ideas but before final unit assessments. **Timing note: Make sure you limit the time allotted for each lesson** so you can get through them all. If you have 6 two-part lessons, you'll have approximately 8 minutes for each lesson (4 minutes for part A, and 4 minutes for part B). If your lesson series has more than 6 two-part lessons, you'll have to decrease the time for each lesson.

<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td></td><td></td><td>
</td><td>Display Slide 24. STL Strategies Highlighted in Genetics Lessons

a. Use this slide in conjunction with the previous slide.</td></tr>
<tr><td>12:00–12:45
45 min</td><td colspan="3">LUNCH</td></tr>
<tr><td>12:45–3:15

150 min (Includes 10-min break)

Math Content Deepening: Genetics

Slides 25–59</td><td>Purpose
• Understand how mathematical modeling (simulation, statistical analysis, and data comparison) can be used to determine rules of expression for simply-inherited traits.
What Participants Do
• Determine rules of expression for simply-inherited traits using mathematical simulation, statistical analysis, and data comparison from activities in the Genetics lessons.
Handouts in Lesson Plans Binder
• 2.1 Mendel's Ideas (from Genetics lesson 2b)</td><td>
</td><td>Display Slide 25. Math Content Deepening: Genetics (Less than 1 min)

Note: Refer to the Genetics Content Background Document and Common Student Ideas about Variation and Inheritance of Traits as needed throughout this phase.
a. "Let's dig into our content deepening work for today."</td></tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	Supplies • Science notebooks **PD Resources** • RESPeCT lesson plans binder **Resources in Lesson Plans Binder** *Resources section:* • Content background document • Common Student Ideas	Content Deepening Focus Questions • Starting with Mendel's ideas about trait inheritance, how can we use mathematical simulation and statistical analysis to determine the **rules of expression** for simply-inherited traits? • What kinds of data sets characterize simply-inherited traits?	**Display Slide 26.** Content Deepening Focus Questions (Less than 1 min) a. Introduce today's content deepening focus questions.
	Purpose • Understand how rules of expression for simply-inherited traits can be deduced from two of Mendel's ideas about inheritance. **Content** • Starting with two of Mendel's ideas about simple inheritance, rules of expression for simply-inherited traits can be deduced using mathematical simulation and statistical analysis. **What Participants Do** • Review Mendel's ideas about simple inheritance and rules of expression for simply-inherited traits.	Mendel's Ideas about Inheritance 1. Individuals receive one allele from each parent, which means that each individual has two alleles for each trait. 2. Which one of the parent's two alleles an individual inherits is a matter of chance. **Rules of Trait Expression:** 1. If an individual inherits the same allele from each parent, that trait will be expressed. 2. If an individual inherits a different allele from each parent, only one of the traits will be expressed.	**Display Slide 27.** Mendel's Ideas about Inheritance (2 min) a. "In Genetics lesson 2, students examine ideas Mendel proposed to explain why a trait expressed in the parents can disappear in first-generation offspring and reappear in the second generation." b. "For example, in lesson 1, a long-haired dachshund and a short-haired dachshund produced short-haired offspring, but in the second generation, some of the offspring had long hair, and others had short hair." c. Point out that two of Mendel's ideas are rules of expression that explain how the genetic information passed from parents to offspring determines trait expression in the offspring. d. Read the rules of trait expression on the slide and ask participants to write them in their science notebooks.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Content Deepening: Focus Question 1 Starting with Mendel's ideas about trait inheritance, how can we use mathematical simulation and statistical analysis to determine the **rules of expression** for simply-inherited traits?	**Display Slide 28.** Content Deepening: Focus Question 1 (1 min) a. Read the focus question on the slide and ask participants to copy it into their notebooks. b. Make sure participants understand that today's content deepening work will focus on using mathematical simulation and statistical analysis to figure out the rules of expression rather than on making predictions. **Note:** Along with probability theory, rules of simple inheritance are often applied to predict the likelihood that offspring will exhibit a particular trait. Participants may be familiar with this concept if they've spoken with a genetics doctor about the chances of inheriting a disease based on family history. If this comes up during the content deepening work, emphasize that trait prediction isn't part of today's investigation and remind participants of the focus question. Rules of expression must be determined before probabilities can be discussed. Today's focus is on using statistical analysis to figure out those rules rather than on making predictions.
	Purpose • Understand how zero-one tables encode possible rules of expression so they can be enumerated. **Content** • A zero-one table encodes a rule of expression showing the trait expression that will result in the offspring from a given combination of alleles from the parents.	Working with Zero-One Tables • Zero-one tables can be used to encode rules of trait expression. • Each zero-one table represents a possible rule of expression. • Each trait we consider will have only two possible expressions. The numbers 0 and 1 on the table represent these trait expressions. • Sample zero-one table: 0 1 0 0 0 1 0 1	**Display Slide 29.** Working with Zero-One Tables (1 min) a. Read the information on the slide to introduce the idea of using zero-one tables to encode possible rules of expression.

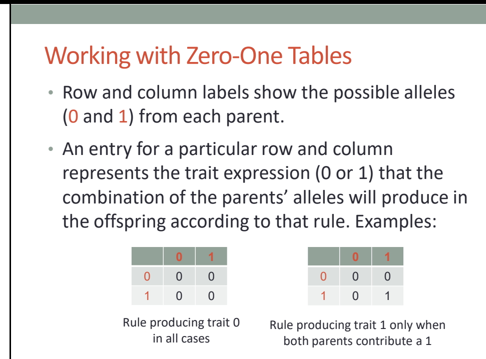
<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr>
<td></td>
<td>

- With simply-inherited traits, one of two types of alleles for a trait is expressed. These alleles are represented by the numbers 0 and 1.

What Participants Do

- Encode possible rules of expression as zero-one tables so they can be enumerated.

</td>
<td>



</td>
<td>

Display Slide 30. Working with Zero-One Tables (4 min)

Note: Zero-one tables may look like Punnett squares, but they aren't! In a Punnett square, the row labels could be 00, 01, or 11 to reflect each parent's alleles, whereas the row labels for a zero-one table are always 01. A zero-one table encodes the *rule* that determines the particular trait expression of a given pair of alleles from the parents.

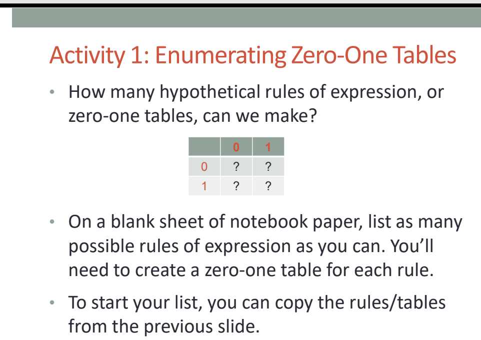
a. Talk through one of the examples on the slide and ask questions to make sure participants understand this encoding.

b. "Let's make sure we understand how these tables represent rules of trait expression. For example, the hypothetical rule for the left-hand table on the slide is that if the row parent contributes a 0 and the column parent contributes a 1, the offspring will exhibit a 0. In fact, this table shows that the offspring will exhibit a 0 no matter what the parents contribute."

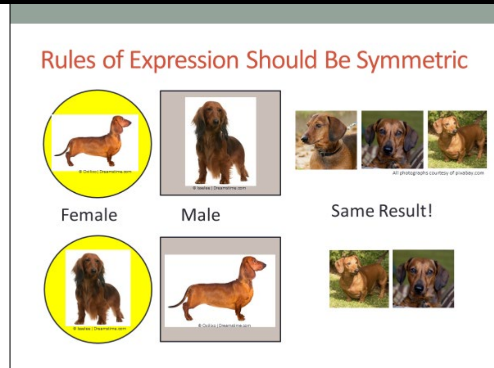
c. "Now let's look at the rule for the right-hand table. What does this rule say the offspring will express if the row parent contributes a 0 and the column parent contributes a 1? What if the row parent contributes a 1 and the column parent contributes a 0? What if both parents contribute a 1?"

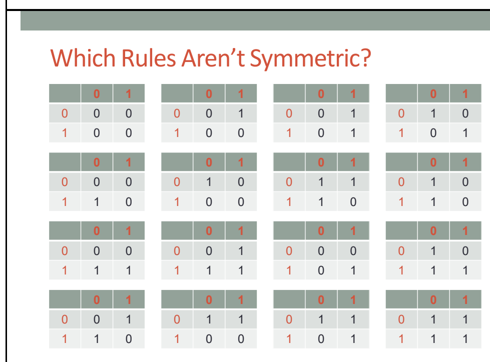
d. Invite participants to contribute their ideas to the discussion.

</td>
</tr>
</table>

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	Purpose • Understand how data encoded as zero-one tables can be used to enumerate possible rules of expression. **Content** • Possible rules of expression can be enumerated using data encoded as zero-one tables. **What Participants Do** • Use encoded data as zero-one tables to enumerate possible rules of expression. • List the 16 possible rules of expression (as zero-one tables).		**Display Slide 31.** Activity 1: Enumerating Zero-One Tables (10 min) a. "To figure out the rules of expression for simply-inherited traits, we need to identify the possible rules and then narrow the possibilities through observation. So how many hypothetical rules of expression, or zero-one tables, can we make?" b. **Individuals:** Ask participants to list the possible rules of expression in their science notebooks (i.e., have them create zero-one tables representing the possible rules). There are 16 possible rules (tables), but participants may not see this at first. Wait until after they complete their lists to reveal this. Thinking through all the possibilities requires some organization and careful planning, so participants may repeat some rules or come up with fewer than 16 possibilities. c. Circulate around the room as participants work on their tables and help anyone who looks stuck. Suggest that participants start with the first two rules from the previous slide and consider other rules they could make by modifying the table entries. d. **Pairs:** After about 5 minutes, ask participants to pair up and compare their lists. e. **Whole group:** After another few minutes, ask participants to share the number of zero-one tables (rules of expression) they came up with. Then discuss the results. f. "The table on this slide has four question marks that we can replace with either a 0 or a 1. So we can make 2 one-by-one tables by replacing the upper-left question mark with a 0 and then with a 1." g. Point to the upper-left question mark as you explain these possibilities. h. "After we replace the upper-left question mark, we

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			can do the same with the upper-right question mark, replacing it with a 0 or a 1. So for this first row of question marks, we can make 4 one-by-two tables, two with a 0 on the right, and two more with a 1 on the right.” i. Point to the upper-right question mark as you describe these new possibilities and then circle the first row of question marks. j. “So we can make 4 one-by-two rows, or a total of 16 two-by-two tables: four tables with 00 in the first row, four with 01 in the first row, four with 10 in the first row, and four with 11 in the first row.” **Note:** References to one-by-one, one-by-two, and two-by-two tables indicate the number of rows and columns.
	Purpose • Understand that the rules of expression for simply-inherited traits should be symmetric. **Content** • By comparing the possible rules of expression with the results of previous experiments, the range of possibilities can be narrowed. **What Participants Do** • Identify the rules of expression that aren’t symmetric and eliminate them from the list of possible rules. **Supplies** • Chart paper and marker		**Display Slide 32.** The 16 Possible Rules of Expression (Less than 1 min) a. “This slide shows the 16 possible rules of expression, or zero-one tables. Our goal now is to narrow the field of candidates by using observation.”

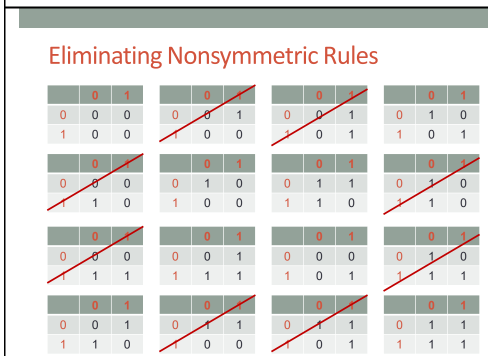
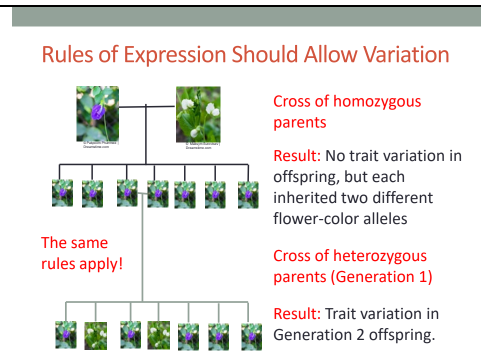
<table>
<tr><th>PD Model: Time/Phase</th><th>Purpose, Content, and What Participants Do</th><th>Slides</th><th>Process</th></tr>
<tr><td></td><td></td><td>
</td><td>Display Slide 33. Rules of Expression Should be Symmetric (2 min)

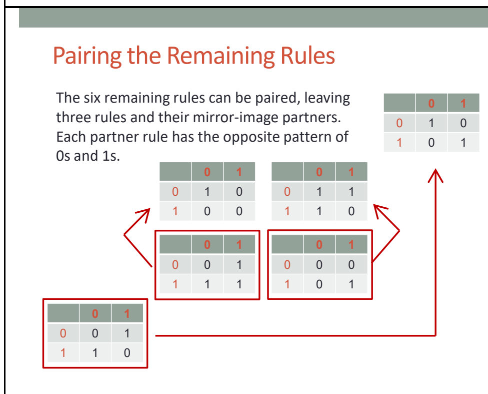
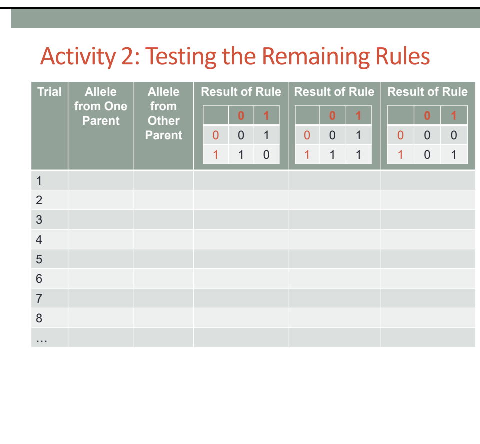
a. “The first observation we can make is that in actual experiments, it doesn’t matter which instruction comes from which parent. For example, if we cross a short-haired, pure-bred, female dachshund with a long-haired, pure-bred, male dachshund, their offspring will all have short hair. Likewise, if we cross a long-haired, pure-bred, female dachshund with a short-haired, pure-bred, male dachshund, their offspring will also have short hair. In this sense, the rules of expression should be symmetric.”</td></tr>
<tr><td></td><td></td><td>
</td><td>Display Slide 34. Which Rules Aren’t Symmetric? (5 min)

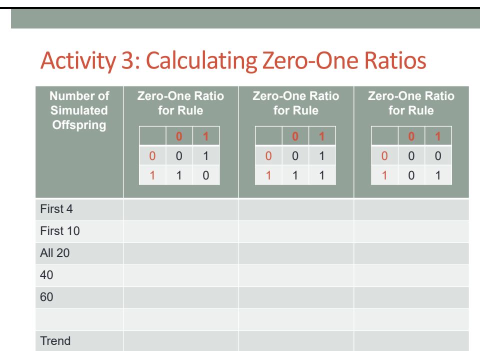
a. “Based on the observation that rules of expression should be symmetric, which of these zero-one tables should we cross off the list?”

b. Ask elicit and probe questions to make participants’ thinking visible. The goal is to elicit the idea that for rules of expression to be symmetric, the upper-right entry of a table needs to be the same as the lower-left entry. Challenge participants to give their reasoning. The upper-right entry is the result of receiving a 0 from the row parent and a 1 from the column parent, while the lower-left entry is the result of receiving a 1 from the row parent and a 0 from the column parent. If the rules of expression are symmetric, then in both cases the offspring should express the same trait.

c. If the group is having trouble seeing this, draw a nonsymmetric table on chart paper showing the father as the row parent and the mother as the column parent. Then ask whether the rules predict that an offspring will have the same trait whether the father contributes a 0 and the mother contributes a 1</td></tr>
</table>

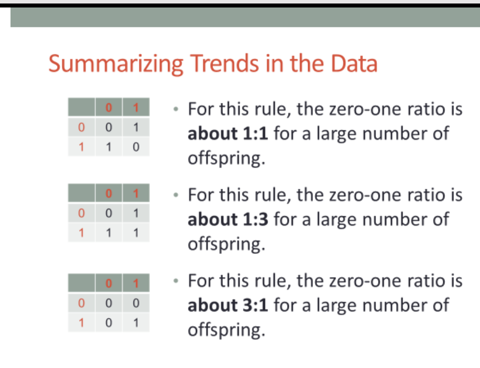
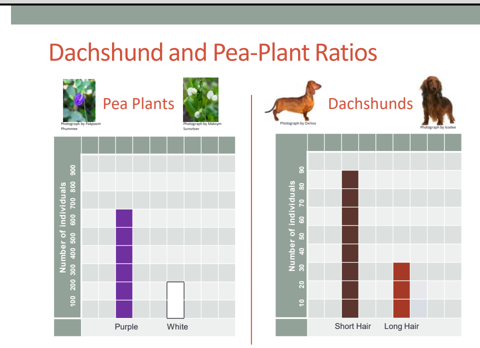
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			or vice versa. d. Ask participants to identify any nonsymmetric rules and cross them off their lists.
		 	**Display Slide 35.** Eliminating Nonsymmetric Rules (Less than 1 min) a. Have participants check their results against the results on the slide. b. Note that the remaining rules are symmetric.
	Purpose • Understand that the rules of expression for simply-inherited traits should allow for variation. **Content** • By comparing the possible rules of expression with the results of previous experiments, the range of possibilities can be narrowed. **What Participants Do** • Identify the rules of expression that don't allow for variation and eliminate them from the list of possible rules.	 	**Display Slide 36.** Rules of Expression Should Allow Variation (5 min) a. Point out that a *homozygous* parent has two of the *same allele* of a gene, and a *heterozygous* parent has two *different alleles* of a gene. b. "When Mendel crossed a purple-flowered, pure-breeding pea plant with a white-flowered, pure-breeding pea plant, he observed no variation among the offspring. All of the plants had purple flowers. But when he crossed a pair of the first-generation offspring, he observed a variation in flower color among the second-generation offspring. Assuming that the same rules of expression apply in each instance of crossbreeding, our rules must allow variation to occur as well." c. "So which of our remaining zero-one tables don't allow variation?" d. Direct participants to identify those rules and cross them off their lists.

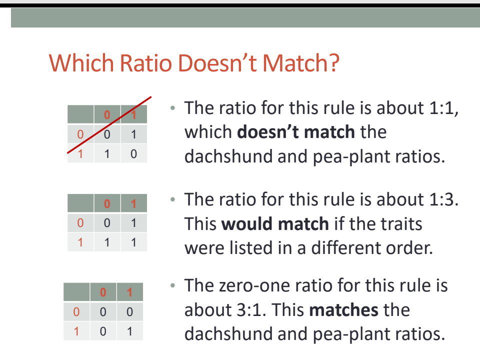
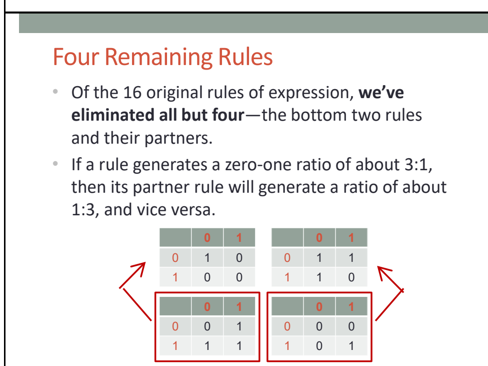
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 37.** Eliminating Rules without Variation (Less than 1 min) a. Have participants check their results against the results on the slide. b. Note that the remaining rules are symmetric and allow for variation.
			**Display Slide 38.** Pairing the Remaining Rules (1 min) a. Point out that the six remaining rules can be paired up as shown on the slide, leaving three rules and their mirror-image partners. Each partner rule has the opposite pattern of 0s and 1s. b. “Next we’ll test the three rules in the red boxes and compare the results to the dachshund and pea-plant experiments from Genetics lesson 2.”
	Purpose • Using mathematical simulation, apply the three remaining rules of expression to data sets of increasing numbers of offspring (generations) from the same heterozygous parents. **Content** • Mathematical simulation is one means of generating data for rules of expression. **What Participants Do**		**Display Slide 39.** Activity 2: Testing the Remaining Rules (20 min) a. Have participants create a table in their notebooks like the sample on the slide, **but with 20 rows**. It’s best if participants start out with a blank sheet of paper and place the header row at the top of the page. **Note:** Participants may need to turn the page sideways (landscape) to allow more space for the column headings. b. After participants have created their tables, give

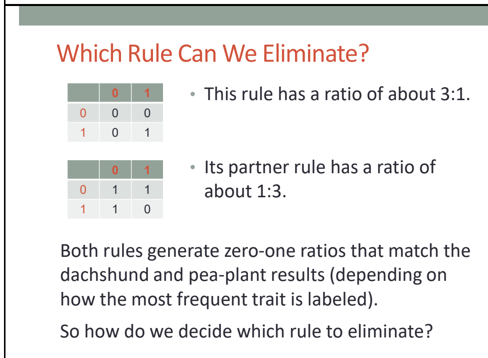
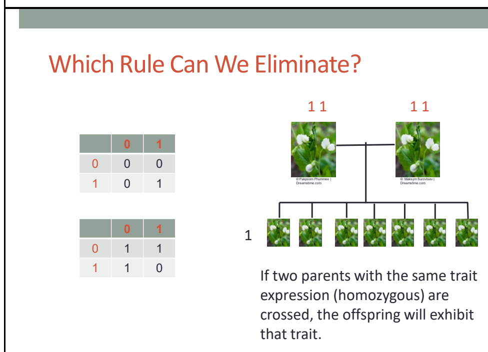
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Flip a coin to choose which of the parents' alleles to pass on to their offspring. • Work with a partner to apply rules of expression that will determine the outcome of simply-inherited traits. • Simulate a new generation from the same pair of parents using the three remaining rules to predict trait expression in the offspring. **Supplies** • 1 coin per participant		each of them a coin. c. "Now we'll apply our three rules by simulating the creation of a new generation of offspring. The parents are *heterozygous*, meaning that each parent has two different alleles of a gene. So each parent could contribute a 0 or a 1 randomly to the offspring. We'll decide which alleles the parents contribute by flipping a coin: 0 for heads and 1 for tails." d. Direct participants to flip their coins 20 times and record the results (0 or 1) in the first column of their tables. e. Afterward, have them pair up and record their partner's sequence in column 2 and then fill in the remaining columns. For each of these columns, they should apply the corresponding rule to the alleles each parent contributed and record the results. f. Since the rule is different in each scenario, it can be confusing and easy to make mistakes. Encourage pairs to work methodically through each column, making sure they're consistently applying the rule for that column and checking each other's work. To avoid confusion, suggest that they cover up each completed rule column before moving on to the next one. Only the data in the two allele columns should be visible throughout the activity.
	Purpose • Analyze the results of applying the three rules of expression in a mathematical simulation to generate larger data sets and observe patterns in the data. **Content** • Ratios for subgroups can be used to study data patterns. **What Participants Do**		**Display Slide 40.** Activity 3: Calculating Zero-One Ratios (20 min) a. Direct participants to create a table on a new sheet of paper like the sample on the slide. b. "In our simulation, each offspring exhibits only one expression of a trait, either a 0 or a 1. In a given group of offspring, the frequency of 0 equals the total occurrences of the trait expression of 0 in that group. Let's compare the frequency of 0 to the frequency of 1 by computing the zero-one ratio for

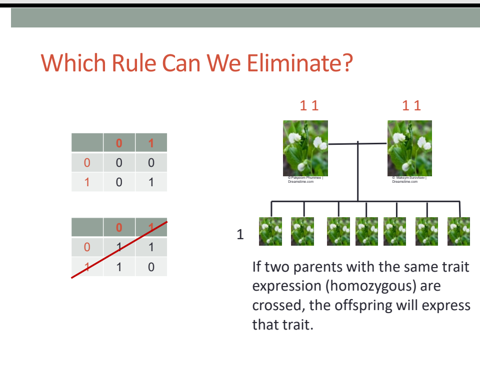
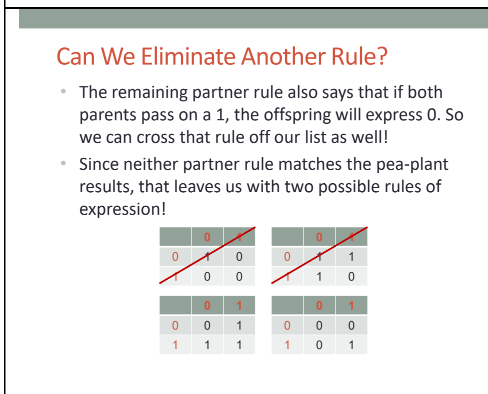
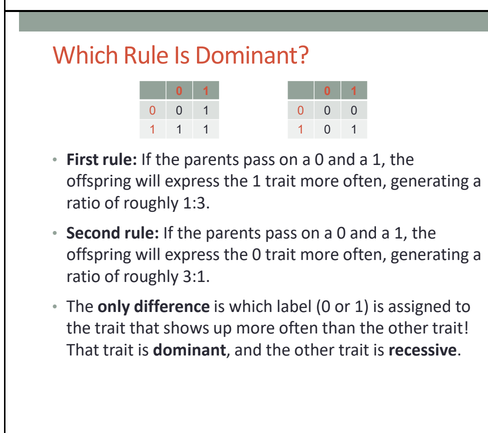
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	• Compute zero-one ratios for subgroups of increasing size and study patterns in the data. **Supplies** • Chart paper and marker		that group, or the ratio of the frequency of 0 to the frequency of 1." c. "Look at the data you and your partner generated in the previous table and calculate the zero-one ratio for the first four offspring of each rule and enter it in the table. Then compute the ratio for the first 10 of each rule, and then the first 20 of each rule." d. Suggest that one partner count the occurrences in the first table while the other partner records the results in the second table. Afterward, the first partner can copy the results into his or her table. e. While pairs are working on this task, create a large version of this table on chart paper for recording the group's results. f. After pairs have completed their calculations, record the ratios on chart paper as indicated in the following directions. **It's essential that you follow these directions exactly so that everyone will see the trend in the ratios for each rule with increasing numbers of offspring.** You'll use the statistics from these trends to determine the rules of expression among the remaining candidates. 1. Ask each pair to share their ratios for the first four offspring for the first rule. Document the results on chart paper, recording each pair's ratios next to one another in the first row, first column. 2. Then ask each pair to share their ratios for the first 10 offspring for the first rule, recording the results on the second row, first column. 3. Next, ask each pair to share their ratios for all 20 offspring for the first rule, recording the results on the third row, first column. If a pair gives you a reduced ratio like 3:1, ask the group what the frequencies were and then record 15:5 on the chart. This will make it easier to pool the data to generate more ratios. Add the frequencies of 0s and 1s from the pairs to obtain

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			data for 40 offspring. Compute the zero-one ratio and record it on the chart. Direct participants to do the same. 4. Finally, combine the data for 20 offspring from all three pairs, compute a zero-one ratio for 60 offspring, and record this ratio on the chart. 5. Ask participants, "Do you see a trend in these ratios as the number of offspring increases?" 6. On chart paper, convert each A-B ratio into (A/B):1 and point out that the fraction A/B gets closer to 1 as the number of offspring increases. Write "About 1:1" on the chart as the trend for the first rule and direct participants to copy this into their notebooks. 7. Repeat steps 1 through 4 for the second rule. Then convert each A-B ratio to 1:(B/A), since the number B will most likely be larger. Point out that the fraction B/A should get closer to 3 as the number of offspring increases. Write "About 1:3" on the chart as the trend for the second rule and direct participants to copy this into their notebooks. 8. Repeat steps 1 through 4 for the third rule. Then convert each A-B ratio to (A/B):1, since the number A will most likely be larger. Point out that the fraction A/B should get closer to 3 as the number of offspring increases. Write "About 3:1" on the chart as the trend for the third rule and direct the participants to copy this into their notebooks.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 41.** Summarizing Trends in the Data (1 min) a. Summarize the trends observed in the data for each rule and emphasize that the trend emerged as the number of offspring increased.
	10-MINUTE BREAK		
			**Display Slide 42.** Dachshund and Pea-Plant Ratios (6 min) a. Review the dachshund and pea-plant data from Genetics lesson 2. Ask participants to compute the ratio of purple to white flowers for pea plants and reduce it to a unit fraction representation. Then illustrate that the ratio of short hair to long hair for dachshunds is also 3:1. **Note:** This is a good opportunity to point out that even though the lesson data is fabricated to make the 3:1 ratios easy to calculate, it still represents a real-life scenario. b. “Which of our rules of expression doesn’t match the dachshund and pea-plant ratios?” c. Direct participants to identify any rules that don’t match and cross them off their lists.

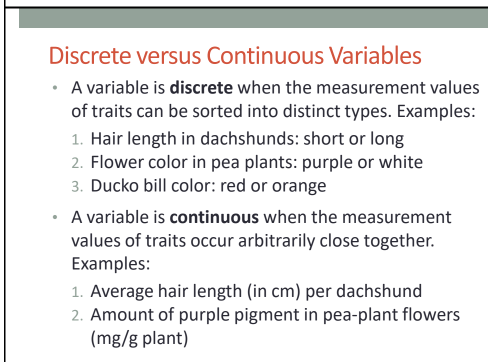
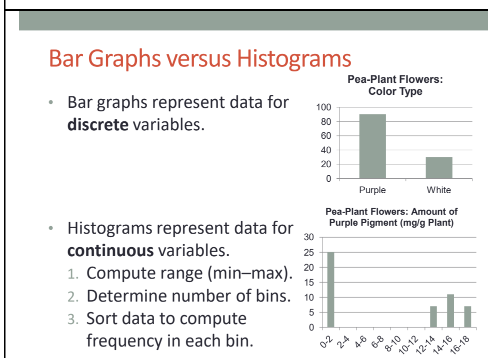
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 43.** Which Ratio Doesn't Match? (8 min) a. Have participants check their own results against the results on the slide. **Note:** Some participants may think the second rule, which produced a ratio of about 1:3, should be eliminated as well. Emphasize that the most frequently occurring expression just happened to be listed first. If the traits had been listed in a different order, this would have produced a ratio of 1:3. b. "So which of the remaining rules would you eliminate?" c. As participants share their responses, challenge their reasoning. They should reach the conclusion that the partner rule to the rule with the 1:1 ratio should be crossed off the list. The partner rule is obtained by interchanging 0s and 1s with the primary rule. So if the primary rule has a zero-one ratio of about 1:1, and the partner rule has a one-zero ratio of about 1:1, both rules have a 1:1 ratio. So neither matches the dachshund and pea-plant ratios. d. Direct participants to strike the partner rule with the 1:1 ratio off their lists.
			**Display Slide 44.** Four Remaining Rules (Less than 1 min) a. "Of the 16 original rules of expression, we've eliminated all but four—the bottom two rules on the slide and their partners." b. Emphasize that if a rule generates a zero-one ratio of about 3:1, we can expect the partner rule to generate a ratio of about 1:3, and vice versa.

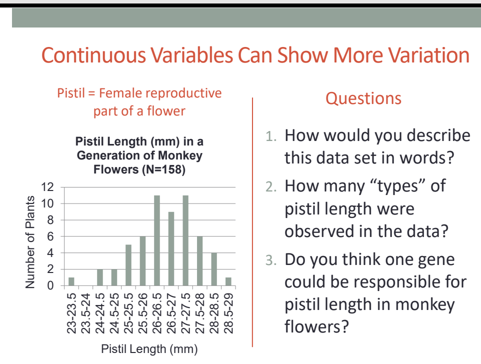
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			**Display Slide 45.** Which Rule Can We Eliminate? (7 min) a. Read through the information on the slide; then pose the question. b. Ask participants to discuss this question with a partner. c. After a few minutes, invite participants to share their ideas and reasoning. Challenge them to provide evidence to support their answers.
			**Display Slide 46.** Which Rule Can We Eliminate? (3 min) a. "To figure out which rule to eliminate, let's consider the example on the slide. If two pure-breeding parents with the same trait expression are crossed, the offspring will exhibit that trait. For instance, if we cross two pea plants with white flowers, all of their offspring will have white flowers." b. Explain that if the parents are *homozygous* (each of them has the same two alleles), they'll pass on one instruction no matter what. If both parents have the same trait expression, then the two instructions an offspring inherits will be the same, and the offspring will express the same trait as the parents. c. "So which rule on the slide would produce this result?"

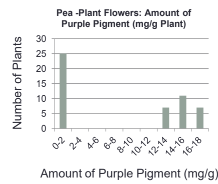
PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		 	**Display Slide 47.** Which Rule Can We Eliminate? (Less than 1 min) a. "The partner rule at the bottom of the slide says that if both parents pass on a 1, the offspring will express a 0. That rule doesn't match the pea-plant results, so we can cross it off the list." b. "Now let's see if we can eliminate any other rules."
		 	**Display Slide 48.** Can We Eliminate Another Rule? (Less than 1 min) a. "The partner rule we just eliminated said that if both parents pass on a 1, the offspring will express the 0 trait. Since the remaining partner rule says the same thing, we can cross it off the list as well." b. "Neither partner rule matches the pea-plant results, so that leaves us with just two possible rules of expression."
		 	**Display Slide 49.** Which Rule Is Dominant? (5 min) a. Highlight the two remaining rules and read through the points on the slide. Emphasize the final point: The only difference between the two rules is which label (0 or 1) is assigned to the trait that shows up roughly three times more often than the other trait. b. "The trait that shows up more often is *dominant*, and the other trait is *recessive*. So if we designate 0 as the dominant trait, the right-hand table on the slide would dictate the rules of expression. How would you express these rules in words?"

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			c. Ask elicit and probe questions to draw out participants' ideas and prompt participants to rephrase their responses in terms of dominant and recessive alleles instead of 0s and 1s. Following are ideal responses: • "If both parents pass on the dominant allele to their offspring, the offspring will express the dominant trait." • "If the parents pass on different alleles to their offspring, the offspring will still express the dominant trait." • "If both parents pass on the recessive allele to their offspring, the offspring will express the recessive trait."
		Putting the Rules of Expression into Words 1. If an individual inherits the same two alleles (two 0s or two 1s) from the parents, that trait will be expressed. 2. If an individual inherits two different alleles (a 0 and a 1) from the parents, only one of the traits will be expressed. 3. The trait that is expressed most often is **dominant**, and the other trait is **recessive**.	**Display Slide 50.** Putting the Rules of Expression into Words (4 min) a. Read the summary statements on the slide and ask participants whether these statements encapsulate their interpretations of the rules of expression. b. Then ask participants to locate handout 2.1 in their lesson plans binders (Genetics lesson 2b) and compare these statements with Mendel's ideas about inheritance.
		Reflect: Content Deepening Focus Question 1 Starting with Mendel's ideas about trait inheritance, how can we use mathematical simulation and statistical analysis to determine the **rules of expression** for simply-inherited traits?	**Display Slide 51.** Reflect: Content Deepening Focus Question 1 (5 min) a. Revisit the first content deepening focus question and ask participants to write an answer in their science notebooks. Allow at least 5 minutes for this task, since participants have a lot of ideas to synthesize. **Ideal response:** • Since each parent passes one of two types of instructions (alleles) to their offspring, and each

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			offspring exhibits only one expression of a trait, we know there are 16 possible rules of expression. It doesn't matter which rule comes from the mother and which comes from the father, so we can cross off the rules that aren't symmetric. Since some generations show trait variations (i.e., some of the offspring exhibit different traits), we can cross off the rules that don't allow for variation. This leaves six rules of expression that can be paired. By applying these rules in a simulation and matching the data with the results of previous experiments, we can cross off the rules that don't generate a ratio of roughly 3:1 or 1:3. This leaves two rules and their partners to consider. Since the offspring of pure-breeding parents with the same expression of a trait also exhibit that trait, we can cross off the partner rules showing offspring with a different trait. The only difference between the remaining two rules is which label is assigned to the more frequently occurring expression of the trait. The dominant trait is identified as the trait that shows up more often in large groups of offspring. The other trait is recessive. Mendel's ideas from lesson 2 summarize these rules of expression.
		Content Deepening: Focus Question 2 What kinds of data sets characterize simply-inherited traits?	**Display Slide 52.** Content Deepening: Focus Question 2 (3 min) a. Introduce the second content deepening focus question and direct participants to write it in their notebooks. b. "The dachshunds in the Genetics lessons express one of two hair-length traits: short hair or long hair. Do you think that if we measure the actual hair length in a group of offspring, we'll observe only one of two possible hair-length measurements?" **Possible responses:** 1. "No. It might depend on which hair you measure

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			on each dog. Not all hairs will be exactly the same length. In long-haired dachshunds, facial hair is shorter than body hair.” 2. “No. It might depend on whether the offspring are puppies or adults. Hair length in long-haired puppies might be shorter than in long-haired adults, but long-haired puppies could still have longer hair than short-haired adults. There could be more than two possibilities.”
			**Display Slide 53.** Discrete versus Continuous Variables (1 min) a. Read through the information on the slide, highlighting the difference between discrete and continuous variables. Emphasize that a variable is *discrete* when the measurement values of traits can be sorted into two or more distinct types. A variable is *continuous* when the measurement values of traits occur arbitrarily close together.
			**Display Slide 54.** Bar Graphs versus Histograms (1 min) a. Highlight the difference between a bar graph and a histogram. b. **Bar graphs** represent data for *discrete* variables. In a bar graph, each bar has a label indicating a possible value (such as purple or white flowers). c. **Histograms** represent data for *continuous* variables. In a histogram, each bar has a label indicating a bin (or interval) of values (such as an interval of 2–4).

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
	Purpose • Explore ideas about discrete versus continuous variation. **Content** • Representation of data. • Variation of data. • Mode of data. **What Participants Do** • Compare and contrast two data sets and discuss observations.		**Display Slide 55.** Continuous Variables Can Show More Variation (7 min) a. Direct participants to discuss the questions on the slide with a partner. b. Invite pairs to share their answers to the first question with the group. Ask elicit, probe, and challenge questions to elicit ideas, clarify thinking, and challenge participants to provide reasoning to support their answers. Participants should find questions 1 and 3 easy to answer. Question 2 is purposefully vague to encourage scientific argumentation. There is no "right" answer to this question, and participants may reasonably come up with different responses. The main point is that with such a large random sample, nearly every bin is populated, and it isn't clear that pistil length can be sorted into distinct types. **Ideal responses:** • *Question 1:* "The 26.5 to 27 millimeter interval contains the most data, but pistil length varies from 23 to 29 millimeters." • *Question 2:* "This question is hard to answer. There are 12 bins in the histogram, but we don't think there are 12 types of pistil length because it's a continuous variable." • *Question 3:* "We think not, because if there were one gene, this variable would have only two possible values: long or short." c. "What is the mode of this data set? In other words, what pistil length occurred most frequently in these measurements?" **Note:** The mode of a data set is the most frequently occurring measurement.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Continuous Variables Can Show More Variation Pistil = Female reproductive part of a flower  Questions 1. How would you describe this data set in words? 2. How many “types” of amount of purple pigment were observed? 3. Do you think one gene could be responsible for the amount of purple pigment in pea-plant flowers?	**Display Slide 56.** Continuous Variables Can Show More Variation (7 min) a. Direct participants to discuss the questions on the slide with a partner. b. Invite pairs to share their answers to the first question with the group. Ask elicit, probe, and challenge questions to elicit ideas, clarify thinking, and challenge participants to provide reasoning to support their answers. Participants should find questions 1 and 3 easy to answer. Question 2 is purposefully vague to encourage scientific argumentation. Since it’s unclear that purple pigment can be sorted into different types, participants may reasonably come up with different answers to this question. **Ideal responses:** • *Question 1:* “The data are separated into two distinct clusters, or groups, widely separated by unpopulated bins.” • *Question 2:* “There are anywhere from 2 to 4 types of amount of purple pigment depending on whether the data from intervals 12 to 18 are considered part of the same group or three different types.” • *Question 3:* “We say yes because we can identify two distinct types: white (low amount of purple pigment) and purple (high amount purple pigment).” c. “What would you say is roughly the most frequently occurring measurement in the first group? What about in the second group?” **Content note:** The most frequently occurring data measurement is the mode of a *discrete* variable. But for a continuous variable, it’s unlikely that any two measurements will exactly agree. For this reason, the data values are grouped in bins or intervals of

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
			equal size. In this table, each bin includes three values (0–2, 2–4, etc.). The central value of a bin can then be used as the approximate value of all the data points in the bin, and the central value of the bin that contains the most data points is considered an approximation of the mode. For example, a value of 1 is the approximate value of the data points in the 0–2 bin. Unfortunately, this approximation can be different depending on the size of the bins or intervals, so this is a rough idea.
		Comparing Types of Variation 1. The continuous data for the amount of purple pigment in pea-plant flowers is separated into two distinct groups, each with small variations. • The mode of the first group is roughly 1 mg/g plant with a frequency of 25. • The mode of the second group is roughly 15 mg/g plant with a frequency of 11. • The ratio of the frequencies of the modes is roughly 3:1. 2. The continuous data for pistil length in monkey flowers is not clearly separated into distinct groups.	**Display Slide 57.** Comparing Types of Variation (1 min) a. Highlight the key points on the slide comparing continuous data and types of variation.
		Genetics Questions • Is it possible that pistil length is **not** a simply-inherited trait? • Is it possible that more than one gene could be responsible for pistil length? • But then what are the rules? • How can we explain the data we observe? • Could environmental factors explain the variations?	**Display Slide 58.** Genetics Questions (1 min) a. Read the genetics questions on the slide and note that scientists pursue these types of questions to understand life.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Reflect: Content Deepening Focus Question 2 What kinds of data sets characterize simply-inherited traits?	**Display Slide 59.** Reflect: Content Deepening Focus Question 2 (5 min) a. Review the second content deepening focus question and have participants write an answer in their science notebooks. Allow the full 5 minutes for this activity, since participants have a lot of ideas to synthesize. **Ideal response:** • Simply-inherited traits are characterized as two groups of data sets with little variation in each group, and with the mode of one group (the most frequently occurring measurement) roughly three times the mode of the other.
3:15–3:30 15 min **Wrap-Up: Summary, Homework, and Reflections** Slides 60–63	**Purpose** • Summarize and reflect on key ideas from today's learning and preview the transition to the Science Content Storyline Lens (SCSL) strategies. **What Participants Do** • Review today's focus questions. • Share key ideas from the lesson analysis (strategy 6), lesson plan review, and content deepening work. • Copy down the homework assignment. • Write their reflections on today's learning. **Handouts in PD Binder** • 4.7 Daily Reflections—Day 4 **Supplies** • Science notebooks	Today's Focus Questions 1. Why is it necessary to engage students in using and applying new science ideas in a variety of ways and contexts? 2. How will the Student Thinking Lens strategies help you teach the Genetics lessons? 3. Starting with Mendel's ideas about trait inheritance, how can we use mathematical simulation and statistical analysis to determine the **rules of expression** for simply-inherited traits? 4. What kinds of data sets characterize simply-inherited traits?	**Display Slide 60.** Today's Focus Questions (2 min) a. Review today's focus questions. b. **Individual think time (1 min):** Ask participants to reflect on these questions and think about how they might revise their answers.
		Let's Summarize! **Lesson Analysis Strategy 6** • What new understandings did you develop? • What do you still have questions about? **Lesson Plans Review** • What new insight(s) did you gain? • What do you still have questions about? **Content Deepening** • What did you learn? • What do you still have questions about?	**Display Slide 61.** Let's Summarize! (5 min) a. **Individual think time (1 min):** Give participants a minute to think about the questions on the slide and consider questions they still have. Challenge them to formulate a statement summarizing what they learned in each area. b. **Whole-group share-out:** Have participants share at least two different statements about each of the areas on the slide. Elicit more if time allows.

PD Model: Time/Phase	Purpose, Content, and What Participants Do	Slides	Process
		Homework 1. Read in the STeLLA strategies booklet: • Student Ideas and Science Ideas Defined • Introduction to the Science Content Storyline Lens • Science Content Storyline Lens, STeLLA Strategy A: Identify One Main Learning Goal 2. Complete strategy-A column on the Coherent Science Content Storyline Strategies Z-fold summary chart (front binder pocket).	**Display Slide 62.** Homework (3 min) a. "Next week we'll focus on the Science Content Storyline Lens strategies and explore a new content area: the Sun's effect on climate. To prepare, complete the homework tasks on the slide." b. Make sure participants copy the assignment into their science notebooks.
		Reflections on Today's Session Complete the Daily Reflections sheet (handout 4.7 in PD program binder). 1. This weekend you bump into a friend who knew you were attending RESPeCT this week. What would you say you've learned about the STeLLA Student Thinking Lens strategies and their potential impact on your teaching practice and/or student learning? 2. What do you understand better about trait variation and inheritance after this week's session? What helped clarify your understanding?	**Display Slide 63.** Reflections on Today's Session (5 min) a. Give participants time to reflect on today's session and write their responses to the questions on the Daily Reflections sheet (handout 4.7 in PD program binder).