Genetics
Lesson 4b: Ducko Model of Inheritance—Patterns of Traits in Generation 2

Grade 6	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 4b of 6 two-part lessons on genetics
Unit central question: Why are individuals of a species different from one another?		**Lesson focus question:** How can a model of inheritance further explain how offspring can have a trait their parents don't have?
Main learning goal: During reproduction, parents' chromosomes (and the genes located on them) are randomly separated and recombined in their offspring. All offspring will exhibit the dominant trait if they inherit a dominant allele from one or both parents. If offspring inherit a recessive allele from each parent, they will exhibit the recessive trait even though their parents don't.		
Science content storyline: Genes provide instructions for a trait. Different forms of the same gene are called *alleles*. Alleles provide instructions for variations of a trait. Organisms that reproduce sexually have two alleles for each gene, one allele from their mother, and the other from their father. Just like traits, alleles can be described as dominant or recessive. Offspring exhibit the dominant trait if they inherit a dominant allele from one or both parents. They exhibit the recessive trait if they inherit a recessive allele from each parent. The particular alleles offspring inherit from their parents are one factor that explains the variations we see among individuals of a species.		
Ideal student response to the focus question: If each parent has an allele for the recessive trait and an allele for the dominant trait, a trait that doesn't show up in the parents might show up in the offspring. That means if the dominant trait shows up in the parents, the recessive trait would be hidden or covered up. If the offspring receive a recessive allele from each parent, the recessive trait will show up even though neither of their parents exhibit that trait.		

Preparation

Materials Needed
- Science notebooks
- 1 brown lunch bag for each student (for chromosomes)
- 1 lunch-sized, resealable plastic bag for each pair of students (for Legos)
- Legos for each pair of students:
    - 4 yellow 2 × 4 bricks
    - 2 yellow 2 × 2 bricks
    - 2 red 2 × 2 bricks
    - 2 orange 2 × 2 bricks

Student Handouts and Teacher Masters
- 4.3 B Alleles (see Ahead of Time)
- 4.4 b Alleles (see Ahead of Time)
- 4.5 Making Generation 2 Duckos (1 per student)
- 4.6 Bar Graph for Generation 2 Duckos Bill Color (Teacher Master) (1 blank graph to fill in on document reader and 1 sample graph)

Ahead of Time
- Review the Genetics Content Background Document, especially sections 1 and 6.
- Label the brown lunch bags "Generation 1 Nucleus."
- Make one copy each of handouts 4.3 and 4.4 for classes of 30 or fewer students, or two copies of each for larger classes. Use the same two colors of cardstock as handouts 4.1 and 4.2.
- Cut out the "chromosomes" from handouts 4.3 and 4.4. Place one "B" chromosome and one "b" chromosome in each of the Generation 1 Nucleus bags.
- Place a set of Lego bricks in each of the plastic bags (see materials list).

Lesson 4b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** Using what they've learned about genes and alleles, students share their best answers to the focus question from the previous lesson and explain why they think the orange-bill trait seemed to disappear in Generation 1 of the duckos.	• Genes provide instructions for a trait. Different forms of the same gene are called *alleles*. Alleles provide instructions for variations of a trait. Some alleles are dominant and others are recessive.
3 min	**Lesson focus question:** The teacher introduces today's focus question, *How can a model of inheritance further explain how offspring can have a trait their parents don't have?*	
6 min	**Setup for activity:** Students offer predictions and reasons for what they expect to see when alleles for the bill-color trait are passed from the first generation of duckos to the next generation.	
15 min	**Activity:** Students simulate chromosomes from Generation 1 parents being passed to their offspring and then use Legos to create Generation 2 duckos.	• Offspring exhibit the dominant trait if they inherit a dominant allele from one or both parents. They exhibit the recessive trait if they inherit a recessive allele from each parent. The particular alleles that individuals inherit is one factor that explains the variations we see among individuals of a species.
10 min	**Follow-up to activity:** The teacher tallies the number of red-billed and orange-billed duckos in Generation 2, and students use this data to make a class bar graph. Then they surmise why there are more red-billed duckos in Generation 2 than orange-billed duckos, and how a trait that was absent in Generation 1 reappeared in Generation 2.	• If both parents have a dominant and a recessive allele, they will exhibit the dominant trait. However, these parents can still pass on the recessive allele to their offspring. If both parents pass on a recessive allele, their offspring will exhibit the recessive trait.
5 min	**Synthesize/summarize today's lesson:** Students answer the focus question based on the Generation 2 results. The teacher summarizes key science ideas from the lesson.	• If both parents have a dominant and a recessive allele, they will exhibit the dominant trait, but they can still pass on a recessive allele to their offspring. If the offspring inherit a recessive allele from each parent, they'll exhibit the recessive trait even though their parents don't.
1 min	**Link to next lesson:** The teacher foreshadows the next lesson by introducing the idea that different combinations of alleles in the parents lead to trait variations in the offspring.	

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5 min	**Link to Previous Lesson** **Synopsis:** Using what they've learned about genes and alleles, students share their best answers to the focus question from the previous lesson and explain why they think the orange-bill trait seemed to disappear in Generation 1 of the duckos. **Main science idea(s):** • Genes provide instructions for a trait. Different forms the same gene are called *alleles*. Alleles provide instructions for variations of a trait. Some alleles are dominant and others are recessive.	Highlight key science ideas and focus question throughout.	**Show slides 1 and 2.** At the end of the last lesson, you wrote in your science notebooks your best answer to the focus question, *How can a model of inheritance explain how a trait may seem to disappear in a family?* How did you answer this question? Let's hear your ideas and explanations based on what you know about chromosomes, genes, and alleles. **NOTE TO TEACHER:** *The purpose of this discussion is to reinforce students' understandings that genes have different forms. These different forms, or alleles, provide the instructions for traits. In Generation 1 of the duckos, each offspring receives one red-bill allele from each parent, so according to the gene instructions, it isn't possible for any of the offspring to have the orange-bill* ***trait****. However, the Generation 1 offspring do have an orange-bill* ***allele****. That leads to different outcomes in Generation 2, which students investigate in this lesson.*	Each ducko in Generation 1 had one parent with a red bill. So each ducko had one instruction card that said, "Give the ducko a red bill." The instructions were the genes or alleles. I'm not sure which one. Genes each have two alleles, so we had two alleles in our bag, one from the mother and one from the father. The orange-bill trait	What did these instructions represent? What is the difference between a gene and an allele?

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				disappeared in the Generation 1 duckos because the instructions for that allele said, "If there is no allele with instructions for a red bill, give the ducko an orange bill." But every ducko in Generation 1 had instructions for a red bill, so that was the trait that showed.	Does anyone agree or disagree? Do you have anything to add on?
3 min	**Lesson Focus Question** **Synopsis:** The teacher introduces today's focus question, *How can a model of inheritance further explain how offspring can have a trait their parents don't have?*	Set the purpose with a focus question or goal statement.	**Show slide 3.** Our focus question today is similar to the one from our previous lesson: *How can a model of inheritance further explain how offspring can have a trait their parents don't have?* Both focus questions talk about a *model of inheritance*. What do you think that means? What is a model of inheritance, and what does it show us?	We read about how chromosomes in cells divide and then get back together. Is that a model of inheritance? We've been looking at how inheritance works	Can anyone add to this idea?

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			You're on the right track. A model of inheritance shows how chromosomes, genes, and alleles of parents separate and then recombine in offspring to produce certain traits. We'll continue exploring this model today as we refine our science ideas.	in duckos. I guess that's a model of inheritance. It's all about traits, genes, and alleles and how they work in cells.	
6 min	**Setup for Activity** **Synopsis:** Students offer predictions and reasons for what they expect to see when alleles for the bill-color trait are passed from the first generation of duckos to the next generation.	Make explicit links between science ideas and activities **before** the activity. Ask questions to elicit student ideas and predictions.	**Show slide 4.** In our last lesson, we applied our understanding of chromosomes, genes, and alleles to a new organism called duckos, and we investigated what happened in the first generation of ducko offspring when their parents had different-colored bills. Today we'll think about the second generation of ducko offspring. Based on what we saw with the dachshunds and pea plants, what do you predict Generation 2 duckos will look like? **NOTE TO TEACHER:** *Keep this discussion brief. Students should indicate that Generation 2 will include offspring with both red and orange bills. They may or may not predict that there will be*		

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			more offspring with one bill color, but that's okay at this point. **Turn and Talk:** Why do you think one variation of the ducko bill trait seems to disappear in Generation 1 and then shows up again in Generation 2? Discuss this question with a partner. **ELL support:** *Variation* is a Tier 2 vocabulary word that you could explain to ELL students. **NOTE TO TEACHER:** *Give students 2 or 3 minutes to discuss their ideas. Circulate among the pairs, listening for correct and incorrect understandings of the science ideas so you can address them during the activity.*		
15 min	**Activity** **Synopsis:** Students simulate chromosomes from Generation 1 parents being passed to their offspring and then use Legos to create Generation 2 duckos. **Main science idea(s):** • Offspring exhibit the dominant trait if they inherit a dominant allele from one or both parents. They exhibit the recessive trait if they	Engage students in using and applying new science ideas in a variety of ways and contexts. Select content representations and models matched to the learning goal and engage students in their use.	**Show slide 5.** Now you and your partner will use our model of inheritance to create the next generation of duckos. **NOTE TO TEACHER:** *Distribute handout 4.5, Making Generation 2 Duckos; then review the directions on the slide and the handout prior to handing out the Generation 1 Nucleus bags and ducko parts to students. Pause at step 2 on the handout and ask the following question before continuing.* Why do you think the handout directions say to shake the bag and remove one		

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	inherit a recessive allele from each parent. The particular alleles that individuals inherit is one factor that explains the variations we see among individuals of a species.		chromosome *without looking*? **NOTE TO TEACHER:** *Emphasize that the way chromosomes separate occurs randomly. By shaking the bag and choosing a chromosome without looking, students are modeling the random nature of inheritance.* *Emphasize step 3: Students should return the chromosomes to their bags and shake again. They should **not** just use the remaining chromosomes in their bags. Make sure that each student gets a Generation 1 Nucleus bag and a set of Legos.* Look inside your Generation 1 Nucleus bag. The alleles are marked with either a capital *B* or a lowercase *b* to indicate that they contain instructions for either the red-bill trait (B) or the orange-bill trait (b). Each of you should have a red-bill allele and an orange-bill allele. Why does everyone have the same two alleles? Do you remember where the Generation 1 duckos got their alleles from?	Each of our duckos got their alleles from their mom and their dad, and since one parent had two red alleles and one parent had two orange alleles, each kid ended up with a red and an	

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			NOTE TO TEACHER: *After the discussion, direct students to return the chromosomes to their lunch bags, making sure that each bag has one chromosome with a B allele and one chromosome with a b allele. Then have pairs of students follow the instructions on handout 4.5 to build two baby duckos using Lego bricks.*	orange allele.	
10 min	**Follow-Up to Activity** **Synopsis:** The teacher tallies the number of red-billed and orange-billed duckos in Generation 2, and students use this data to make a class bar graph. Then they surmise why there are more red-billed duckos in Generation 2 than orange-billed duckos, and how a trait that was absent in Generation 1 reappeared in Generation 2. **Main science idea(s):** • If both parents have a dominant and a recessive allele, they will exhibit the dominant trait. However, these parents can still pass on the recessive allele to their		**Show slide 6.** Now that you've created your Generation 2 baby duckos, let's count how many have red bills and how many have orange bills. ***NOTE TO TEACHER:*** *Have students raise their hands so you can count how many red-billed and orange-billed duckos were created. Record the data on the board and then guide students in using this data to make a class bar graph that represents the results.* *Display a copy of handout 4.6 on a document reader to create the bar graph. The bar representing the number of red-billed duckos should be shaded in red, and the bar representing the number of orange-billed duckos should be orange.* **Show slide 7.** What patterns do you see in the bar-		

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	offspring. If both parents pass on a recessive allele, their offspring will exhibit the recessive trait.		graph data for the Generation 2 duckos? **ELL support:** Allow time for ELL students to practice discussing their ideas in same-language groups using both their native languages and English before articulating them to the whole class. Who can explain how we ended up with orange-billed and red-billed duckos when all the parents had red bills? Make sure to include what you know about genes and alleles in your explanations. **NOTE TO TEACHER:** *At this point, it might be helpful to remind students of today's focus question:* How can a model of inheritance further explain how offspring can have a trait their parents don't have? *Point out that the ducko model of inheritance illustrates the answer to this question.*	There are both red-billed and orange-billed duckos. There are more red-billed duckos than orange-billed duckos.	0
		Engage students in constructing explanations and arguments.	Who can explain why there are more red-billed duckos than orange-billed duckos in Generation 2?	Because red is the dominant trait. You had to pull an orange allele from each bag to get an orange-billed ducko. That didn't happen very often	What do you mean by "dominant"? How do you know red is the dominant trait?

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				because we got fewer orange-billed duckos than red ones.	
				Because orange is the recessive trait.	Why did you need two orange alleles to make an orange-billed ducko?
				Because if the offspring got a red allele from either or both of their parents, the instructions say to give the baby ducko a red bill.	How do you know that orange is a recessive trait?
					What does it mean if a trait is recessive?
			Do you think there will always be more red-billed duckos than orange-billed duckos? Why or why not?	It would depend on what genes the parents had. If both parents had orange bills, then you wouldn't get any red-billed duckos at all.	
			Let's compare our results for the Generation 2 duckos with bar graphs for other Generation 2 organisms to see if the patterns of trait inheritance are the same. **Show slide 8.**		

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			What do you notice about the bar graphs for the second generations of dachshunds and pea plants? Are they similar to our bar graph for the Generation 2 duckos? In what ways? **Show slide 9.** Now let's look at bar graphs for two other Generation 2 organisms—guinea pigs and parakeets. Are these bar graphs similar to our bar graph for the Generation 2 duckos? Why or why not?	Yes, all the bar graphs show more of the dominant trait than the recessive trait.	
5 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students answer the focus question based on the Generation 2 results. The teacher summarizes key science ideas from the lesson. **Main science idea(s):** • If both parents have a dominant and a recessive allele, they will exhibit the dominant trait, but they can still pass on a recessive allele to their	Highlight key science ideas and focus question throughout. Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 10.** Our focus question is *How can a model of inheritance further explain how offspring can have a trait their parents don't have?* In other words, can you explain how two red-billed ducko parents produced some orange-billed offspring? **Turn and Talk:** Discuss these questions with a partner and then answer the focus question in your science notebooks. Use the science ideas you've learned and the Generation 2 data we gathered today to explain your reasoning.		

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	offspring. If the offspring inherit a recessive allele from each parent, they'll exhibit the recessive trait even though their parents don't.		Your answers should include the words *chromosomes*, *genes*, *alleles*, *dominant*, and *recessive traits*. **NOTE TO TEACHER:** *Give students 3 or 4 minutes to answer the focus question.* **ELL support:** Remind students that classroom resources are available to explain the vocabulary words. Alternatively, reviewing these words with ELL students before they answer the focus question will help them incorporate these terms in their writing. Including visual representations may also help them translate these concepts into written language. **Show slide 11.**		
		Summarize key science ideas.	Let's review a few key science ideas that explain how two parents that *don't* show a trait can have offspring that *do* show the trait. 1. If each parent has two different alleles of a gene, the dominant allele determines which trait they exhibit. 2. Even though both parents exhibit the dominant trait, each of them can still pass on a recessive allele to the offspring. 3. If both parents pass on a recessive		

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			allele, their offspring will exhibit the recessive trait.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher foreshadows the next lesson by introducing the idea that different combinations of alleles in the parents lead to trait variations in the offspring.	Link science ideas to other science ideas.	**Show slide 12.** Today we learned how a model of inheritance can help us explain how offspring can have a trait their parents don't have. In our ducko model, we figured out how the Generation 2 ducko offspring had both red and orange bills, even though their parents had only red bills. We also saw that more of the Generation 2 duckos had red bills than orange bills. This raises some interesting questions. Does the dominant trait always show up in offspring? Are there ever any situations where **none** of the offspring have the dominant trait? Or could more of the offspring have the recessive trait than the dominant trait? What do you think? Tomorrow, we'll explore how different combinations of the parents' alleles can influence the pattern of trait variations in the offspring.	If neither of the parents has a dominant allele, then I guess all the offspring would have the recessive trait.	