Genetics
Lesson 4a: Ducko Model of Inheritance—Pattern of Traits in Generation 1

Grade 6	**Length of lesson:** 50 minutes	**Placement of lesson in unit:** 4a 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 explain how a trait may seem to disappear in a family?
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.		
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 variation 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, the recessive trait might show up in the offspring even if it doesn't show up in the parents. That means if the dominant trait shows up in each parent, the recessive trait will 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 • 2 brown lunch bags (large enough to hold the "chromosomes" in handouts 4.1 and 4.2) **Student Handouts** • 4.1 Bill-Color Gene (Red) (1 copy on two different colors of cardstock) • 4.2 Bill-Color Gene (Orange) (1 copy on two different colors of cardstock)	**Ahead of Time** • Review the Genetics Content Background Document, especially sections 1 and 6. • Label one of the lunch bags "Red-billed Parent Nucleus," and the other "Orange-billed Parent Nucleus." • Cut out the "chromosomes" from handouts 4.1 and 4.2. Place the two chromosomes from handout 4.1 in the Red-billed Parent Nucleus bag, and the two chromosomes from handout 4.2 in the Orange-billed Parent Nucleus bag. Consider laminating these cutouts for use with multiple classes or across multiple years.

Lesson 4a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** The teacher reviews key science ideas from lessons 2 and 3.	• By experimenting with pea plants, Gregor Mendel came up with some ideas about how traits are passed from parents to offspring. Many years later, scientists used microscopes to figure out that the genes controlling how traits are passed from parents to offspring are located on chromosomes in the nucleus of each cell. We can use that information to explain the pattern of trait variations that occurred in the dachshunds and pea plants.
3 min	**Lesson focus question:** The teacher introduces the focus question, *How can a model of inheritance explain how a trait may seem to disappear in a family?*	
6 min	**Setup for activity:** The teacher introduces an activity simulating how alleles for the bill-color trait in "duckos" are passed from parents to offspring. Students predict what they expect to see in the first (F1) generation and discuss the reasons for their predictions.	
15 min	**Activity:** Students simulate how traits are passed from parents to offspring in duckos and explain the pattern of traits observed in the F1 offspring.	• 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.
10 min	**Follow-up to activity:** Students analyze their bill-color data and explain why no ducko offspring in Generation 1 exhibit the recessive orange-bill trait.	• 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. The dominant allele covers up the recessive allele. That doesn't mean the recessive allele has disappeared, but it won't be visible in the Generation 1 offspring.
10 min	**Synthesize/summarize today's lesson:** Using the ducko model of inheritance, students explain why the recessive orange-bill trait is hidden in Generation 1 offspring.	• Even though offspring get instructions (genes) for a trait from both the mother and the father, if the offspring inherit a different allele from each parent, they will exhibit only the dominant trait, and the recessive trait will be covered up. In the case of the duckos, the red-bill allele is dominant, so all the offspring in Generation 1 have red bills. None of the duckos have orange bills, but the allele for the orange bill is still there. It just can't be seen.
1 min	**Link to next lesson:** The teacher links science ideas about the first generation of duckos to the next lesson and asks what will happen to the bill trait in the second generation.	

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5 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews key science ideas from lessons 2 and 3. **Main science idea(s):** • By experimenting with pea plants, Gregor Mendel came up with some ideas about how traits are passed from parents to offspring. Many years later, scientists used microscopes to figure out that the genes controlling how traits are passed from parents to offspring are located on chromosomes in the nucleus of each cell. We can use that information to explain the pattern of trait variations that occurred in the dachshund and pea plants.	Link science ideas to other science ideas.	**Show slides 1 and 2.** First, let's review some of the key words and science ideas we've learned in this unit on genetics. **NOTE TO TEACHER:** *Review the key terms on slide 2:* • *Cell* • *Nucleus* • *Chromosomes* • *Genes* **ELL support:** You may also want to review the following terms: *offspring*, *generation* (e.g., Generation 1, Generation 2), *dominant*, and *recessive*. Visual representations of these words should be posted where students can see them throughout the lesson series. In our last lesson, we learned about some important scientific discoveries that took place long after Mendel came up with his ideas about how traits are passed from parents to offspring. Around 40 years after Mendel's experiments with pea plants, scientists figured out that genes are located on chromosomes in the nucleus of each cell. **ELL support:** Rather than summarizing this information for students, prompt them to share what they've learned. By examining cells under a microscope,		

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			scientists observed how a parent's chromosome pairs separate to create sperm and eggs, and then one of the mother's and one of the father's chromosomes come together to make a new individual. We can use this information about chromosome behavior to explain the pattern of trait variations that occurred in the dachshunds and Mendel's pea plants. To do that, let's review the pedigrees we analyzed in lesson 2. **Show slide 3.** Who can describe the patterns of traits that were passed from the parents to the offspring in Generation 1 and Generation 2 of the dachshunds and the pea plants? Just describe your observations for now. What patterns do you see in each family? Are the patterns the same for both the dachshunds and the pea plants? **ELL support:** Give students time to pair up and discuss their observations in their native languages before the class discussion.	The parents had two different traits, but the first generation had only one of the two traits. The second generation had a mix of the two traits.	What do you mean by "a mix of the two traits"? Was the trait halfway between the parents' traits? As you look at the second generation of offspring in both the dachshund

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					family and the pea plants, do you see a pattern in how many offspring had one trait or the other?
				In the second generation, more of the offspring had the trait that showed up in the first generation, and only a few offspring showed the trait that was missing in Generation 1.	
			How do you explain the fact that the first generation of dachshund offspring didn't have the long-hair trait, and the first generation of pea-plant offspring didn't have the white flower color, but the second generations of offspring in both of these pedigrees did?		Do you think that pattern was a fluke or coincidence?
				We figured out that everyone has two genes for a trait, and that some genes are dominant and some genes are recessive. If you have both a dominant and a recessive gene, you'll show the dominant trait, and the recessive trait will be hidden.	
3 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the focus		**Show slide 4.** Today we're going to use Mendel's ideas about dominant and recessive traits and		

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	question, *How can a model of inheritance explain how a trait may seem to disappear in a family?*	Set the purpose with a focus question or goal statement.	Sutton's ideas about how chromosomes separate and recombine to see if we can explain how traits can be covered up in one generation and then reappear in other generations. Our focus question for this lesson is *How can a model of inheritance explain how a trait may seem to disappear in a family?* Write this question in your science notebooks and draw a box around it. **NOTE TO TEACHER:** *Explain that like a pedigree, a model of inheritance is another way of tracking the trait patterns from one generation to the next in a family. It shows how parents' traits combine to produce specific traits in their offspring.*		
6 min	**Setup for Activity** **Synopsis:** The teacher introduces an activity simulating how alleles for the bill-color trait in "duckos" are passed from parents to offspring. Students predict what they expect to see in the first (F1) generation and discuss the reasons for their predictions.	Make explicit links between science ideas and activities **before** the activity. Highlight key science ideas and focus question throughout.	**Show slide 5.** Two of Mendel's key ideas will help us generate an explanation that answers today's focus question: 1. Genes are instructions for a trait. Different forms of the same gene are called *alleles*. Alleles provide instructions for variations of a trait. 2. Some alleles are dominant, and some are recessive. **Show slide 6.**		

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			Today's activity involves hypothetical or made-up organisms that we'll call *duckos*. Let's see if the same pattern of traits shows up in the ducko offspring that we observed in the dachshund family and the pea plants. **NOTE TO TEACHER:** *In addition to the ducko picture on the slide, hold up a red-billed and an orange-billed Lego ducko so that students can see an actual model of each.*		
		Ask questions to elicit student ideas and predictions.	In what way are these two duckos different from one another? What trait variation do you see?	One ducko has a red bill, and the other has an orange bill.	Can you say more about why you think this?
			Bill color in duckos is determined by genes. Remember that genes are instructions for a particular trait. These duckos come from a *long* line of duckos that always have the same bill color. For example, the orange-billed duckos' parents and grandparents and great-grandparents all had orange bills. Likewise, the red-billed duckos' ancestors all had red bills. Based on what happened in the dachshund family, if these two duckos breed, what do you predict the		

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			Generation 1 offspring will look like? **NOTE TO TEACHER:** *Keep this discussion brief! The key idea students should come up with is that all the Generation 1 duckos will have the same bill color. If students disagree about which color will show up, emphasize that either color may be the dominant trait in Generation 1, and regardless of which color shows up, all of the ducko offspring will have the* ***same*** *bill color. Everyone should be able to agree with this conclusion. As a reminder, show students the Generation 1 pedigree results for both the dachshund family and the pea plants.*	Some of the duckos will have red bills, and some will have orange bills. I think all of the ducko offspring will have red bills, because red is dominant. The baby duckos will all have the same color bill, either orange or red.	How do you know that red is dominant?
15 min	**Activity** **Synopsis:** Students simulate how traits are passed from parents to offspring in duckos and explain the pattern of traits observed in the F1 offspring. **Main science idea(s):** • 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	Make explicit links between science ideas and activities **during** the activity.	**Show slide 7.** Today we're going to focus on the first generation of ducko offspring and think about how Mendel's ideas about genes and Sutton's ideas about chromosomes help us understand how traits and alleles pass from one generation to another. **NOTE TO TEACHER:** *Invite two students to come to the front of the class and stand on either side of you. Have one student represent the red-billed ducko, and the other represent the orange-billed ducko. Hand the first student the lunch bag labeled Red-billed Parent Nucleus. The second student should be given the bag labeled Orange-billed Parent Nucleus.*		

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	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.	Link science ideas to other science ideas. Select content representations and models matched to the learning goal and engage students in their use.	Each bag represents the nucleus of one ducko's cells. Remember that all the genes, or instructions, for an individual are found in the nucleus of a cell. **NOTE TO TEACHER:** *Direct the student volunteers to open the bags, take out the chromosomes, and tape them up on the board. The student representing the red-billed ducko will have two chromosomes showing a red bill-color gene, and the student representing the orange-billed ducko will have two chromosomes showing an orange bill-color gene.* *After they complete this task, thank the volunteers and have them return to their seats.* *Next, draw a circle around each of the two sets of chromosomes on the board to represent the cell nucleus, and another circle around these circles to represent the cell. Explain that each of diagrams represents a cell from each ducko and the nucleus with its chromosomes in each cell. Point out the genes that are located on the chromosomes.* As you look at these diagrams, what chromosomes and genes do you find in each nucleus that determine bill color? What alleles for bill color do each of		

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			these duckos have? Notice that all of the chromosomes have the bill-color gene in the same place. But these two chromosomes say "red," and these two say "orange." Both genes are about bill color, but they represent two different possibilities. In other words, there's one gene for bill color, but two different versions of that gene. What do we call the variations of a gene (like the instructions for a red bill or the instructions for an orange bill)? **ELL support:** Encourage discussion by drawing this information out of ELL students. **NOTE TO TEACHER:** *As you present this information, write "2 red-bill alleles" or "2 orange-bill alleles" on the board and draw arrows from these labels to the two bill-color genes in each cell. Direct students to draw these representations in their science notebooks as well.* **Show slide 8.** How could we represent what will happen to the chromosomes and genes if the red-billed ducko and the orange-billed ducko breed to produce Generation 1 duckos?	Alleles.	
		Ask questions to elicit student ideas and predictions.			

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			Turn and Talk: Discuss this question with a partner and be ready to share your ideas with the class. **NOTE TO TEACHER:** *Give students a minute or two to talk about how to represent what happens.* **Whole-class discussion:** Who would like to come up and show us what will happen to the chromosomes and genes when egg or sperm cells are made? **NOTE TO TEACHER:** *The volunteer should separate each parent's two chromosomes (with their corresponding genes) to make two egg or sperm cells. Ask students whether they agree or disagree with the representation and remind them to include their reasons.* Now who wants to come up and show what will happen with the chromosomes and genes to make a baby ducko? **NOTE TO TEACHER:** *The volunteer should combine one chromosome (with its corresponding gene) from each parent to make a new baby ducko.* Does everyone agree that this is what happens? The genes give the instructions for the bill color, right? These instructions appear in small words on the alleles of these chromosomes. Let's read what the instructions say.		

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			NOTE TO TEACHER: *Have a volunteer read each of the instructions. No matter how the chromosomes were matched up, one set of instructions will say "Give the ducko a RED bill," and the other will say "IF there is no allele with instructions for a red bill, give the ducko an ORANGE bill."* **Show slide 9.** What bill color will each baby ducko have? Which trait is dominant, and which trait is recessive? How do you know? So just like traits, the red-bill allele is dominant, and the orange-bill allele is recessive. Now let's try to make sense of our bill-color data.	Red. Red is the dominant trait, and orange is the recessive trait.	
10 min	**Follow-Up to Activity** **Synopsis:** Students analyze their bill-color data and explain why no ducko offspring in Generation 1 exhibit the recessive orange-bill trait.		**Show slide 10.** Why do you think that none of the ducko offspring have orange bills? What happened to the orange-bill trait? Did it disappear? **Turn and Talk:** Discuss these questions		

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	Main science idea(s): • 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. The dominant allele covers up the recessive allele. That doesn't mean the recessive allele has disappeared, but it won't be visible in the Generation 1 offspring.	Engage students in analyzing and interpreting data and observations. Engage students in communicating in scientific ways. Summarize key science ideas.	with a partner, using what you know about chromosomes, genes, and alleles to explain what happened to the orange-bill trait. Look at our ducko model of inheritance if you need help. **Whole-class share-out:** So what do you think happened to the orange-bill trait in the ducko offspring? Can you explain why none of them have orange bills? **NOTE TO TEACHER:** *Help students distinguish between the **trait**, which is the **visible** result of genes combining in the offspring, and the **alleles**, which provide specific instructions for the trait. In this case, all offspring have one red-bill allele and one orange-bill allele, but because the red-bill allele is dominant, all offspring exhibit the red-bill trait.* So the orange-bill *allele* didn't disappear in the Generation 1 duckos after all! But we don't see this *trait* in the offspring because these duckos also inherited the red-bill allele. Since the red-bill allele is dominant, that's the trait we see. What if the parent duckos had 10 or 20 offspring? Could their chromosomes and	The red-bill trait is stronger. The red-bill trait is dominant, so it covers up the orange-bill trait. Well, there is still an allele for the orange bill, but the trait isn't there because the red-bill trait took over.	What do you mean by "stronger"? What is the science idea? Does everyone agree? Can anyone add to or modify this idea?

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			genes be combined in such a way that some of these offspring would have orange bills? Why or why not? This is the same result we saw with the dachshunds, isn't it? In the Generation 1 dachshunds, all of the offspring had short hair, and the long-haired trait seemed to disappear. With the duckos, all of the offspring have red bills, and the orange-bill trait seemed to disappear. But now that you know what happens with genes and alleles, you can explain *why* these trait seemed to disappear in the Generation 1 offspring! **ELL support:** To encourage further discussion, you could ask ELL students to compare the ducko results with the dachshund results.	The offspring will always get a red-bill gene from the red-billed parent, and since it's dominant, the offspring can't have an orange bill.	
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Using the ducko model of inheritance, students explain why the recessive orange-bill trait is hidden in Generation 1 offspring. **Main science idea(s):**	Highlight key science ideas and focus question throughout. Engage students in making connections by synthesizing and	**Show slide 11.** Today we considered the focus question, *How can a model of inheritance explain how a trait may seem to disappear in a family?* **Turn and Talk:** Discuss this question with a partner and then write an answer in your science notebooks. Make sure to explain your ideas in terms of		

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	• Even though offspring get instructions (genes) for a trait from both the mother and the father, if the offspring inherit a different allele from each parent, they will exhibit only the dominant trait, and the recessive trait will be covered up. In the case of the duckos, the red-bill allele is dominant, so all the offspring in Generation 1 have red bills. None of the duckos have orange bills, but the allele for the orange bill is still there. It just can't be seen.	summarizing key science ideas.	chromosomes, genes, and alleles. You may also draw a picture or diagram to show how a model of inheritance can help us determine which traits the offspring will exhibit. Here's a hint: Look at our ducko model of inheritance and explain why no offspring would show the orange-bill trait. Write down your best ideas, and we'll share them at the beginning of the next lesson.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher links science ideas about the first generation of duckos to the next lesson and asks what will happen to the bill trait in the second generation.	Link science ideas to other science ideas.	**Show slide 12.** What bill color do you think the second generation of ducko offspring will have? Do you think the bill-color trait will follow the same pattern we observed in the dachshunds and pea plants? That's what we'll find out in the next lesson.		