Genetics
Lesson 2a: A Pedigree of Inheritance

Grade 6	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 2a of 6 two-part lessons on genetics
Unit central question: Why are individuals of a species different from one another?		**Lesson focus questions:** Can certain traits disappear in a family? Why or why not?
Main learning goal: Some forms of a trait can mask or cover up other forms so they seem to disappear in the next generation. But these masked traits don't actually disappear.		
Science content storyline: Sometimes when parents have different traits, all of their offspring will exhibit one parent's trait, and the other parent's trait will seem to disappear because none of the offspring exhibit it. A trait that is present in one generation might not appear in the next generation, and conversely, a trait that doesn't show up in one generation might appear in the next generation. For each trait, individuals inherit a set of instructions from their mother and another set of instructions from their father. These instructions for a particular trait are called *genes*, and different instructions for the same trait are called *alleles*. If an individual gets the same set of instructions from both parents, that trait will be expressed. If an individual gets a different set of instructions from each parent, only one of the traits will be expressed. When this happens, the trait that is expressed is called a *dominant trait*, and the trait that is hidden or unexpressed is called a *recessive trait*. Tracking the pattern of trait expression across several generations of a family can help you figure out whether a particular trait is dominant or recessive.		
Ideal student response to the focus questions: A trait from one parent can seem to disappear in a family if it doesn't show up in any of the offspring. But the trait could reappear in a later generation. That's because some traits are dominant and some are recessive. Even though you get instructions for a trait from both your mom and your dad, if those instructions are different, the dominant trait will show up, and the recessive trait will be hidden. In the case of the dachshund puppies, the short-hair trait was dominant, so all of the offspring had short hair. Even though none of the puppies had long hair, instructions for the long-hair trait were still passed on to them, and the trait came back in the next generation.		

Preparation

Materials Needed	**Ahead of Time**
• Science notebooks • Class charts: Our Current Ideas about Inheritance; Our Questions about Inheritance (from lesson 1) • Markers **Student Handouts** • 1.1 Possible Explanations for the Dachshund Results (from lesson 1b)	• Review the Genetics Content Background Document, especially sections 1 and 6.

Lesson 2a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to the previous lesson**: The teacher reviews the class charts of student ideas and questions from the previous lesson.	
3 min	**Lesson focus questions:** The teacher introduces the focus questions; *Can certain traits disappear in a family? Why or why not?*	
5 min	**Setup for activity:** Students predict whether the long-hair trait has disappeared forever in the dachshund family and explain their reasoning.	• A trait that is present in one generation might not appear at all in the next generation. • A trait that does not show up in one generation might appear in the next generation.
15 min	**Activity:** The teacher introduces a pedigree chart showing the parents and first-generation offspring of the dachshund family. Students learn the basic rules of pedigree analysis and predict what the second generation of puppies will look like if each of the first-generation dachshunds mates with another short-haired dachshund that also has one parent with short hair and one parent with long hair.	• A pedigree is a chart that tracks certain traits across several generations of a family.
6 min	**Follow-up to activity:** Students try to explain how the long-hair trait showed up in the second generation of dachshund puppies even though their parents have short hair.	• Sometimes when parents have different traits, all of their offspring will exhibit one parent's trait, and the other parent's trait will seem to disappear because none of the offspring exhibit it. A trait that is present in one generation might not appear in the next generation, and conversely, a trait that does not show up in one generation might appear in the next generation.
10 min	**Synthesize/summarize today's lesson:** Students revisit the three student claims about inheritance from the previous lesson and evaluate whether today's pedigree results support any of claims.	• The dachshund puppies inherited instructions from both parents for hair length. The instructions for short hair covered up the instructions for long hair in the first generation of puppies, but not in the second.
1 min	**Link to next lesson:** The teacher foreshadows the next lesson in which students will become acquainted Gregor Mendel's important ideas about inheritance.	

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5 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews the class charts of student ideas and questions from the previous lesson.	Highlight key science ideas and focus question throughout. Ask questions to probe student ideas and predictions.	**Show slides 1 and 2.** Yesterday we investigated three explanations for what happened to the long-hair trait in the dachshund puppies and then shared our own ideas. Let's review our inheritance charts and add any new ideas or questions you have. **ELL support:** Explicit exposure to Tier 2 and 3 terms is helpful for ELL students. You may want to review key vocabulary words before the main thrust of the lesson begins. Some words from this lesson include *pedigree*, *sexually reproducing organisms*, *genes*, and *alleles*. ELL students also benefit from repeated exposure to science words, so it may be helpful to review key terms from lesson 1 or post these words in the classroom for students to refer to throughout the lesson sequence. Today we will investigate more about how traits are passed from parents to offspring. We will start by talking about the dachshund family, but keep in mind that traits are passed down from parents to offspring in *all* sexually reproducing organisms. This includes plants as well	*Ideas students might bring up during the discussion:* • We get our traits from our parents. • Different kinds of living things get their traits from their parents, even plants. • Some traits are stronger than others are. • If parents have different traits, the kids might have one trait or the other, but not half of one trait and half of the other (like one brown eye and one blue eye, or medium-length fur).	*Probe and challenge questions to ask:* • Why do you think that? • What evidence or past experience are you basing your answer on? • What did we see or do yesterday that supported this idea?

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			as animals. **Show slide 3.** In each lesson in this series on genetics, we will think about the best way to answer our unit central question, *Why are individuals of a species different from one another*?		
3 min	**Lesson Focus Questions** **Synopsis:** The teacher introduces the focus questions; *Can certain traits disappear in a family? Why or why not?*	Set the purpose with a focus question or goal statement.	**Show slide 4.** First let's talk about today's focus questions; *Can certain traits disappear in a family? Why or why not?* **ELL support:** The word *disappear* has two meanings: "to go away completely" and "not seen, but with the possibility of coming back later." Encourage ELL students to be more specific about which meaning is intended when this word is used. The words *gone forever* may be clearer. **NOTE TO TEACHER:** *Direct students to write today's focus questions in their science notebooks and draw a box around them.* Think about our dachshund family from yesterday's lesson. What evidence did we gather during the lesson that might help us answer our focus questions? **ELL support:** ELL students may benefit	One parent had long hair, and one parent had short hair. But all of the	

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			from explicit prompts that help them understand what they should think about. Some possible questions include the following: • What did the dachshund parents look like? • What did the offspring look like? • What reasons did you give for why the offspring looked the way they did?	puppies had short hair. None of them had long hair. We saw that all the puppies had short hair, so that evidence tells us the long-hair trait disappeared.	
5 min	**Setup for Activity** **Synopsis:** Students predict whether the long-hair trait has disappeared forever in the dachshund family and explain their reasoning. **Main science idea(s):** • A trait that is present in one generation might not appear at all in the next generation. • A trait that does not show up in one generation might appear in the next generation.	Ask questions to elicit student ideas and predictions.	**Show slide 5.** Do you think the long-hair trait in the dachshund family is gone forever? Will there ever be more long-haired puppies? **Turn and Talk:** Share your ideas with a partner. Then write your predictions in your science notebooks under today's focus questions. **NOTE TO TEACHER:** *After students write down their predictions, have them indicate by a show of hands whether they think the long-hair trait in the dachshund family is gone forever. Ask a few students to share their responses and reasoning. If new ideas or questions about trait inheritance emerge, add them to the class charts.* **Show slide 6.** What did you predict about the long-hair		

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		Ask questions to probe student ideas and predictions. Make explicit links between science ideas and activities **before** the activity.	trait in the dachshund family? Let's see a show of hands. How many of you think the long-hair trait is gone forever? How many of you think this trait is *not* gone forever? **Whole-class share-out:** Now let's hear some of your ideas and reasons.	I think the long-hair trait disappeared because now all the dogs have short hair, so the short-hair trait was stronger and beat out the long-hair trait. I think it depends not just on the parents but on what kind of hair the grandparents, uncles, and aunts have. I think the stronger gene is overpowering the	Why do you think that? So if these dogs have babies, does that mean they'll all have short hair in every generation from now on? What past experience or knowledge are you basing your answer on?

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				weaker gene, but the weaker gene is still there, so it might show up in the next generation or several generations later. I think whether these puppies grow up to have offspring with long or short hair depends on the other parent.	What impact do you think the second parent might have on future offspring?
15 min	**Activity** **Synopsis:** The teacher introduces a pedigree chart showing the parents and first-generation offspring of the dachshund family. Students learn the basic rules of pedigree analysis and predict what the second generation of puppies will look like if each of the first-generation dachshunds mates with another short-haired dachshund that also has one parent with short hair and one parent with long hair.	Make explicit links between science ideas and activities **during** the activity. Select content representations	To help us answer our question about the long-hair trait, we need to look at more data. One way scientists follow traits in a family is by using a chart called a *pedigree.* A pedigree is similar to a family tree, but instead of tracking family relationships, it tracks specific *traits* across several generations of a family. **ELL support:** Although the word *pedigree* typically refers to breeding animals, it also has a technical meaning related to ancestry. It may be helpful to disambiguate this for ELL students. Today we are going to create a pedigree chart that tracks the long-haired and		

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	Main science idea(s): • A pedigree is a chart that tracks certain traits across several generations of a family.	and models matched to the learning goal and engage students in their use. Ask questions to elicit student ideas and predictions. Ask questions to	short-hair traits through the dachshund family. **Show slide 7.** Let's review some of the basic rules for creating a pedigree chart. 1. Circles represent females, and squares represent males. 2. Parents are shown with a horizontal line between them. 3. When a specific trait is being tracked, the different shading or colors of the circles and squares represent different versions of the trait. In this example, yellow shading represents short hair, and gray shading represents long hair. **Show slide 8.** This slide shows the first generation of dachshund puppies. There's one new pedigree rule to highlight: • Brothers and sisters are connected by a horizontal line above them. Do you think this pedigree accurately represents the dachshund family from the previous lesson? • If you saw the pedigree chart without the dogs' pictures, would	In the pedigree chart, you can tell who is a boy and who is a girl and	

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		probe student ideas and predictions. Highlight key science ideas and focus question throughout.	you be able to tell the difference between the parents and the offspring and whether the offspring have long or short hair? • What information does this content representation tell you about the dogs in this family? • What information does this content representation not include about the dogs? **ELL support:** You may need to remind ELL students what a content representation is and what constitutes a good representation. Ask students to recall other content representations they've used in the past so they have a model to follow. **ELL support:** If ELL students bring up the dogs' lives and environments, this may present an opportunity to discuss which kinds of traits are inherited and which are not. Today's focus questions are *Can certain traits disappear in a family? Why or why not?* I asked earlier if you thought the long-hair trait in the dachshund family is gone forever. Let's see a show of hands again. Who said yes? Who said no? If we follow the dachshund family	whether or not each one has a particular trait, so I think this is a good representation. The pedigree shows only the hair-length trait, so I'd only be able to tell whether the dogs have short or long hair. I wouldn't be able to identify any other traits.	

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		Ask questions to elicit student ideas and predictions.	through several generations, we might be able to answer our focus questions. **Show slide 9.** Let's imagine that these puppies grew up and mated with other short-haired dachshunds that had one parent with long hair and one parent with short hair. Do you think this second generation of puppies will look like their parents? **Turn and Talk:** Talk with a partner about what you think the offspring will look like and why. Then write your predictions in your science notebooks. **NOTE TO TEACHER:** *After the Turn and Talk, have a few students share their predictions. Then ask for another show of hands to elicit student predictions.* **Whole-group share-out:** So what did you predict about the offspring of these grown-up puppies? Do you think this second generation of puppies will have long hair, short hair, or somewhere in between? Let's hear a few of your predictions and reasons.	I think all the offspring in the next generation will have long hair. Because in one generation, one trait might be the stronger one, but in the next	Why do you think that? What are your reasons?

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				generation, the other trait might be the stronger one. I think it depends on whether you get the trait from your mother or your father. Girls have more of their mothers' traits, and boys have more of their fathers' traits.	Why do you think the stronger trait might change from one generation to the next? What evidence or past experience do you have that supports your idea?
			Now let's see a show of hands. • How many of you predicted that all of the offspring will have short hair? • How many predicted that all of the offspring will have long hair? • How many predicted that the offspring will have medium-length hair? • How many predicted that some of the offspring will have long hair, and some will have short hair? We have a lot of different ideas about what might happen in the next generation of puppies! Each prediction seems reasonable based on the ideas on our chart. But let's see which predictions are		

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			accurate. **Show slide 10.** What do you notice about the offspring on this slide? How do these results compare with your predictions? **ELL support:** ELL students benefit from repeated language exposure. Have them talk with a partner about their observations or briefly jot a word or two in their notebooks. **NOTE TO TEACHER:** *After students share their observations, highlight the following key science ideas.* **Show slide 11.** Here are some key science ideas to keep in mind about the dachshund pedigree: • In all sets of parents, one parent had long hair, and one parent had short hair. • In the first generation of offspring, all of the puppies had short hair. • In the second generation of puppies, some had short hair and some had long hair. So what happened to the long-hair trait in the dachshund family? Did it	Most of the puppies have short hair, but some have long hair. This was different from my prediction. I thought all of Generation 2 would have the short-hair trait. The long-hair trait didn't disappear! It reappeared in this generation of puppies.	
		Highlight key science ideas and focus question throughout.			

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			disappear forever?	No! It just skipped the first generation of puppies and came back in the second generation!	
6 min	**Follow-Up to Activity** **Synopsis:** Students try to explain how the long-hair trait showed up in the second generation of dachshund puppies even though their parents have short hair. **Main science idea(s):** • Sometimes when parents have different traits, all of their offspring will exhibit one parent's trait, and the other parent's trait will seem to disappear because none of the offspring exhibit it. A trait that is present in one generation might not appear in the next generation, and conversely, a trait that does not show up in one generation might appear in the next generation.	Highlight key science ideas and focus question throughout.	**Show slide 12.** Our focus questions are *Can certain traits disappear in a family? Why or why not?* Did the pedigree results change any of your ideas about these questions? If so, how have they changed? **Turn and Talk:** Talk about these questions with an elbow partner, and be prepared to share your answers with the class. **Whole-class share-out:** So did the pedigree results change your ideas about the focus questions? Do you think certain traits in a family can disappear? If they do not show up in the next generation, does that mean they are gone forever? **Show slide 13.** Why do you think the long-hair trait reappeared in the second generation of dachshund puppies? What might explain this result? **Turn and Talk:** Work with your partner		

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			on these questions, using any ideas from the class chart that you think might help explain the differences in hair length in this generation of puppies. The claims that Juan, Celia, and Michael made might also give you some ideas. Be prepared to share your ideas with the class, and make sure to include reasoning and evidence in your responses. **NOTE TO TEACHER:** *Invite students to share their ideas and add any new ideas or questions to the class charts. If students reject any earlier ideas, cross them off the chart, but make sure they're still legible.* **ELL support:** You may want to refresh students' memories by summarizing the ideas already on the chart.		
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students revisit the three student claims about inheritance from the previous lesson and evaluate whether today's pedigree results supports any of the claims. **Main science idea(s):** • The dachshund puppies inherited instructions from both parents for hair length. The	Engage students in making connections by	**Show slide 14.** To summarize what we've learned so far about trait inheritance, let's review the claims Juan, Celia, and Michael made on the handout from the last lesson. **NOTE TO TEACHER:** *Have students locate handout 1.1, Possible Explanations for the Dachshund Results, from lesson 1b.* **Turn and Talk:** I would like you to pair up again for this activity. First, reread each claim or idea about how the hair-		

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	instructions for short hair covered up the instructions for long hair in the first generation of puppies, but not in the second.	synthesizing and summarizing key science ideas.	length trait passed from the dachshund parents to their offspring. Then use today's pedigree evidence to decide whether you now agree or disagree with each claim. Use the sentence starters on the slide and complete the statements in your science notebooks, making sure to include the reasons for your decisions based on the pedigree results. At the beginning of tomorrow's lesson, you'll have an opportunity to share your ideas with the class.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher foreshadows the next lesson in which students will become acquainted with Gregor Mendel's important ideas about inheritance.		**Show slide 15.** Next time we'll learn about Gregor Mendel, a nineteenth-century scientist who came up with some important ideas about inheritance.		