Genetics
Lesson 6b: Applying Knowledge of Inheritance to Real-World Problems

Grade 6	**Length of lesson:** 50 minutes	**Placement of lesson in unit:** 6b 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 ideas about trait inheritance help solve real-world problems?
Main learning goal: Understanding how parents' chromosomes segregate to make sex cells and unite to produce offspring enables scientists and doctors to reconstruct a family's genetic history for particular traits across multiple generations. It can also answer questions or solve problems related to inherited traits.		
Science content storyline: In most cases, individuals have two sets of instructions, called *genes*, for any specific trait. They get one set of instructions from each parent. *Alleles* are different forms of the same gene. For certain traits, one allele is dominant and the other is recessive. Each individual has a combination of alleles that determine what a particular trait will look like. If you have a trait controlled by a recessive allele, you must have two recessive alleles, one from your mother and one from your father. If you have a trait controlled by a dominant allele, you could have either two dominant alleles—one from each parent—or a dominant allele from one parent and a recessive allele from the other. A *pedigree* is a helpful tool for tracking specific alleles through several generations of a family.		
Ideal student response to the focus question: If you know certain information, like whether a trait is dominant or recessive, you can often figure out which alleles different family members have. By knowing a person's alleles, you might be able to predict the chances of someone else in the family having a particular trait, or you might be able to figure out whether genes play a role in a particular disease.		

Preparation

Materials Needed • Science notebooks • Class chart: A Simple Model of Inheritance (from lesson 6a) **Student Handouts and Teacher Masters** • 6.3 Case History 2: The Hansen Family (1 per student) • 6.4 The Hansen Family Pedigree (1 per student) • 6.4 The Hansen Family Pedigree (Teacher Master)	**Ahead of Time** • Review the Genetics Content Background Document, especially sections 1, 5, and 8.

Lesson 6b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
10 min	**Link to previous lesson:** The teacher reviews key science ideas from the previous lesson.	
3 min	**Lesson focus question:** The teacher reviews the focus question from the previous lesson: *How can ideas about trait inheritance help solve real-world problems?* The class also revisits the unit central question, *Why are individuals of a species different from one another?*	
5 min	**Setup for activity:** Students review the Wilson family case study from the previous lesson and prepare to investigate another case study.	• Because trait inheritance follows certain rules that result in patterns of traits across multiple generations of a family, ideas about how traits are passed from parents to offspring can be used to answer questions related to trait variations in offspring.
15 min	**Activity:** Students solve a second inheritance problem. In this case study, they figure out whether a skin condition that several family members exhibit might be passed on genetically from parents to offspring.	• For certain traits, individuals get a set of instructions—called a *gene*—from each parent. Different forms of the same gene are called *alleles*. • Some alleles are dominant, which means they override any other instructions for a trait, and offspring will exhibit the dominant trait even if a recessive allele is present. • Recessive alleles provide instructions for a trait variation that will appear in offspring only when two recessive alleles—one from each parent—are paired. • Individuals with a trait controlled by a recessive allele must have two recessive alleles, which means they got one from their mother and one from their father. • Individuals with a trait controlled by a dominant allele might have two dominant alleles for that trait or a dominant allele from one parent and a recessive allele from the other parent.
6 min	**Follow-up to activity:** Students consider the science ideas about trait inheritance and allele dominance that they used to answer real-world questions.	• If you know certain information, such as whether a trait is dominant or recessive, you can often figure out which alleles different family members have. By knowing a person's alleles, you might be able to predict the chances of someone else in the family having a particular trait or figure out whether genes play a role in a certain disease.
10 min	**Synthesize/summarize today's lesson:** Students review the science ideas they documented in their science notebooks throughout the Genetics unit and write their best answers to the unit central question.	• Trait inheritance—parents passing on different gene combinations to their offspring—is one way to explain why individuals of the same species are different from one another.
1 min	**Link to future lessons:** The teacher makes a summary statement emphasizing that there is much more to learn about trait variations in individuals of a species.	

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10 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews key science ideas from the previous lesson.	Highlight key science ideas and focus question throughout.	**Show slides 1 and 2.** Today is the final lesson in our unit on genetics. So let's review some important science ideas about inheritance that we've been building on throughout this series of lessons. For this review, we'll use examples from the Wilson family case study and pedigree from the last lesson, so please find those handouts before we begin. **NOTE TO TEACHER:** *Keep this discussion brief. Make sure students are connecting key science ideas to the Wilson family case study and pedigree. Do they show their understanding from the examples they provide? This conversation will set the stage for today's case study of the Hansen family.* **Show slides 3 and 4.** As I summarize each key science idea, I want you to think about how this idea relates to the Wilson family case study or pedigree and give me an example for each idea. 1. For certain traits, individuals get a set of instructions—called a *gene*—from each parent. Different forms of the same gene	*Idea 1:* In the Wilson family case study, the parents passed	

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			are called *alleles*. 2. Some alleles are dominant, which means they override any other instructions for a trait, and offspring will exhibit the dominant trait even if a recessive allele is present. 3. Recessive alleles provide instructions for a trait variation that will appear in offspring only when two recessive alleles—one from each parent—are paired. 4. Individuals with a trait controlled by a recessive allele must have two recessive alleles, which means they got one from their mother and one from their father. 5. Individuals with a trait controlled by a dominant allele might have two dominant alleles for that trait or a dominant allele from one parent and a recessive allele from the other parent.	instructions to their offspring for or not for Marfan syndrome. We represented the different forms of the alleles as a big *M* for Marfan syndrome and a little *m* for normal height. *Idea 2:* This happened with children like Greg and Susanna. They both have a big *M*, which is dominant, so they both have Marfan syndrome, even though they both have a small *m*, too. *Ideas 3 and 4:* That happened with James, Cindy, and Peter because they don't have Marfan syndrome. So they all got a little *m* from each parent that means they have the recessive trait for normal height. *Idea 5:* We figured out	What do you mean by "for or not for Marfan syndrome"? How do you know they don't have two dominant alleles (MM)? What is their allele combination, then?

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			Good job! You'll apply these science ideas again today when you investigate a second family case study.	that Joseph and Maryanne had a dominant and a recessive allele instead of two dominant alleles for Marfan syndrome (MM), because if they had two dominant alleles, all of their children would have Marfan syndrome, and they didn't.	Tell us more about your ideas. Can you relate this idea to our experience with the two generations of duckos?
3 min	**Lesson Focus Question** **Synopsis:** The teacher reviews the focus question from the previous lesson: *How can ideas about trait inheritance help solve real-world problems?* The class also revisits the unit central question, *Why are individuals of a species different from one another?*	Set the purpose with a focus question or goal statement.	**Show slide 5.** Today's focus question is the same as the question we explored in the last lesson: *How can ideas about trait inheritance help solve real-world problems?* Today we'll continue thinking about that question as we investigate a second family case study. **Show slide 6.** Then at the end of the lesson, you'll		

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			think about everything you've learned in this unit and write your best answer to our unit central question, *Why are individuals of a species different from one another?* By now, you should have a lot of ideas about why individuals of a species are different from one another instead of all alike.		
5 min	**Setup for Activity** **Synopsis:** Students review the Wilson family case study from the previous lesson and prepare to investigate another case study. **Main science idea(s):** • Because trait inheritance follows certain rules that result in patterns of traits across multiple generations of a family, ideas about how traits are passed from parents to offspring can be used to answer questions related to trait variations in offspring.	Make explicit links between science ideas and activities **before** the activity.	**Show slide 7.** Last time, we worked on solving a real-world problem for the Wilson family. What question were we trying to answer? Yes, Peter and Susanna Wilson know their children might inherit Marfan syndrome because of the genetic history in both of their families. Today we'll investigate a different health issue in the Hansen family. **NOTE TO TEACHER:** *Distribute handouts 6.3 and 6.4 (Case History 2: The Hansen Family, and The Hansen Family Pedigree) and read the opening paragraph of handout 6.3.* Let's read about the skin condition that	We were trying to find out how likely it is that Peter and Susanna Wilson will have children with Marfan syndrome.	

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			runs in this family. In this case, we'll investigate whether this condition is passed on genetically from parents to their offspring and see if there's a pattern of inheritance. You'll also use what you know about traits, genes, and dominant and recessive alleles to find out whether this case is consistent or inconsistent with our simple model of inheritance. **NOTE TO TEACHER:** *Display the simple model of inheritance students developed in lesson 6a so they can refer to it throughout the lesson.*		
15 min	**Activity** **Synopsis:** Students solve a second inheritance problem. In this case study, they figure out whether a skin condition that several family members exhibit might be passed on genetically from parents to offspring. **Main science idea(s):** • For certain traits, individuals get a set of instructions—called a *gene*—from each parent. Different forms of the same gene are called *alleles*. • Some alleles are dominant, which means they override any other	Make explicit links between science ideas and activities **during** the activity. Engage students in using and applying new science ideas in a variety of ways and contexts.	**Show slide 8.** The Hansen family case study is more of a puzzle than the Wilson family case study. We know that Marfan syndrome is caused by a dominant allele. But the Hansen family history doesn't tell us whether the skin rash several family members have is caused by a dominant allele, represented with a big *S*, or a recessive allele, represented with a small *s*. How can we find out whether this trait is caused by a dominant allele or a recessive allele? To investigate this genetics problem, we'll break up into small groups. **NOTE TO TEACHER:** *Divide the*		

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	instructions for a trait, and offspring will exhibit the dominant trait even if a recessive is present. • Recessive alleles provide instructions for trait variations that will appear in offspring only when two recessive alleles—one from each parent—are paired. • Individuals with a trait controlled by a recessive allele must have two recessive alleles, which means they got one from their mother and one from their father. • Individuals with a trait controlled by a dominant allele might have two dominant alleles for that trait or a dominant allele from one parent and a recessive allele from the other parent.	Engage students in	*class into small groups and review instructions for the handouts, making sure that students understand what they should do. Remind them that they should make decisions together but complete the handouts independently.* **Show slide 9.** **Small groups:** Read through the Hansen family case study (handout 6.3) and discuss the questions in your group. Make sure to shade in the pedigree (handout 6.4) based on the information provided in the case study. As you work through this challenge, keep two important questions in mind: 1. Does the pattern of inheritance match what might be expected if the skin rash were a *dominant* trait? 2. Does the pattern of inheritance match what might be expected if the skin rash were a *recessive* trait? To find out whether the skin-rash trait is dominant or recessive, you might need to test both possibilities by creating a Punnett square on the case-study handout. If the skin condition appears to be an inherited trait, record the two-letter allele		

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		constructing explanations and arguments.	combination underneath each family member's name on the pedigree handout. Make sure your group reaches a consensus before marking your answers. **NOTE TO TEACHER:** *Circulate among the small groups, paying attention to how students are approaching the problem. Encourage them to look at all three generations in the Hansen family and notice that at least one person in each generation has the skin rash. Is that similar to the patterns of dominant and recessive traits they observed in Generation 1 and Generation 2 offspring in previous lessons? What alleles must be present for a recessive trait to appear?* **Show slide 10.** **Whole-class discussion:** So what did your group decide? Do you think this skin condition is caused by genes that offspring inherited from their parents, or do you believe there must be some other cause? What allele combinations did you come up with? Make sure to support your answers with evidence from the Hansen family pedigree. **NOTE TO TEACHER:** *Encourage students to share the strategies they used to figure out their solutions to the*		

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			problem. After students have shared their evidence and reasoning, display the teacher master for handout 6.4 and give students an opportunity to compare the allele combinations with the ones on their pedigree handouts and offer comments or questions.		
6 min	**Follow-Up to Activity** **Synopsis:** Students consider the science ideas about trait inheritance and allele dominance that they used to answer real-world questions. **Main science idea(s):** • If you know certain information, such as whether a trait is dominant or recessive, you can often figure out which alleles different family members have. By knowing a person's alleles, you might be able to predict the chances of someone else in the family having a particular trait or figure out whether genes play a role in a certain disease.	Highlight key science ideas and focus question throughout.	**Show slide 11.** Our focus question today is *How can ideas about trait inheritance help solve real-world problems?* **Turn and Talk:** Discuss with a partner how science ideas about inheritance helped answer the questions the Hansen and Wilson families raised about different genetic conditions. **Whole-class share-out:** What ideas did you and your partner come up with to answer our focus question? How did science ideas help solve the problems both of these families were facing?	*Ideal student response:* If you know certain information, like whether a trait is dominant or recessive, you can often figure out which alleles different family members have. By knowing a person's alleles, you might be able to predict the chances of someone else in the family having a	

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				particular trait or figure out whether genes play a role in a certain disease.	
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students review the science ideas they documented in their science notebooks throughout the Genetics unit and write their best answers to the unit central question. **Main science idea(s):** • Trait inheritance—parents passing on different gene combinations to their offspring—is one way to explain why individuals of the same species are different from one another.	Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 12.** Throughout this series of lessons on genetics, we've been thinking about our unit central question, *Why are individuals of a species different from one another?* Since the beginning of this unit, we've learned a lot about how traits are passed from parents to offspring. Mendel's ideas offer *some* good explanations for why individuals of a species are different. But these simple rules of inheritance can't explain all of the differences among plants and animals (including humans). That's because other factors control trait inheritance, like the combinations of several types of genes, the environment, and even the events in a person's life. Even so, we've learned a lot that can help us explain the differences among individuals. **Think-Pair-Share:** Take a few minutes right now and look over the ideas you recorded in your science notebooks from the beginning of this unit. As you're doing this, think about how you'd answer the unit central question. Then share a few ideas with a partner and		

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			write your best answers to the unit central question in your notebooks. In your responses, try to incorporate these key terms: • Chromosome • Gene • Allele • Dominant • Recessive • Trait • Inherit **ELL support:** Remind students where to find these terms posted in the room or in their key-word dictionaries. Allow them to incorporate visual references and diagrams as they construct their answers to the unit central question. **Whole-class share-out:** Who would like to share your best answer to the unit central question? Make sure to use science ideas in your explanations! **NOTE TO TEACHER:** *Invite a few students to share their responses with the class. In their explanations, listen for science concepts that have been emphasized throughout the lesson series. If misconceptions emerge, address them immediately. (To refresh your memory, refer to the Common Student Ideas chart in the lesson materials.) Direct students to the simple model of inheritance they developed in the previous lesson and ask*		

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			them to think about how their ideas (and misconceptions) relate to the science ideas they've been working with. **ELL support:** Ask students how the ideas they've shared compare with the simple model of inheritance the class created during the previous lesson.		
1 min	**Link to Future Lessons** **Synopsis:** The teacher makes a summary statement emphasizing that there is much more to learn about trait variations in individuals of a species.	Link science ideas to other science ideas.	**Show slide 13.** This lesson series has helped us understand *one* reason why individuals of a species are different from one another. What is that reason? In future lessons on genetics, we'll consider other possible reasons for trait variations among individuals, such as environmental factors like animals getting enough food or plants getting enough sunlight. We'll also consider the special case of organisms, like bacteria, that don't reproduce sexually like most animals and plants do.	Individuals of a species are different because they inherit different combinations of alleles from their parents.	