Genetics
Lesson 5b: Patterns of Inheritance

Grade 6	**Length of lesson:** 55 minutes	**Placement of lesson in unit:** 5b of 6 two-part lessons on genetics
Unit central question: Why are individuals of a species different from one another?		**Lesson focus questions:** Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?
Main learning goal: By understanding the movement of chromosomes (and the genes located on them) when egg and sperm are produced and unite to make a new individual, we can predict inheritance patterns for some traits. The Punnett square is a helpful tool for representing the possible combinations of alleles in offspring.		
Science content storyline: Different combinations of alleles in parents lead to trait variations in their offspring. A *Punnett square* is a helpful tool for representing all the possible allele combinations for a trait that offspring can inherit from their parents. Since recessive traits are expressed only if an individual inherits a recessive allele from each parent, a Punnett square makes it possible to predict which traits might show up in the offspring. A Punnett square can also forecast the expected frequency (ratio) of dominant to recessive traits among the offspring resulting from crosses between parents who have different combinations of alleles.		
Ideal student response to the focus questions: The parents' alleles determine the possible traits their offspring might have. If you use a Punnett square, you can actually see the possible combinations of alleles and figure out the expected pattern (ratio) of dominant and recessive traits if the parents have a lot of offspring.		

Preparation

Materials Needed • Science notebooks • Colored pencils or pens **Student Handouts** • 5.1 Exploring Trait Patterns in Offspring (1 per student)	**Ahead of Time** • Review the Genetics Content Background Document, especially sections 1 and 7.

Lesson 5b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** The teacher reviews students' preliminary answers to the focus questions from the previous lesson.	
3 min	**Lesson focus questions:** The teacher reviews the focus questions from the previous lesson: *Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?*	
10 min	**Setup for activity:** Students reconsider why there were no orange-billed duckos in Generation 1 and practice using a Punnett square to explain this result.	• A Punnett square is a helpful tool for representing all of the possible allele combinations for a trait that offspring can inherit from their parents.
15 min	**Activity:** Students complete Punnett squares on their own to explore patterns of inheritance and calculate ratios for three different parental allele combinations.	• Different combinations of alleles in the parents lead to different possible trait variations in their offspring. • A Punnett square can show all the possible allele combinations for a trait and explain the expected frequency (ratio) of dominant to recessive traits among the offspring resulting from crosses between parents who have different combinations of alleles.
15 min	**Follow-up to activity:** Using science ideas from the Punnett-square activity, students construct explanations for why offspring inherit certain traits from their parents.	• The parents' alleles determine the possible traits their offspring might have. • A Punnett square can help predict all the possible parental allele combinations for a trait and figure out the expected pattern (ratio) of dominant and recessive traits if the parents had many offspring. However, a Punnett square can't help predict exactly which traits *individual* offspring will have, only what the ratio of traits is likely to be in a group of offspring.
6 min	**Synthesize/summarize today's lesson:** Students review and revise their earlier answers to the focus questions to include ideas about how a Punnett square can help them predict the traits of offspring whose parents have different alleles.	• In rare cases, a Punnett square can help predict the exact trait individual offspring will have. For example, when two parents have only one allele for a trait, all of their offspring will have that trait. • However, since individual offspring have the same random chance of having particular traits, a Punnett square can't always help in accurately predicting which traits *individual* offspring will have. It can only help determine the expected *ratio* of traits in a group of offspring.
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will use pedigrees and Punnett squares to apply what they know about inheritance to real-world problems.	

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5 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews students' preliminary answers to the focus questions from the previous lesson.	Make explicit links between science ideas and activities.	**Show slides 1 and 2.** Let's review your answers to the focus questions from our last lesson: *Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?* What patterns did you observe in the ducko offspring that helped you answer these questions? I agree that the patterns we've observed so far indicate that second-generation	It seemed like the recessive trait always skipped one generation. In the second generation, there were always more offspring with the dominant trait than the recessive trait. In all the examples we observed in Generation 2, like the dachshunds, pea plants, guinea pigs, and duckos, the ratio of dominant to recessive traits was always 3:1, so I think that's the way it always will be.	Does anyone have a different idea?

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			offspring show the traits of their parents in a ratio of three dominant traits to one recessive trait. What do you think might happen if both parents *didn't* have one dominant and one recessive allele? That's what we'll investigate today using Punnett squares.		
3 min	**Lesson Focus Questions** **Synopsis:** The teacher reviews the focus questions from the previous lesson: *Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?*	Set the purpose with a focus question or goal statement.	**Show slide 3.** Our focus questions for today should look familiar: *Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?* In this lesson, we'll gather more information to answer these questions.		
10 min	**Setup for Activity** **Synopsis:** Students reconsider why there were no orange-billed duckos in Generation 1 and practice using a Punnett square to explain this result. **Main science idea(s)**: • A Punnett square is a helpful tool for	Make explicit links between science ideas and activities **before** the activity. Select content representations and models matched to the learning goal and	Today's activity will give you some practice using Punnett squares to explore trait patterns in offspring whose parents have different alleles. **Show slide 4.** We'll begin with our ducko parents. First let's set up a Punnett square to represent the possible allele combinations these parents might pass on to their offspring.		

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	representing all of the possible allele combinations for a trait that offspring can inherit from their parents.	engage students in their use.	**NOTE TO TEACHER:** *Model how students should set up a Punnett square in their science notebooks.* Where would you put the mom's alleles on this Punnett square? Where would you put the dad's alleles? How would you show the possible allele combinations the parents could pass on to their offspring? **Turn and Talk:** Now I'd like you to work in pairs to fill in each box of the Punnett square, showing all the possible allele combinations. Then talk with your partner about a question we've considered before: *Why weren't there any orange-billed ducko offspring in Generation 1, even though the dad had an orange bill?* Remember to include science ideas about chromosomes, genes, and alleles in your answers. **ELL support:** Review Tier 3 words with students, such as *allele*, *dominant*, *recessive*, and *offspring*, or remind them where they can find these resources. **NOTE TO TEACHER:** *Circulate among pairs as they complete their Punnett squares, and listen to their reasoning as they explain why none of the Generation 1 ducko offspring had the*		

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			orange-bill trait. *Ask probe questions to make sure students understand that the dominant trait is expressed when a dominant and a recessive allele combine.* **Show slide 5.** Now let's examine the allele combinations and traits our ducko offspring might inherit from their parents. How does this Punnett square compare with your results? Based on these results, why did none of the Generation 1 duckos have orange bills? **NOTE TO TEACHER:** *Advance through the slide animation, allowing students to comment on the Punnett-square results and compare them with their own. Help them reconcile any discrepancies before proceeding to the activity.*	There weren't any orange-billed duckos in the first generation because all of the offspring had a dominant and a recessive allele. They all had one red-bill allele and one orange-bill allele. This combination of alleles means that all the duckos will have red bills. The allele with instructions for an orange bill is still there, but that allele doesn't show up if there's a	What happened with the orange-bill allele? Is it still there?
		Ask questions to probe student ideas and predictions.			

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				dominant allele, too.	
15 min	**Activity** **Synopsis:** Students complete Punnett squares on their own to explore patterns of inheritance and calculate ratios for three different parental allele combinations. **Main science idea(s):** • Different combinations of alleles in the parents lead to different possible trait variations in their offspring. • A Punnett square can show all the possible allele combinations for a trait and explain the expected frequency (ratio) of dominant to recessive traits among the offspring resulting from crosses between parents who have different combinations of alleles.	Engage students in using and applying new science ideas in a variety of ways and contexts. Ask questions to probe student ideas and predictions. Ask questions to challenge student	**Show slide 6.** **NOTE TO TEACHER:** *Distribute handout 5.1 (Exploring Trait Patterns in Offspring) and divide the class into groups of three or four students.* Let's look at some new patterns in the ducko parents' alleles. **Small-group discussion:** In your small groups, figure out the possible allele combinations and trait patterns in each of the scenarios on the handout. Fill in the Punnett squares and record in the space provided the number of times each allele combination occurs and the number of times each trait occurs in the offspring. Then calculate the ratio of dominant to recessive traits and answer the questions for each scenario in complete sentences. **ELL support:** Using previous examples from classroom work, review with students how to calculate ratios. **NOTE TO TEACHER:** *Circulate among the groups and ask probe and challenge questions to make sure students understand the following:* • *The letters they write at the top and on the side of the Punnett*		

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		thinking.	*square to represent the parents' alleles, and the letters they write inside the square show the possible allele combinations the parents can pass to their offspring.* • *They'll need to calculate the ratio of dominant to recessive traits they predict in the offspring. Walk them through this if they need help.*		
15 min	**Follow-Up to Activity** **Synopsis:** Using science ideas from the Punnett-square activity, students construct explanations for why offspring inherit certain traits from their parents. **Main science idea(s):** • The parents' alleles determine the possible traits their offspring might have. • A Punnett square can help predict all the possible parental allele combinations for a trait and figure out the expected pattern (ratio) of dominant and recessive traits if the parents had many	Engage students in constructing explanations and arguments.	**Show slide 7.** **Whole-class discussion:** What combinations of alleles and traits did you come up with for each scenario? Were the results what you expected to see? Why or why not? **Show slide 8.** Let's discuss the three questions on the slide to summarize what we've learned about patterns in trait variation. Make sure to support your answers with evidence from the scenarios. 1. What is the pattern of trait variation in the offspring when the parents have two different traits? Will offspring of parents with two different traits always show only the dominant trait? Why or why not?		

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	offspring. However, in most cases, a Punnett square can't help predict exactly which traits *individual* offspring will have, only what the ratio of traits is likely to be in a group of offspring.		2. What is the pattern of trait variation in the offspring when the parents have the same trait? Will offspring of parents with the same trait always have that trait? Why or why not? 3. Based on the Punnett squares, can you predict the traits of *individual* offspring? For example, if parents have four offspring, can you predict which trait the fourth offspring will have? Can you predict the exact ratio of dominant to recessive traits that all four offspring will have? Why or why not?		
6 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students review and revise their earlier answers to the focus questions to include ideas about how a Punnett square can help them predict the traits of offspring whose parents have different alleles. **Main science idea(s):** • In rare cases, a Punnett square can help predict the exact traits individual offspring will have. For example,	Highlight key science ideas and focus question throughout.	**Show slide 9.** Today we gathered more information to answer our focus questions, *Do the dominant and recessive traits of parents always result in similar patterns of trait variation in offspring? Why or why not?* Look back at your initial answers to these questions in your science notebooks. Then take out a different-colored pencil or pen and add to or revise your earlier response. Or draw a line below your earlier response, and underneath that answer, write a new response that includes what you've learned about how a Punnett square can help you identify all of the allele		

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	when two parents have only one allele for a trait, all of their offspring will have that trait. • However, since individual offspring have the same random chance of having particular traits, a Punnett square can't always help in accurately predicting which traits *individual* offspring will have. It can only help determine the expected *ratio* of traits in a group of offspring.		combinations parents can pass on to their offspring, and the pattern of traits you might expect to see in the offspring.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next lesson, students will use pedigrees and Punnett squares to apply what they know about inheritance to real-world problems.	Link science ideas to other science ideas.	**Show slide 10.** In this lesson, we looked at different combinations of alleles in parents and saw that the ratio of dominant to recessive traits in the offspring isn't always 3:1. The pattern of trait variation in the offspring depends on the two alleles each parent has for a particular trait. We can't know for sure which alleles the offspring have just by looking at them, unless they have a recessive trait. Then we know for sure that they inherited two		

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			recessive alleles from their parents. In the next lesson, we'll use pedigrees and Punnett squares to investigate how science ideas about inheritance can help us solve real-world problems.		