Genetics
Lesson 3a: Understanding Inheritance

Grade 6	**Length of lesson:** 55 minutes	**Placement of lesson in unit:** 3a of 6 two-part lessons on genetics
Unit central question: Why are individuals of a species different from one another?		**Lesson focus question:** What do we know about genes today that Gregor Mendel didn't know?
Main learning goal: The pattern of chromosome movement matches the way Gregor Mendel described gene behavior. This led scientists to conclude that genes are located on chromosomes.		
Science content storyline: About 40 years after Gregor Mendel researched genes and their behavior, scientists discovered how chromosomes move by examining them under microscopes that enabled them to observe cells in greater detail. *Chromosomes* are thread-like structures inside the nucleus of each reproducing cell. Sexually reproducing organisms have pairs of these chromosomes that are identical in size and shape. Offspring inherit one chromosome from the mother's pair, and one from the father's pair. Scientists also discovered that when sperm and egg cells are made and then unite to make a new individual, the chromosomes behave in exactly the way Mendel described the behavior of genes: • One sperm or egg cell receives one chromosome from each pair of the parents' chromosomes. • The single chromosome each parent contributes to the sperm or egg is randomly selected. • When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created. • One set of chromosomes comes from the mother, and the other set comes from the father. Because the behavior of chromosomes matches the behavior of genes exactly, scientists proposed that genes are located on chromosomes.		
Ideal student response to the focus question: We know now that genes are found on chromosomes in the nucleus of every cell. Using a microscope, we can see that when sperm and egg cells are made, chromosomes of the same size match up. Each sperm or egg gets one chromosome from each pair, either from the father or the mother. When egg and sperm come together to make a baby, the chromosomes pair up again, with one chromosome in each pair coming from the mom and the dad. This is exactly the way Mendel described how genes move.		

Preparation

Materials Needed
• Science notebooks
• Class charts: Our Current Ideas about Inheritance; Our Questions about Inheritance (from previous lessons)
• Markers
• Colored pencils (to mark up handout 3.1)
 	
Student Handouts and Teacher Masters
• 2.1 Mendel's Ideas (from lesson 2b)
• 3.1 Understanding Inheritance: Results from Studies of Cells (1 per student)
• 3.2 A Read-Aloud/Think-Aloud Example (Teacher Master)
• 3.3 Sample Marked Essay (Teacher Master)
	Ahead of Time
	• Review the Genetics Content Background Document, especially sections 1 and 6.
	• Prior to beginning this module, make sure students have been introduced to the following ideas:
	  • Living things are made of cells.
	  • Each cell has a nucleus that controls its activities.
	  • DNA is the molecule of heredity.
	  • Microscopes are tools that enable scientists to examine cells and parts of cells too small for the naked eye to see.

Lesson 3a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** The teacher reviews Mendel's ideas from the previous lesson.	
3 min	**Lesson focus question:** The teacher introduces the focus question, *What do we know about genes today that Gregor Mendel didn't know?*	• About 40 years after Mendel, scientists began connecting Mendel's ideas about inheritance with what they saw happening inside cells under a microscope. This research led to greater knowledge about genes than Mendel's initial understandings.
6 min	**Setup for activity:** Students relate their current understandings of cell structures to trait inheritance.	• Organisms are composed of one or more cells. The nucleus of each cell contains long strands of DNA called *chromosomes*.
20 min	**Activity:** The teacher uses a read-aloud/think-aloud strategy to support students in reading and understanding an essay about cells and chromosomes.	• In sexually reproducing organisms, chromosomes exist in pairs that are similar in size, shape, and the genes they contain. • Each individual inherits one chromosome from the mother's pair and one from the father's pair. • The single chromosome each parent contributes to the sperm or egg is randomly selected. • When sperm and egg cells are made, each sperm or egg cell receives one chromosome from each pair of the parents' chromosomes. • When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created. One set comes from the mother, and one comes from the father.
15 min	**Follow-up to activity:** Students work with a partner to describe science ideas from the essay in their own words. Then they update and revise the class charts of ideas and questions about inheritance.	• When sperm and egg cells are made, the chromosomes pair up, and each sperm or egg cell receives one from each chromosome pair from the parents. When egg and sperm come together to make a baby, the chromosomes pair up again, with one chromosome in each pair coming from the mom and the dad.
5 min	**Synthesize/summarize today's lesson:** Students write down new ideas from today's lesson that might help them answer the unit central question, *Why are individuals of a species different from one another?*	• Each individual inherits one chromosome from the mother's pair, and one from the father's pair. This new combination of chromosomes makes each offspring somewhat like and somewhat different from each parent.
1 min	**Link to next lesson:** The teacher briefly reviews what students have learned so far about inheritance and then foreshadows the next lesson.	

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5 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews Mendel's ideas from the previous lesson.	Highlight key science ideas and focus question throughout.	**Show slide 1.** **NOTE TO TEACHER:** *Make sure students have already been introduced to these science ideas:* • *Living things are made of cells.* • *Each cell has a nucleus that controls its activities.* • *DNA is the molecule of heredity.* • *Microscopes are tools that enable scientists to examine cells and parts of cells too small for the naked eye to see.* *Students may also have discussed cell division (mitosis or meiosis), but prior knowledge isn't necessary for this lesson.* **ELL support:** Repeated exposure to vocabulary words can be beneficial for ELL students. Ask them what certain words mean, such as *DNA*, *heredity*, *traits*, *chromosomes*, *genes*, and *alleles*. **Show slide 2.** In the last lesson, we learned about Mendel's experiments with pea plants and what he discovered about how traits are passed from parents to offspring. **NOTE TO TEACHER:** *Have students locate handout 2.1 from the previous*		

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			lesson and review the seven ideas on the chart.		
		Summarize key science ideas.	Let's review Mendel's ideas about inheritance from yesterday's lesson. Can you describe some of these ideas in your own words?	Sometimes kids don't look like their parents.	
		Highlight key science ideas and focus question throughout.	**NOTE TO TEACHER:** *Make sure students have a solid understanding of the science ideas from the previous lesson so they can put them together with the ideas in this lesson. Emphasize the following key ideas:* • *Genes are a set of instructions for a trait.* • *Genes can have different forms that provide instructions for variations of a trait. These different forms of a gene are called* alleles. • *Individuals get one variation of a gene (allele) from each parent, which means that each individual has two alleles for each trait.* • *Some traits are dominant and some are recessive.*	When the parents pass on two sets of instructions, only the dominant trait shows up in the offspring. That's why the dachshund puppies had short hair, not long hair or medium-length hair. Parents pass on genes to their kids. Genes are instructions. Instructions for traits, like short hair or long hair. Everyone has two genes for a trait.	Say more about why you thought the puppies might have medium-length hair. What are genes? Instructions for what? Where do these two genes come

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				From their parents! They get one gene from their mom and one from their dad.	from? Tell us more about that.
			Mendel and other scientists figured out these inheritance "rules" by experimenting with plants and animals. From observing variations and patterns in traits from generation to generation, they came up with some good ideas about what must be happening, but they didn't know exactly how traits were passed from parents to offspring or what actually took place inside the cells.		
3 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the focus question, *What do we know about genes today that Gregor Mendel didn't know?* **Main science idea(s):** • About 40 years after Mendel, scientists began connecting Mendel's ideas about inheritance with what they saw happening inside cells under a microscope. This	Set the purpose with a <u>focus question</u> or goal statement.	**Show slide 3.** It wasn't until about 40 years after Mendel's pea-plant experiments that other scientists began to connect Mendel's ideas with what they saw happening in the cells they examined under a microscope. These observations helped them understand important ideas about inheritance that Mendel didn't know about. **Show slide 4.** That brings us to our focus question for today: *What do we know about genes today that Gregor Mendel didn't know?* Write this question in your science		

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	research led to greater knowledge about genes than Mendel's initial understandings.		notebooks and draw a box around it.		
6 min	**Setup for Activity** **Synopsis:** Students relate their current understandings of cell structures to trait inheritance. **Main science idea(s):** • Organisms are composed of one or more cells. The nucleus of each cell contains long strands of DNA called *chromosomes*.	Make explicit links between science ideas and activities **before** the activity.	**Show slide 5.** What do you remember from studying cells earlier this year that might help us better understand how traits are passed from parents to offspring? **NOTE TO TEACHER:** *If students need prompting, remind them of one or two of the activities from the previous unit on cells, but don't belabor this. As students recall facts about cells, you might find it useful to draw a circle (for animal cells) or a rectangle (for plant cells) and add the parts they list. But keep this brief!* **ELL support:** It might also be useful to have students act out the functions of cell parts (cell wall, nucleus, chromosome) and envision themselves as part of the system. This content representation could be incorporated at the end of the lesson as well. **NOTE TO TEACHER:** *If chromosomes weren't mentioned in the earlier unit on cells, simply tell students that the nucleus of a cell contains chromosomes. Then draw a nucleus with some squiggly lines representing the*	Cells have a nucleus. I think that traits have something to do with the nucleus. The nucleus is the brain of the cell. It controls what the cell does. The nucleus has chromosomes. DNA is found in the cell nucleus.	Does anyone have any other ideas about how the cell nucleus might have something to do with traits? What do you think the nucleus has to do with traits like long or short hair or purple or white flowers? How do you think the nucleus can control the cell? What role do you

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			chromosomes. **ELL support:** ELL students might benefit from an explicit explanation of what chromosomes are. Today we're going to learn how scientists confirmed Mendel's ideas by linking the evidence they gathered from observing cell structures under a microscope to his ideas about how genes are passed from parents to offspring.	When cells divide, all the information in the nucleus divides too, so all the genetic information is available in each cell.	think DNA plays in determining what traits you have? How do you think DNA from parents might be passed to the offspring?
20 min	**Activity** **Synopsis:** The teacher uses a read-aloud/think-aloud strategy to support students in reading and understanding an essay about cells and chromosomes. **Main science idea(s):** • In sexually reproducing organisms, chromosomes exist in pairs that are similar in size, shape, and the genes they contain. • Each individual inherits	Make explicit links between science ideas and activities **during** the activity.	**Show slide 6.** **NOTE TO TEACHER:** *Distribute handout 3.1—Understanding Inheritance: Results from Studies of Cells—and display a copy on a projector or document reader to mark up.* Now we're going to read about what scientists discovered when they looked at cells under a microscope. As we read the essay aloud, I'll share any thoughts and questions I have and make notes on the projected copy. This will help you learn how to read science information so you can understand it better.		

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	one chromosome from the mother's pair, and one from the father's pair. • The single chromosome each parent contributes to the sperm or egg is randomly selected. • When sperm and egg cells are made, each sperm or egg cell receives one chromosome from each pair of the parents' chromosomes. • When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created. One set comes from the mother, and one comes from the father.	Link science ideas to other science ideas.	**NOTE TO TEACHER:** *Read the essay aloud as students follow along. (Do not read the final two paragraphs of the essay about Walter Sutton, since students will read that information in the next lesson.) Use a read-aloud/think-aloud strategy to model and verbalize your thought processes for students so they can understand how to read informational text. Refer to the read-aloud/think-aloud example in handout 3.2 as needed.* *Alternatively, you could have students read segments of the essay aloud and then describe the notes they might write in the margins. (See handout 3.3 for a sample marked essay.) This activity could be done as a class, or you could divide the class into small groups and circulate among the groups to monitor their understanding of the science content.* **ELL support:** Point out that many of the words in this essay were presented earlier. It might be useful to move the vocabulary discussion to this part of the lesson. You might also want to underline the words used to label the pictures in the handout. **ELL support:** In addition to or in lieu of verbalizing your thoughts as you read the essay, provide opportunities for		

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			students to talk about the science ideas. Stop at each image and have students discuss the ideas in same-language groups using their native language and English. **ELL support:** The handout describes organisms that reproduce sexually. It may be useful to name some organisms that don't reproduce sexually so that students understand the difference.		
15 min	**Follow-Up to Activity** **Synopsis:** Students work with a partner to describe science ideas from the essay in their own words. Then they update and revise the class charts of ideas and questions about inheritance. **Main science idea(s):** • When sperm and egg cells are made, the chromosomes pair up, and each sperm or egg receives one of each chromosome pair from the parents. When egg and sperm come together to make a baby, the chromosomes pair up again, with one chromosome in each pair coming from the	Engage students in constructing explanations and arguments.	That was a lot of information to absorb, wasn't it? Let's put our heads together and see if we can make sense of it all. **Show slide 7.** On page 2 of the handout, it says that "scientists also discovered that when a new individual is made, special kinds of cells combine. These cells are called *egg cells* and *sperm cells*." **Optional:** *Instead of having students pair up for the following task, you may want to have them work in groups of three.* **Turn and Talk:** Work with a partner to explain *in your own words* what these special egg and sperm cells have to do with inheritance. What takes place in the parents' cells to make offspring? First, read the information on page 2 of		

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	mom and the dad.	Ask questions to probe student ideas and predictions.	the handout again and then review Mendel's ideas from yesterday's lesson. Can you figure out how the ideas in these two handouts relate to each other? Think about how you'd explain this information to another 6th grader who isn't in our class. What would you say about the process of inheritance? This is complex information, so do your best to make sense of how offspring inherit half of their genetic information from their mother and half from their father. **NOTE TO TEACHER:** *Give students about 5 minutes to wrestle with these science ideas. Encourage them to draw their own pictures or diagrams to make sense of how organisms receive half of their genetic information from their mother and half from their father.* *As you move around the room, pay attention to what students seem to understand and what seems to confuse them. Their explanations don't need to be perfect. Ask probe questions as needed, but it isn't necessary to correct students' thinking, since they'll continue working with these ideas in the next lesson. Simply listen and note any areas of confusion to address in future lessons.*		

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		Engage students in communicating in scientific ways.	**Whole-class share-out:** So did you figure out what egg and sperm cells have to do with inheritance? Let's hear a few of your explanations. As you listen to your classmates' explanations, be thinking about whether you agree or disagree with the ideas, and whether you have any questions or ideas to add on. Make sure to communicate your feedback in scientific ways. After our discussion, we'll add any new science ideas and questions to our class charts.	*Ideal student response:* When sperm and egg cells are made, the chromosomes pair up, and each sperm or egg cell gets one of each pair. When the egg and sperm come together to make offspring, the chromosomes pair up again, with one chromosome in each pair coming from the mom and one from the dad.	
5 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students write down new ideas from today's lesson that might help answer the unit central question, *Why are individuals of a species different from one another?* **Main science idea(s):** • Each individual inherits one chromosome from	Highlight key science ideas focus question throughout.	**Show slide 8.** At the end of our last lesson, you wrote down some ideas you thought might help us answer the unit central question, *Why are individuals of a species different from one another?* Find that page in your science notebooks and add any new ideas about inheritance that you learned about in today's lesson. Make sure to leave some space so you can keep adding ideas in future lessons.		

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	the mother's pair, and one from the father's pair. This new combination of chromosomes makes each offspring somewhat like and somewhat different from each parent.				
1 min	**Link to Next Lesson** **Synopsis:** The teacher briefly reviews what students have learned so far about inheritance and then foreshadows the next lesson.	Link science ideas to other science ideas.	**Show slide 9.** Yesterday and today, we learned about the ideas Mendel came up with to explain the behavior of genes and the patterns he observed in how parents pass traits to their offspring. Many years later, a scientist named Walter Sutton figured out how this works by studying cells under a microscope. In the next lesson, we'll add to what we already understand about inheritance by exploring Sutton's ideas and comparing them with Mendel's ideas.		