# Genetics
# Lesson 3b: Mendel's Ideas and the Proof Found in Cells

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| **Grade 6** | **Length of lesson:** 40 minutes | **Placement of lesson in unit:** 3b 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 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:<br>• One sperm or egg cell receives one chromosome from each pair of the parents' chromosomes.<br>• The single chromosome each parent contributes to the sperm or egg is randomly selected.<br>• When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created.<br>• One set of chromosomes comes from the mother, and the other set comes from the father.<br>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**

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| **Materials Needed**<br>• Science notebooks<br>• Class charts: Our Current Ideas about Inheritance; Our Questions about Inheritance (from previous lessons)<br>• Markers<br><br>**Student Handouts and Teacher Masters**<br>• 3.1 Understanding Inheritance: Results from Studies of Cells (from lesson 3a)<br>• 3.2 A Read-Aloud/Think-Aloud Example (Teacher Master from lesson 3a)<br>• 3.3 Sample Marked Essay (Teacher Master from lesson 3a)<br>• 3.4 Genes and Chromosomes (1 per student)<br>• 3.4 Genes and Chromosomes (Teacher Master) | **Ahead of Time**<br>• Review the Genetics Content Background Document, especially sections 1 and 6. |

**Lesson 3b General Outline**

| Time | Phase of Lesson | How the Science Content Storyline Develops |
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| 5 min | **Link to previous lesson:** Students share science ideas from the previous lesson that might help them answer the unit central question, *Why are individuals of a species different from one another?* The teacher adds new ideas and questions about inheritance to the class charts. | |
| 3 min | **Lesson focus question:** The teacher reviews the focus question, *What do we know about genes today that Gregor Mendel didn't know?* | |
| 5 min | **Setup for activity:** Students prepare to investigate the relationship between Mendel's ideas and Sutton's observations and ideas. | • After Mendel, scientists discovered how chromosomes move inside cells by using microscopes that enabled them to examine cells in greater detail. |
| 10 min | **Activity:** Students compare Mendel's ideas about gene behavior with Sutton's observations and ideas about how chromosomes move in cells. | • The pattern of chromosome movement in cells matches the way Mendel described gene behavior. This led scientists to conclude that genes are located on chromosomes. |
| 10 min | **Follow-up to activity:** Students write and then share their answers to the focus question, *What do we know about genes today that Gregor Mendel didn't know?* | • When sperm and eggs cells are made, each sperm or egg cell receives one chromosome from each pair of the parents' chromosomes.<br>• The single chromosome each parent contributes to the sperm or egg cell is randomly selected.<br>• When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created.<br>• One set of chromosomes comes from the mother, and the other set comes from the father. |
| 6 min | **Synthesize/summarize today's lesson:** The teacher summarizes key science ideas from the lesson. | • The pattern of chromosome movement matches the way Mendel described gene behavior: Like genes, chromosomes exist in pairs, and offspring inherit one chromosome from each parent. Chromosomes separate from each other when eggs or sperm are produced and then unite with their counterpart from the other parent when an offspring is made. These observations led scientists to conclude that genes are located on chromosomes. |
| 1 min | **Link to next lesson:** The teacher forecasts the science ideas students will put together in the next lesson. | |

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| 5 min | **Link to Previous Lesson**<br><br>**Synopsis:** Students share science ideas from the previous lesson that might help them answer the unit central question, *Why are individuals of a species different from one another?* The teacher adds new ideas and questions about inheritance to the class charts. | | **Show slides 1 and 2.**<br><br>Last time, we read an essay about what scientists discovered when they studied cells and chromosomes under a microscope.<br><br>Then at the end of the lesson, you added some new science ideas to the list in your notebooks that might help us answer our unit central question, *Why are individuals of a species different from one another?*<br><br>What new ideas did you write down about how traits are passed from parents to their offspring and how chromosomes behave when egg and sperm cells develop?<br><br>How do you think these ideas help us explain why individuals of the same species are different from one another?<br><br>**NOTE TO TEACHER:** *During this brief discussion, listen carefully to the ideas students verbalize. Are they starting to put together the science ideas from previous lessons? They'll have many opportunities to make sense of the science ideas about inheritance in this lesson and subsequent lessons, so be patient as their understanding develops regarding how traits are passed from parents to offspring and what makes* | Kids get different genes from each parent.<br><br>Chromosomes divide up, and you get half from your mother and half from your father, and their genes are different.<br><br>It's like the dachshunds and pea plants. Sometimes some traits get covered up until there are different combinations. | What do you mean by "different genes"?<br><br>Does anyone want to add anything? |

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| | | | *individual offspring unique.*<br><br>*Make sure to add to the class charts (Our Ideas about Inheritance, and Our Questions about Inheritance) any new ideas and questions that emerge during this discussion.* | We learned that some traits are dominant and some are recessive, so the dominant ones show up. I don't really understand exactly how that happens.<br><br>It seems like there are lots of versions of traits you could get from your mom or your dad. That's why kids from the same parents look kind of alike and kind of different. | Say more about traits being "covered up."<br><br>Does anyone have another way of saying this? |
| | | Link science ideas to other science ideas. | Yesterday we learned that Mendel and other scientists figured out some rules or patterns about inheritance to explain what happens when traits are passed from one generation to the next. Then about 40 years after Mendel's experiments with pea plants, scientists discovered how chromosomes move by observing them under microscopes that enabled them to examine cells in greater detail.<br><br>Today, scientists know exactly how traits are passed from parents to offspring and what takes place in the parents' cells when this happens. | | |

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| | | | In this lesson, we'll see whether Mendel's ideas about inheritance were accurate by comparing them with the ideas of another scientist who had the advantage of examining cells under a microscope that enabled him to observe them in greater detail. | | |
| 3 min | **Lesson Focus Question**<br><br>**Synopsis:** The teacher reviews the focus question: *What do we know about genes today that Gregor Mendel didn't know?* | Set the purpose with a focus question or goal statement. | **Show slide 3.**<br><br>Our focus question for today is the same one we considered yesterday: *What do we know about genes today that Gregor Mendel didn't know?*<br><br>What did scientists learn about inheritance 40 years after Mendel that Mendel couldn't have known about?<br><br>Did these new understandings about how genes are passed from parents to offspring show that Mendel's ideas were right or wrong?<br><br>These are the questions we'll investigate today. | | |
| 5 min | **Setup for Activity**<br><br>**Synopsis:** Students prepare to investigate the relationship between Mendel's ideas and Sutton's observations and ideas. | Make explicit links between science ideas and activities **before** the activity. | By examining cells under a microscope, a scientist named Walter Sutton discovered how chromosomes move and concluded that genes are found on chromosomes. He had good evidence for this idea.<br><br>Let's read the final two paragraphs | | |

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| | **Main science idea(s):**<br>• After Mendel, scientists discovered how chromosomes move inside cells by using microscopes that enabled them to examine cells in greater detail. | | about Sutton's hypothesis in the essay from yesterday.<br><br>**NOTE TO TEACHER:** *Have students locate handout 3.1, Understanding Inheritance: Results from Studies of Cells.*<br><br>Sutton hypothesized that the movement of chromosomes in cells exactly matched Mendel's ideas about how genes behave.<br><br>Next, we'll compare Mendel's ideas with Sutton's ideas and see if we find an exact match too. | | |
| 10 min | **Activity**<br><br>**Synopsis:** Students compare Mendel's ideas about gene behavior with Sutton's observations and ideas about how chromosomes move in cells.<br><br>**Main science idea(s):**<br>• The pattern of chromosome movement in cells matches the way Mendel described gene behavior. This led scientists to conclude that genes are located on chromosomes. | | **Show slide 4.**<br><br>**NOTE TO TEACHER:** *Distribute handout 3.4, Genes and Chromosomes.*<br><br>**ELL support:** It might be useful to include information about Sutton at the top of the handout or modify the content to reflect the views of other scientists in the 1900s, not just Sutton's.<br><br>Three of Mendel's ideas are described in the left column of this handout. There are also some labeled drawings that illustrate each of his ideas. You'll work in small groups to fill in the right-hand column showing which of Sutton's ideas about cells and chromosomes match up with Mendel's ideas about genes. | | |

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| | | Engage students in analyzing and interpreting data and observations.<br><br>Engage students in constructing explanations and arguments.<br><br>Ask questions to probe student ideas and predictions.<br><br>Ask questions to challenge student thinking. | **Small groups:** In your groups, review the essay from yesterday's lesson to identify any of Sutton's ideas that seem to match one of Mendel's ideas on the handout. When you find an idea you think matches one of Mendel's, talk about it in your group, and if everyone agrees, add it to your handout in the right-hand column next to Mendel's idea. Write down the science idea in a complete sentence and draw a diagram to illustrate it.<br><br>**NOTE TO TEACHER:** *Move among small groups as they work on the activity and listen to their discussions. Ask probe questions to help students clarify their thinking or challenge questions to help them consider other possibilities. Direct them back to the essay as needed.*<br><br>**Whole-class share-out:** Let's hear what you came up with. Did any of Sutton's ideas seem to match Mendel's ideas? Why do you think the ideas match?<br><br>**NOTE TO TEACHER:** *After students share their answers, display the teacher master for handout 3.4 on a document reader and give students an opportunity to compare the answer key with their responses. Allow time for comments and questions.* | I think Sutton's idea about sperm and eggs getting just one chromosome goes with having two genes for each trait. | Why do you think this idea matches *best* with the idea about two genes for a trait? |

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| 10 min | **Follow-Up to Activity**<br><br>**Synopsis:** Students write and then share their answers to the focus question, *What do we know about genes today that Gregor Mendel didn't know?*<br><br>**Main science idea(s):**<br>• When sperm and egg cells are made, each sperm or egg cell receives one chromosome from each pair of the parents' chromosomes.<br>• The single chromosome each parent contributes to the sperm or egg cell is randomly selected.<br>• When the sperm and egg unite at fertilization, a new individual with two sets of chromosomes is created.<br>• One set of chromosomes comes from the mother, and the other set comes from the father. | Highlight key science ideas and focus question throughout. | **Show slide 5.**<br><br>Our focus question today is *What do we know about genes today that Gregor Mendel didn't know?*<br><br>**Think-Pair-Share:** Using Mendel's and Sutton's ideas from today's handout think about the focus question and write your *best* answers in your science notebooks. Then share your answers with a partner and talk about how scientists figured out what happens inside cells.<br><br>**ELL support:** Allow students to share their answers to the focus question in their native languages, if desired.<br><br>**Whole-class share-out:** Let's hear a few of your answers, and then we'll update our class charts on inheritance. | We know about chromosomes and how they divide up in cells.<br><br>There are only half as many chromosomes in each egg and sperm cell.<br><br>Not exactly, but he knew that offspring got traits from both parents | What's interesting about how chromosomes divide up in egg and sperm cells?<br><br>Is this something Mendel knew about? |

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| | | | | somehow.<br><br>We know about how chromosomes pair up and divide. | What else do we know now that Mendel didn't? |
| 6 min | **Synthesize/Summarize Today's Lesson**<br><br>**Synopsis:** The teacher summarizes key science ideas from the lesson.<br><br>**Main science idea(s):**<br>• The pattern of chromosome movement matches the way Mendel described gene behavior: Like genes, chromosomes exist in pairs, and offspring inherit one chromosome from each parent. Chromosomes separate from each other when eggs or sperm are produced and then unite with their counterpart from the other parent when an offspring is made. These observations led scientists to conclude that genes are located on chromosomes. | Summarize key science ideas. | **Show slide 6.**<br><br>**NOTE TO TEACHER:** *Wrap up the lesson by summarizing key science ideas gleaned from Mendel's and Sutton's observations.*<br><br>In today's lesson, we learned some science ideas that Mendel didn't know about. For example,<br><br>• Sexually reproducing organisms have two pairs of chromosomes in each cell.<br>• When sperm and egg cells are made, each cell gets just one chromosome from each pair that's randomly selected.<br>• When sperm and egg unite during fertilization, a new individual with two sets of chromosomes is created. One set comes from the mother, and one set comes from the father.<br><br>Even though Mendel didn't know about chromosomes and their behavior, Sutton and other scientists discovered that his ideas about how genes (or "factors") | | |

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| | | | were right. By examining cells under a microscope, they figured out that genes and chromosomes move in exactly the same way.<br><br>Mendel figured out many important ideas about how traits are passed from parents to their offspring from his experiments with pea plants. | | |
| 1 min | **Link to Next Lesson**<br><br>**Synopsis:** The teacher forecasts the science ideas students will put together in the next lesson. | Link science ideas to other science ideas. | **Show slide 7.**<br><br>Now that we understand more about how traits are passed from parents to their offspring, it's time to put all these ideas together!<br><br>In the next lesson, we'll make some baby animals of our own and see if we can recreate the pattern of traits we observed in the dachshund and pea-plant pedigrees. | | |