

Middle School Life Science

The Building Blocks of Photosynthesis

Essential Question(s):

- How do story elements help us to understand scientific concepts?
- What things are needed for plants and other living organisms to survive?

Materials/Resources

Teacher:

- <https://www.youtube.com/watch?v=FnJgQyctZRE> Clementine Bordeaux “Lakota Creation Story”
- *The Gift of the Sacred Pipe* - Chapter 5 “The Sun Dance” excerpt
- 6 red cubes
- 18 green cubes
- 12 blue cubes
- Sun’s Energy stickers

Student:

- Science journals
- pencil/pen

Essential Vocabulary

Molecules

- Chemical reaction
- Glucose
- Oxygen
- Hydrogen
- Carbon
- Photosynthesis
- *Maka*
- *Win*
- *Mni*
- Inference

Learning Experience

Standards and Practice:

7.L.1.1 Identify basic cell organelles and their functions

7.L.3.1 Students are able to predict the effects of biotic and abiotic factors on a species survival.

OSEU 3: The origin, thought and philosophy of the Oceti Sakowin continues in the contemporary lifestyles of tribal members. Tribal cultures, traditions and languages are incorporated and observed by many tribal members both on and off the reservation.

	<p>This lesson supports students' understanding of the following topics in chemistry:</p> <ul style="list-style-type: none"> ● Reactions ● Photosynthesis ● Conservation of matter
<p>Cultural Integration:</p>	<p>Lakota culture and language is integrated into this lesson through the sharing of stories and identification of Lakota terminology. Students will align Lakota concepts of energy and survival to the process of photosynthesis.</p>
<p>Objectives:</p>	<p>By the end of this lesson, students should be able to</p> <ul style="list-style-type: none"> ● Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. ● Demonstrate understandings of scientific concepts through illustration and/or models. ● Identify how Lakota and scientific concepts align.
<p>Engage: Activating Strategy/Hook:</p>	<ul style="list-style-type: none"> ● Students will begin by writing in their science journals "What things does a plant need to survive?" ● They will watch the Lakota Creation Story video while taking notes. Students will be prompted to take note of things that relate to science. ● Following the short video, they will engage in a think-pair-share: What does this story have to do with plants? What things does a plant need to survive? (from their journal answers) The discussion should address why some things are necessary for plants to grow based on prior knowledge, inference from the "Lakota Creation Story" and/or what science tells us. If there is some discrepancy about what plants need to grow, students will be asked to prove their ideas by creating an experiment to test their theory. For example, if students are unsure of whether plants need soil (<i>maka</i>) to grow, they should create an experiment investigating what happens to a plant growing without soil and a plant growing with soil. (Students should discover that soil is the vehicle for nutrients. Plants don't have to have soil but they do need

	<p>nutrients found in soil. Hydroponics is an example of that.)</p> <ul style="list-style-type: none"> • Students can label their experiment pieces with Lakota terminology learned in the “Lakota Creation Story.” When the class has determined that a plant needs water, carbon dioxide, and sunlight (<i>wi</i>) to grow, write the final list on the board, and discuss how these elements are represented in the “Lakota Creation Story.” • Next the students will read <i>The Gift of the Sacred Pipe</i> - Chapter 5 excerpt “The Sun Dance” (either independently or in small groups) • Following the reading they will respond to the following question in their science journals: What role does the Sun play in the survival of the Lakota people--“That the people shall live?”
<p>Explore: Learning Experiences</p>	<ol style="list-style-type: none"> 1. Have the blocks available and write the key on the board that explains what each colored blocks represent: <ul style="list-style-type: none"> Red = Carbon Blue = Oxygen Green = Hydrogen 2. Ask students to independently list what a plant needs to grow. 3. Ask students, “<i>What is water made of? What elements? Do you know other names for water? (Mni - Mni Wiconi: Water is life)</i>” This question should lead to the idea that water is made of H₂O. 4. Write H₂O on the board next to the key. Ask, “<i>What does H₂O mean? Can you make H₂O out of the blocks that are provided?</i>” 5. Have students volunteer and share their models of water. Discuss as a group until the group has decided that water is made out of two hydrogen atoms and one oxygen atom (two green blocks and one blue blue). 6. Tell students; “<i>Plants take in six molecules of water at a time. Please make six molecules of water.</i>” 7. Write on the board “6 H₂O +”

8. Ask students, *"Plants need water to survive. What else to they need?"* Allow students to answer carbon dioxide.
9. Ask students, *"What do you think carbon dioxide looks like?"* Allow them time to build their idea and then invite students up to explain their thinking.
10. When the class has decided that carbon dioxide is made up of one carbon atom and two oxygen atoms (one red and two blue blocks), have them use the remaining blocks to make carbon dioxide.
11. Ask students, *"How many molecules of carbon dioxide did you make?"* When students answer six, add this to your equation on the board: $6 \text{ H}_2\text{O} + 6 \text{ CO}_2$
12. Ask students, *"What else does a plant needs to survive?"* Most likely they will answer sunlight. Ask, *"What is the sunlight made out of? Are there any more blocks to make more molecules? What can you tell about sunlight?"* If students struggle, go back to the Lakota stories. With guidance, students should conclude that sunlight is an energy source.
13. Ask students, *"What is the energy source in this model? What is moving the blocks?"* They will answer that they are the energy source in the model, and they should realize that in this model they are playing the role of the sun.
14. Give each student a sticker that says "The Sun's Energy," or "The Energy of Wi" so they can remember that they are the energy in the model.
15. Some students may not be able understand that they are using energy. Have them quickly rub their hands together for 15 seconds. When they say they're tired, ask why. When they state that they are using too much energy rubbing their hands together, emphasize the word energy. Tell students, *"You use energy to move things. In both Lakota stories, we learned of the different types of energy: Inyan's blood/water, Wi the sun. The sun gives off energy in a different form. You used a lot of energy to rub your hands together, how do they feel now? That is because you used energy to create that heat from friction, just like the sun uses energy to rearrange the molecules in photosynthesis."* On the equation on the board of $6 \text{ H}_2\text{O} + 6 \text{ CO}_2$ write the "Sun's Energy--Wi" and draw an arrow toward

	<p>the equation to show that it helps the reaction take place but is not part of the molecular equation itself.</p> <p>16. On the board, add a yields sign to your equation “$6 \text{H}_2\text{O} + 6 \text{CO}_2 \rightarrow$” Explain to students that <i>“this symbol is what scientists use in an equation to say ‘yields’. It means that a chemical change is happening between the reactants (the chemicals on the left side of the arrow) and the products (the chemicals on the right side of the arrow).”</i></p> <p>17. Ask students, <i>“What does a plant release during photosynthesis?”</i> Students should answer with oxygen.</p> <p>18. Tell students that, <i>“a plant does give off oxygen. In fact, it gives off six molecules of oxygen in the form of O_2. Can you rearrange your blocks to make six molecules of O_2?”</i></p> <p>19. Add oxygen to your equation, “$6 \text{H}_2\text{O} + 6 \text{CO}_2 \rightarrow 6 \text{O}_2$”</p> <p>20. Say to students, <i>“Now look at all the blocks you have left. What else can the plant make? Use the blocks to make only one molecule of the last remaining chemical a plant makes during this chemical reaction. Figure out the molecular equation and write it down yourself from the blocks you have left.”</i></p> <p>21. Have students share the chemical equation of the molecule that they have left. They should come up with $\text{C}_6\text{H}_{12}\text{O}_6$. Add that to the equation “$6 \text{H}_2\text{O} + 6 \text{CO}_2 \rightarrow 6 \text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6$.”</p> <p>22. Ask students what they think this is. Tell them that, <i>“this molecule is called glucose. It is really a type of sugar. Plants go through a process called photosynthesis to make this sugar. When you eat plants, you consume the sugar.”</i></p>
<p>Explain: Learning Experiences</p>	<p>Have students partner up and illustrate photosynthesis using the chemical equation that they just learned and their own illustrations of what it would look like. They can make connections to the Lakota Creation Story and/or the Sun Dance story in their illustrations. Have them share their explanation with the class.</p> <p>Student examples could be as simple as drawing a plant breathing in air plus a glass of water and sunlight, yielding a bag of sugar and a person breathing in oxygen. On a more complex level, the teacher could have students draw molecules using the</p>

	<p>traditional ball and stick models. This is an opportunity for students of different levels to demonstrate different understandings of scientific and Lakota concepts through their own illustrations.</p>	
Elaborate: Extending & Defining	<p>Ask students what would happen if they added another element to the process of photosynthesis? For example, what if they substituted ethanol (C₂H₅OH) for the water? Or what if they substituted coffee for water? Allow students to pick their own substitute for a part of the equation and create their own investigation where they can investigate the substitutions of different ingredients and form their own conclusions.</p>	
Evaluate: Summarizing Strategy	<p>Students will engage in a final group discussion answering the following:</p> <ul style="list-style-type: none"> • How could you design a test to see if a plant really breathes in carbon dioxide? • How is the model similar and different from the Lakota Creation Story? The Sun Dance? From real life? • What would happen to humans if we didn't have plants? • What other species rely on plants for the sugar they provide? 	
Differentiation Strategies		
Extension	Intervention	Language Development
Assessment(s)		
Formative	Summative	
	<p>Students will work in small groups to create a diorama illustrating the process of photosynthesis using elements from the Lakota Story to increase understandings of scientific concepts.</p>	

Teacher Reflection: (Next steps?)