Incredible Carbon Journey

Tallgrass Prairie Center

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INCREDIBLE PRAIRIE CARBON JOURNEY

BACKGROUND

Carbon is one of the earth’s most important elements. It serves as the fundamental building block for all plant and animal life, and is a key component in many chemical processes. The carbon cycle – one of the earth’s major biogeochemical cycles – describes how carbon moves through the atmosphere, biosphere, geosphere and hydrosphere. Learning about the carbon cycle leads to a better understanding of today’s climate and its effects on agriculture and natural systems.

Much of the earth’s carbon is found in compounds, including carbon dioxide. CO₂ occurs naturally in the atmosphere, and is an essential component of respiration and photosynthesis. As a greenhouse gas it insulates the earth, making it habitable. But as we know, too much greenhouse gas leads to global warming. Because human activities have led to increased carbon production, it’s especially important to know where carbon is stored during the carbon cycle.

Plants use photosynthesis to convert CO₂ into sugar and other carbohydrates used for food and growth. While plants release CO₂ through respiration and decay, it’s stored at a much greater rate. Prairie plants are especially adept at storing carbon, locking up large amounts in their roots. In fact, prairies store more carbon below ground than a forest stores above!

Deep, complex prairie root systems sequester (store) carbon and – with the help of microorganisms – move it to the soil where it stabilizes. Some of these carbon sinks last more than a thousand years! This process of carbon sequestration helped create the productive, flood- and drought-resilient soils of the prairie region. And today, the prairie’s ability to sequester carbon has added significance: it helps combat global warming.

Analyzing how carbon moves through the environment in association with human activities, helps students begin to understand complex environmental issues and possible solutions.

Note: This activity focuses the role of prairie in the carbon cycle. The ocean and other critical aspects of the carbon cycle should be addressed when discussing this activity.
**VOCABULARY**

**Carbon cycle:** The circulation and transfer of carbon between living things and the environment.

**Respiration:** The process of breaking down food and converting it to energy.

**Photosynthesis:** The process of using energy from the sun to transform water, carbon dioxide and minerals into sugars the cell can use as energy.

**Carbon Sink:** An area that absorbs and stores more carbon than it releases.

**TEACHER PREPARATION**

- Make copies of My Prairie Carbon Journey Log sheet (1 per student) (Appendix A)
- Make copies of Why Prairie Carbon Moves Explanation Sheet (Appendix B)
- Make copies of Carbon Cycle Passport (Appendix C)
- Make station signs posted with matching cube (Appendix D)
- Make cubes (Appendix E or F or G)

*Note:* If you do not want students waiting in long lines at carbon sink stations (Fossil Fuel, Prairie Plant Roots) or stations representing large amounts of available carbon (Atmosphere), make additional stations/cubes for Fossil Fuel, Prairie Plant Roots and Atmosphere.

**ACTIVITY**

1. Tell students they’re going to be carbon atoms moving through the carbon cycle in a prairie.

2. Point out all the stations: Soil, Animal, Leaf/Stem, Microorganism, Fossil Fuel, Atmosphere, Prairie Plant Roots. (Students may or may not move to all stations.) Distribute the stations around the room, with the corresponding cube.

3. Arrange students randomly and evenly into the different stations as their starting point.

4. Have student write their starting point under “Station” on their My Prairie Carbon Journey log sheet. At their turn, students roll the cube, record their destination under “Traveled to,” move to the end of the line at that station and and record the station under “Station.” (“Travelled to” and “Station” will be the same.) While waiting for their next turn, students could discuss and complete “Carbon Atoms do this Because …” as shown in Step 6.

   ALTERNATIVE: Students record travels directly in the Carbon Cycle Passport.

   *Note:* See Alternate Activities (p. 3) for alternatives to recording their travel experience.

5. Continue to roll, move and record. (If students roll their current station, record this result and go to the back of the line.)

6. Discuss and complete the “Carbon Atoms Do This Because” column by using prior knowledge and/or information from the “Why Do Carbon Atoms Move” reference sheet. To use the reference sheet, students should locate the station where they were, and the station where they went and record the Reason For Move. (This step can be done while waiting in line at Step 4.)
Discussion

a. When traveling as a carbon atom, were some stations busier than others? Why?
   (If using multiple Fossil Fuel, Prairie Plant Roots and Atmosphere stations, remind students that even though
   they were at different physical stations, they were still in the same part of the cycle.)

b. Did your carbon atom get to some stations more frequently? Did it stay in some longer than others?
   (Remind students that plants are carbon sinks, and prairie roots are especially good at storing carbon.)

c. Did your carbon atom make it to all the stations? Why or why not?

d. How does human activity play a role in the carbon cycle?

e. How would the prairie carbon cycle be different with other plants such as row crops?

f. Did you – as the carbon atom – truly “cycle”?

g. How would the carbon cycle differ between the Pre- and Post-Industrial Revolution?

h. What powers the carbon cycle?

i. Oceans were excluded in this simulation. What role would they play?

j. Do the earth’s various biomes affect the carbon cycle differently?

k. Do some areas have more fossil fuel resources than others? Where? Why?

ASSESSMENTS

1. Write a story about the carbon atom and its adventures as it moved through the stations recorded in the
   Carbon Cycle Passport. Continue the story, or create a future travel plan taking you through all seven
   stations, explaining how the carbon is transferred.

2. Create a graphic organizer, mind map or flow chart of a carbon atom’s movement through the prairie
   carbon cycle. Emphasize the important role of prairie roots.

3. Create a carbon cycle bracelet (see Carbon Cycle Bracelet in Alternate Activities). Students may use
   their choice of bead color/order, but need to justify how a carbon atom could move in that order.

4. Evaluate the students’ understanding from class/group/individual discussions.

EXTENSIONS

1. Graph the number of carbon atoms (students) who visited each station, then discuss the probability
   within the game and its relation to the real-world carbon cycle.

2. Change the dice to represent Pre- and Post-Industrial Revolution

3. Research the depletion of carbon sinks and the increase in atmospheric carbon.

ALTERNATE ACTIVITIES

Paper Chains

Each student creates a paper chain representing his/her Incredible Carbon Journey. As students move
from station to station, they pick up a strip of colored paper matching the cube. Hang the completed
chain to illustrate the movement of carbon atoms. Students will be able to visualize where the majority
of the carbon atoms go.

Discussion questions:
Do the chains have lots of colors, or few?
Does it matter where the chain starts?

Note: Because the sun is the primary power source for the carbon cycle, consider starting the chain
with a yellow link, representing the sun.
Carbon Cycle Bracelet
Similar to Paper Chains (above). Use colored beads to match the station color and put them on a pipe cleaner or ribbon to create a bracelet.

RESOURCES

- [https://www.nwf.org/pdf/Lesson%203/Follow_the_Carbon_Atom_11_05_10.pdf](https://www.nwf.org/pdf/Lesson%203/Follow_the_Carbon_Atom_11_05_10.pdf)
- Adapted from “The Incredible Journey” *Project Wet.*

STANDARDS

5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and non-living parts of an ecosystem.

MS-LS1-6 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.

MS-ESS2-1 Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

*Note:* Literacy and Mathematics standards may apply to this activity’s extensions and assessments.

Prairie Roots lesson plans created by the Tallgrass Prairie Center with funding from the Iowa Living Roadway Trust Fund.

2017
APPENDICES

Appendix A: Carbon Journey Log Sheet
Appendix B: Why Carbon Atoms Move
Appendix C: Carbon Cycle Passport
Appendix D: Station Posters
  1. Soil
  2. Animal
  3. Prairie Plant Leaf/Stem
  4. Microorganism
  5. Fossil Fuel
  6. Atmosphere
  7. Prairie Plant Root
Appendix E: Cube Cards (instructions at the end of appendix)
Appendix F: Alternative printed cubes
Appendix G: Alternative dice stations
My Prairie Carbon Journey Log

<table>
<thead>
<tr>
<th>Station:</th>
<th>Traveled To:</th>
<th>Carbon atoms do this because...</th>
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<tr>
<td>Station you are located</td>
<td>Rolled</td>
<td>Reason for Move</td>
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<td>----------------</td>
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<tr>
<td><strong>ANIMAL</strong></td>
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<tr>
<td>Atmosphere</td>
<td>Animals release carbon dioxide during respiration, or methane in waste production</td>
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<tr>
<td>Soil</td>
<td>The animal dies and carbon is returned to the soil</td>
<td></td>
</tr>
<tr>
<td>Animal (Stay)</td>
<td>Carbon is absorbed into the cells and tissues and stored as fat in the animal, or the animal is eaten by another animal and passes along carbon</td>
<td></td>
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<tr>
<td><strong>ATMOSPHERE</strong></td>
<td></td>
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<tr>
<td>Prairie Plant Leaf</td>
<td>Carbon dioxide is taken in to use during photosynthesis.</td>
<td></td>
</tr>
<tr>
<td>Atmosphere (Stay)</td>
<td>Carbon dioxide builds up in the atmosphere as a greenhouse gas</td>
<td></td>
</tr>
<tr>
<td><strong>FOSSIL FUEL</strong></td>
<td></td>
<td></td>
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<tr>
<td>Atmosphere</td>
<td>Humans have collected and use coal and oil to produce power resulting in the release of carbon.</td>
<td></td>
</tr>
<tr>
<td>Fossil Fuels (Stay)</td>
<td>Fossil fuels take millions of years and proper conditions to develop deep below the ground where they are stored until mined/pumped out</td>
<td></td>
</tr>
<tr>
<td><strong>MICROORGANISM</strong></td>
<td></td>
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<tr>
<td>Atmosphere</td>
<td>Carbon in the soil is broken down and used for energy and released as carbon dioxide during respiration</td>
<td></td>
</tr>
<tr>
<td><strong>PRAIRIE PLANT LEAF/STEM</strong></td>
<td>Plant leaf/stem eaten by an animal</td>
<td></td>
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<tr>
<td>Atmosphere</td>
<td>Carbon dioxide is released into the atmosphere through respiration, or released in prairie fire</td>
<td></td>
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<tr>
<td>Prairie Plant Root</td>
<td>Stored in the roots for future use such as building more plant cells</td>
<td></td>
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<tr>
<td>Soil</td>
<td>Leaves and stem die and decompose in the soil</td>
<td></td>
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<tr>
<td>Animal</td>
<td>Some burrowing animals eat the roots</td>
<td></td>
</tr>
<tr>
<td>Microorganism</td>
<td>Feed off of the roots and can provide nitrogen in exchange</td>
<td></td>
</tr>
<tr>
<td>Prairie Plant Root (Stay)</td>
<td>Deep tap roots and large fibrous root systems can store more carbon below ground than a forest can store above ground</td>
<td></td>
</tr>
<tr>
<td><strong>PRAIRIE PLANT ROOT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>Material not decomposed in the soil under proper conditions over millions of years become coal/oil</td>
<td></td>
</tr>
<tr>
<td>Microorganisms</td>
<td>Break down the carbon in the soil for energy to produce other nutrients such as nitrogen</td>
<td></td>
</tr>
<tr>
<td>Soil (Stay)</td>
<td>Decaying material stays in the soil</td>
<td></td>
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</tbody>
</table>

Appendix B

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Appendix C

Carbon Cycle Passport
Passport

My Incredible Prairie Carbon Cycle Journey
-Life as a Carbon Atom-

By: ____________________________

Departing from: ____________________
Traveling to: ________________________
My Adventure: ____________________

Departing from: ____________________
Traveling to: ________________________
My Adventure: ____________________
Departing from: ____________________
Traveling to: ________________________
My Adventure: ____________________
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Appendix D

Station Posters
Animal
Prairie Plant
Leaf/Stem
Microorganism
Fossil Fuel
Atmosphere
Prairie Plant

Root
Appendix E

CUBE CARDS

(Directions listed at the end of Appendix E)
Microorganism

Prairie Plant Root Cube

Microorganism

Prairie Plant Root Cube

Atmosphere

Microorganism Cube

Atmosphere

Microorganism Cube
Fossil Fuel Cube

Fossil Fuel Cube

Fossil Fuel Cube

Fossil Fuel Cube

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To create cubes, cut out and glue or tape the cards onto seven cubes.

Note: You will glue six cards to each cube. The colored outlines will be the same on each of the six cards are on the same cube. The outline color matches the station color. When complete, you’ll have the following seven cubes:

1. **Soil Cube**: 2 Soil, 2 Fossil Fuel, 2 Microorganisms
2. **Atmosphere Cube**: 3 Atmosphere, 3 Prairie Plant Leaf/Stem
3. **Prairie Plant Leaf/Stem Cube**: 3 Prairie Plant Root, 1 Animal, 1 Atmosphere, 1 Soil
4. **Animal Cube**: 2 Animal, 3 Atmosphere, 1 Soil
5. **Prairie Plant Roots**: 3 Prairie Plant Root, 1 Animal, 2 Microorganism
6. **Microorganism**: 6 Atmosphere
7. **Fossil Fuel**: 4 Fossil Fuel, 2 Atmosphere
Appendix F

Alternative Printed Cubes
Prairie Plant Root

Microorganism

Prairie Plant Root

Microorganism

Animal
Appendix G

Alternative Dice Stations
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<tbody>
<tr>
<td>1</td>
<td><img src="image" alt="Atmosphere Icon" /></td>
<td><strong>Atmosphere</strong> Atmospheare Cube</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td><img src="image" alt="Prairie Plant Leaf/Stem Icon" /></td>
<td><strong>Prairie Plant Leaf/Stem</strong> Atmosphere Cube</td>
<td>5</td>
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<tr>
<td>3</td>
<td><img src="image" alt="Atmosphere Icon" /></td>
<td><strong>Atmosphere</strong> Atmosphere Cube</td>
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<table>
<thead>
<tr>
<th>1-</th>
<th>Prairie Plant Root</th>
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<tbody>
<tr>
<td>2-</td>
<td>Animal</td>
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<tr>
<td>3-</td>
<td>Prairie Plant Root</td>
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<tr>
<td>4-</td>
<td>Atmosphere</td>
</tr>
<tr>
<td>5-</td>
<td>Soil</td>
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<tr>
<td>6-</td>
<td>Prairie Plant Root</td>
</tr>
</tbody>
</table>
Prairie Plant Root

1- Prairie Plant Root

2- Microorganism

3- Prairie Plant Root

4- Prairie Plant Root

5- Microorganism

6- Animal

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<table>
<thead>
<tr>
<th></th>
<th>Microorganism Cube</th>
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<tr>
<td>1</td>
<td><img src="image" alt="Atmosphere" /></td>
<td>4</td>
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<tr>
<td>2</td>
<td><img src="image" alt="Atmosphere" /></td>
<td>5</td>
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<tr>
<td>3</td>
<td><img src="image" alt="Atmosphere" /></td>
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