The Carbon Cycle and its Role in Climate Change: Activity 2

Grade Level(s): 5-8

Time Required: One 45-minute class period

Focus Question:

- What is a carbon sink?

Learning Objectives:

- The students will be able to explain that plants are carbon sinks.

Materials:

- Atom signs created in Activity #1
- Several different colors of chalk or ribbon
- Blanket

Background:

- The students have heard about global warming, but most do not yet have the chemical background to understand what is happening. This activity is designed to give them a basic chemical understanding of the carbon cycle and thereby giving them an understanding of why healthy plants are essential to a healthy habitat. While other greenhouse gases (besides carbon dioxide) are also important, carbon is the example covered here. It is also important for the students to understand that there are other greenhouse gases.

  The story of Democritus' definition of the atom can be used to set a basic understanding. Using cheese as a prop as you talk will maintain the student's curiosity. The story, in brief, is as follows: Democritus stated that if you take a piece of cheese and cut it in half, you still have cheese. If you take that half and cut it again, the smaller piece is still cheese. If you take that tiny piece and cut it again the tinier piece is still cheese. If you could continue cutting the cheese into tinier and tinier pieces you would eventually come down to the most basic of all particles that still have all the qualities of cheese. Democritus called that fundamental particle the atom.

  We now know that cheese is not a fundamental particle, but we still use his word for the fundamental particle, the atom. There are 108 different atoms. They are the fundamental particles or building blocks from which all matter is made. In this lesson we are going to look at only a few of them. What does this have to do with our indicator species? Animals are made of atoms, just like us and just like the plants that it eats. The atom that is found in all living things on earth is carbon. In the upcoming activities keep your eye on where the carbon atoms are going.

Procedures/Instructional Strategies:

1. Begin by referring to Activity #1 and explaining to the students that animals don't eat all of the plants. Therefore lots of carbon stays in the plant material. Talk about the amount of carbon that is stored in forests and marshes.

2. Put several sugar molecule signs into the green circle as a visual aid. These plants act as a carbon "sink" removing CO_2 from the atmosphere.

3. Put a blanket in the circle to represent the stored energy. Remind the students that the formation of CO_2 releases heat. Tell them that CO_2 is a greenhouse gas in the air that acts like a blanket trapping warm air. Creating more CO_2 in the air is like adding more blankets, making everyone hotter. As long as the plants are living or buried in the ground the carbon stays locked up.

4. Have the students brainstorm things that happen to plants that would release the carbon. Examples might include animals eating, forest fires, and burning fossil fuels.

5. Evaluate students with the following questions:
   - How are plants carbon sinks?
     (The plant takes CO_2 out of the air and uses the carbon to make sugar, which is stored in the plant. As long as the plant is alive, the carbon will not return to the atmosphere.)
   - What are some ways that plants might release the carbon back into the atmosphere?
     (Answers will vary. Possibilities include the plant dying and decomposing. The plant could be eaten and the carbon released during the respiration process of the animal. Plants release carbon dioxide when they respire. Fire could burn the plants releasing the carbon.)

National Science Education Standards:

Physical Science

- Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group.
- Chemical elements do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and nonliving substances that we encounter.
- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.
- Energy is a property of many substances and is associated with heat, light, electricity,

mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

- In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.

Life Science

- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers--they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

Earth Science

- The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.
- Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.
- The sun is the major source of energy for phenomena on the earth’s surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun’s energy hitting the surface, due to the tilt of the earth’s rotation on its axis and the length of the day.

Science and Technology

- Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Engineers often build in back-up systems to provide safety. Risk is part of living in a highly technological world. Reducing risk often results in new technology.
- Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.

Science in Personal and Social Perspectives

- Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.
- Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

- Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.
- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids.
- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences. The results are used to determine the options for reducing or eliminating risks.
- Students should understand the risks associated with natural hazards (fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions), with chemical hazards (pollutants in air, water, soil, and food), with biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and with personal hazards (smoking, dieting, and drinking).
- Individuals can use a systematic approach to thinking critically about risks and benefits. Examples include applying probability estimates to risks and comparing them to estimated personal and social benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.
- Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment. The effect of science on society is neither entirely beneficial nor entirely detrimental.
- Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research.
- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should understand the difference between scientific and other questions. They should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.
- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.
- In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to

differ with one another about the interpretation of the evidence or theory being considered. Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.

- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Although scientists may disagree about explanations of phenomena, about interpretations of data, or about the value of rival theories, they do agree that questioning, response to criticism, and open communication are integral to the process of science. As scientific knowledge evolves, major disagreements are eventually resolved through such interactions between scientists.

References:

1. National Research Council, *Learning to Think Spatially*, The National Academies Press, Washington, DC, 2006.