Lesson: Carbon, Carbon Everywhere

FOR THE TEACHER

Summary
In this lesson, students will learn about how Carbon cycles through Earth’s systems and its importance for life on Earth.

Grade Level
Middle School

NGSS Alignment
This lesson will help prepare your students to meet the performance expectations in the following standards:

- **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.
- **Scientific and Engineering Practices**:
  - Engaging in Argument from Evidence
  - Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this lesson, students should be able to

- Indicate 3 reasons why Carbon is essential to life on Earth.
- Explain the atomic structure of carbon and how it bonds.

Chemistry Topics
This lesson supports students’ understanding of

- Atomic structure
- Subatomic Particles
- Organic Chemistry
- Carbon
- Photosynthesis

Time
**Teacher Preparation**: 50 minutes
**Lesson**: 1 hour

Materials
- Computers for each student, or access to the internet
- Image of Carbon Cycle for each student

Safety
- No specific safety precautions need to be observed for this activity.

Teacher Notes
- Differentiation: Have students present their written composition at the end, you will probably need another day for students to present
- Find appropriate websites for students to use as research ahead of time, some I use:
- Example Analysis: To whom it may concern: We need the money to further research this new planet because preliminary tests and studies have shown the possibilities of life on this planet.
Our rovers have returned samples of the soil that include carbon. Not only do they include carbon, but we have even found where it has bonded to hydrogen and oxygen. These single molecules appear to be able to form chains as well, very similarly to glucose and cellulose here on Earth. This must be studied in greater detail as we have only found carbon making single bonds with other elements found on this planet.

FOR THE STUDENT
Lesson

Carbon, Carbon Everywhere

Background
Just like energy cycling through a food web, matter cycles through the ecosystem. Remember that carbon has 4 electrons in its outermost shell and usually forms covalent bonds.

Pre-lab Questions
1. Draw a Lewis dot structure of the element Carbon.
2. What is the Law of Conservation of Mass?
3. What is the chemical equation for Photosynthesis?
4. What is the chemical equation for Cellular Respiration?
5. How do Photosynthesis and Cellular Respiration work together to benefit living things? Do they have anything in common?

Problem
How can scientists use carbon to find life on other planets?

Materials
- Internet
- The carbon cycle

Directions
Analyze the carbon cycle and answer the following questions.

1. Identify 5 places where carbon may be found.
2. Describe how carbon enters and exits a consumer.
3. How are humans involved in the carbon cycle?
4. What process could cause an increase in the amount of carbon dioxide?

Next, read the following passage about Carbon Structures.

As you know, carbon’s outermost shell contains four electrons. As a consequence, carbon is a lender of electrons in some of the covalent bonds it forms with certain elements. But with other elements, carbon is an electron borrower. The ability to be a lender or a borrower of electrons gives rise to a wide variety of carbon-based molecules and molecular chains. In fact, carbon is part of so many different kinds of molecules that an entire branch of chemistry, organic chemistry, is devoted to molecules and chemical reactions involving carbon. Some carbon-based compounds you may be familiar with include plastic, sugar, methane, diamonds, charcoal, graphite, protein, alcohol, rubber, carbon dioxide, natural gas, gasoline, oil, coal, and starch. Surprisingly, most of these materials are made of carbon, oxygen, and hydrogen. The prime difference among them is not their composition but the length and shape of each molecule.

In addition to being able to both borrow and lend electrons, carbon exhibits a second important chemical property – the ability to form double and triple bonds. Typically, when two carbon atoms bond they share one electron. In some molecules, however, the two carbon atoms share two or three electrons. When they share two electrons they form a double bond.

![Ethene](image1)

![Ethyne](image2)

A triple bond forms when two carbon atoms share three electrons. For example, the molecule ethane consists of two carbon atoms and four hydrogen atoms. Each carbon atom bonds to two hydrogen atoms and then completes its outer shell by sharing two electrons with the other carbon atom. Molecules containing double and triple bonds are very chemically reactive because these bonds contain considerable amounts of energy.

5. What kind of bonds allow for carbon to share more than one electron?
6. Why is it important that carbon can share more than one electron?
7. What two chemical properties make carbon such a versatile element?

Glucose is a type of sugar made during photosynthesis. The sun’s energy is required to form glucose’s molecular bonds. Thus, glucose can be thought of as a way to store light energy from the sun, making it vital to life. Later, that energy can be released when glucose bonds are broken during respiration.

Cellulose is used to make the woody and vegetative tissues in plants. Cellulose is made from long chains of glucose molecules linked together. Typically, glucose molecules
dissolve in water, but once linked together as cellulose, they no longer dissolve. This makes them ideal for forming plant structures. Weak bonds along the edges of the chains help keep them parallel, enabling a plant to assemble the chains into cell walls.

8. Why is glucose important to life?
9. Why is it important to plants to make chains?

Analysis
Pretend that you are a scientist trying to get a money grant to fund a trip to a new planet. Explain in your paper what kind of carbon bonds you have found on this new planet and how it indicates life could be there.