



Lesson 9

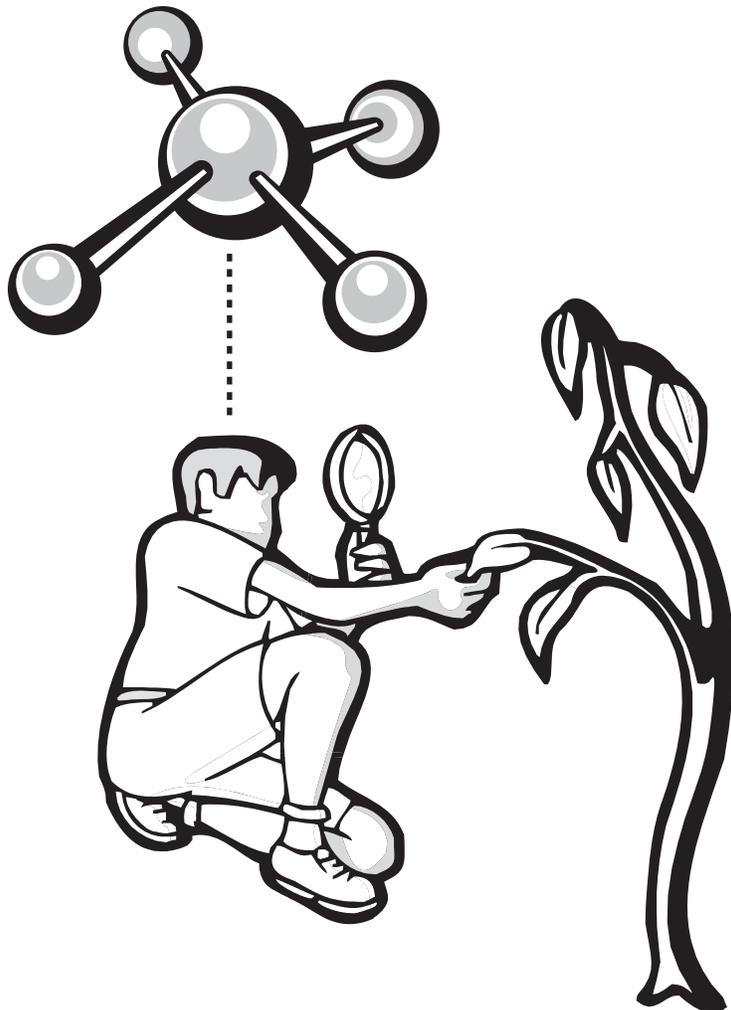
Forests, Carbon & Our Climate

Objectives:

1. To understand that carbon cycles from one form to another and the role that forests play in this process.
2. To understand where and how carbon is stored.
3. To understand how forests can play a role in offsetting climate change.

Subjects:

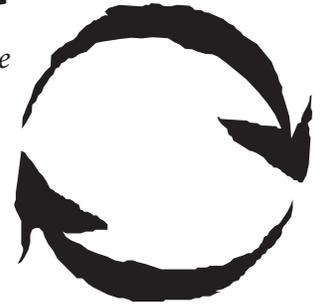
1. Science: Ecology & Chemistry
2. Reading / Language Arts



Focus:

Establish the basic carbon cycle

Why is carbon important? It is the basic building block of nearly all molecules that make up living organisms. It is in sugars, DNA, proteins, fats... etc.



Carbon is in most things around us; people, plants, trees, soil, oceans, and even the air we breathe. There is only a certain amount of carbon in, on, and around the Earth. The total amount of carbon stays the same, it just changes from one form to another. This is called a cycle.

The Carbon Cycle is the movement of carbon, in its many forms, between the biosphere (all of the Earth's living organisms), atmosphere (the gaseous envelope surrounding the Earth), hydrosphere (the Earth's supply of water), and geosphere (the solid part of the Earth).

Translated this means:

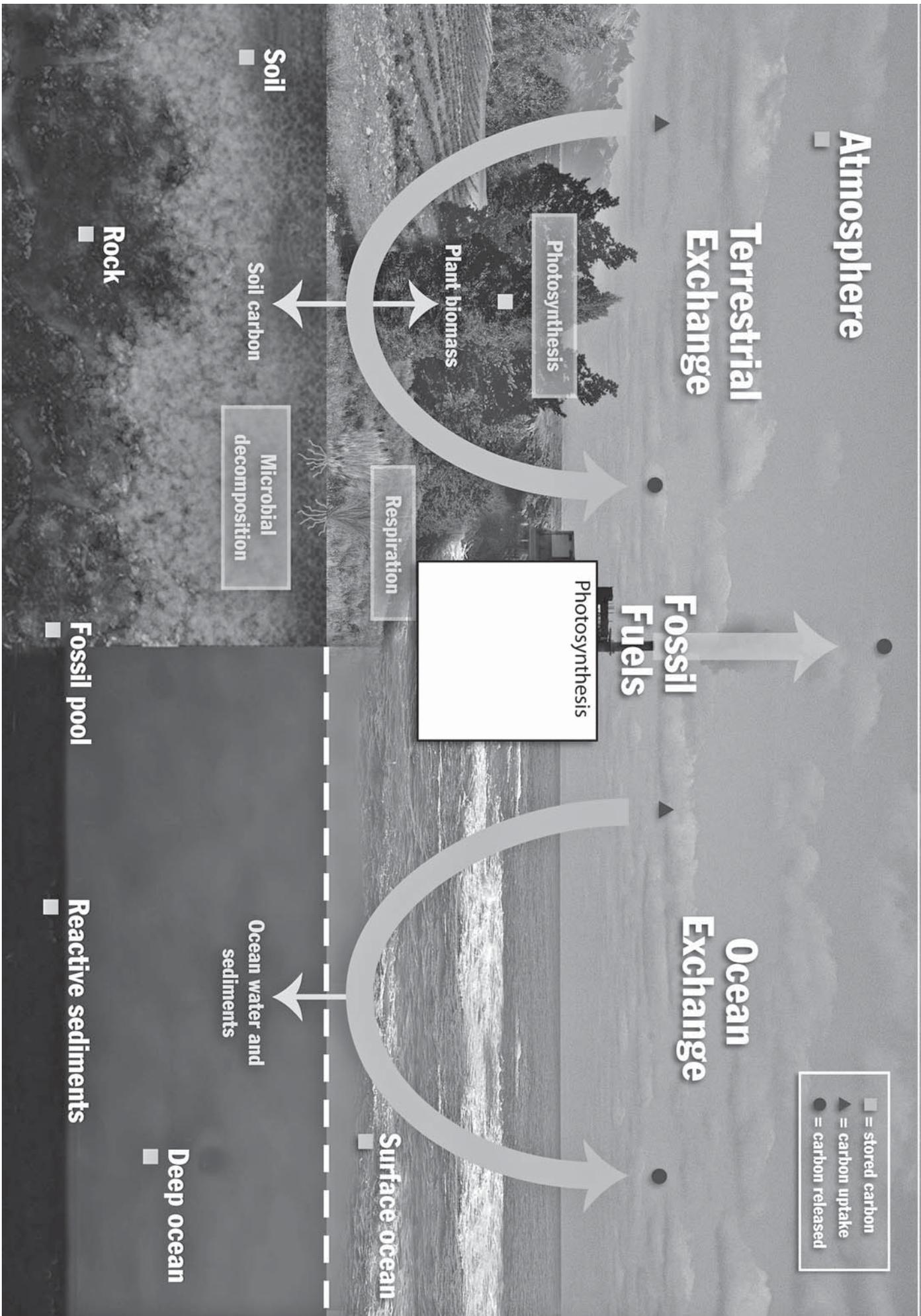
The Carbon Cycle is the movement of carbon, in its many forms, between:

1. All living plants and animals
2. The gas surrounding the Earth
3. Water
4. Soil and rocks

Show students the graphic of the Carbon Cycle. Point out that there are really only a few main pieces to the carbon cycle:

1. The Atmosphere
2. Ocean exchange
3. Fossil fuels emissions
4. Terrestrial exchange

Simplified Global Carbon Cycle



Vocabulary

- 1. Atmosphere:** the gaseous envelope surrounding the Earth.
- 2. Biomass:** the term biomass has two definitions: 1) the total mass of living matter within a given unit of environmental area; or 2) plant material, vegetation, or agricultural waste used as a fuel or energy source.
- 3. Carbon Cycle:** movement of carbon, in its many forms (solid, liquid, and gas), between the biosphere, atmosphere, hydrosphere, and geosphere.
- 4. Carbon Sequestration:** the removal and capture of available atmospheric carbon in plants, soils, oceans, or atmosphere. Trees in the forests, as well as forest products, are primary carbon sequestration mechanisms. Approximately 50% of wood consists of carbon. The place where the carbon is sequestered is often referred to as a carbon sink.
- 5. Decomposition:** the breakdown of organic material into smaller molecules which are then recirculated or used again by another organism. This is nature's way of recycling. During the process, carbon dioxide is released into the atmosphere.
- 6. Emission:** the act of releasing or putting a substance into circulation making it available for chemical reaction. Often the word emission is a term used to describe pollution such as the gases given off by an automobile or a large forest fire; however it can also be used to describe gases that are given off by a tree or a human and released into the air. Contrast with Sequestration.
- 7. Fossil Fuels:** fuels such as oil, natural gas, and coal. These combustible materials are found in the Earth's crust and are the remains of prehistoric organisms. Burning fossil fuels typically results in a release of high levels of carbon into the atmosphere. Fossil fuels are a non-renewable resource.
- 8. Global Warming:** the theory that Earth's surface temperature is rising as a result of the increased concentrations of various gases in the atmosphere called greenhouse gases.
- 9. Greenhouse Effect:** the effect of various gases within the Earth's atmosphere reflecting radiant energy back to the Earth's surface similar to the effect which occurs in a greenhouse. Greenhouse gases, such as CO₂ (carbon dioxide), methane, and ozone, insulate and warm the Earth's surface. Without the Greenhouse Effect, life on Earth, as we know it, would not be possible and there would be no liquid water on the Earth. The greenhouse effect may be enhanced by increased levels of greenhouse gases in the atmosphere thus causing a greater warming of the Earth's surface temperatures (Global Warming).
- 10. Photosynthesis:** the process whereby plants make the carbohydrates glucose, sucrose, and starch from sunlight, carbon dioxide, and water. During this process oxygen and water are released as byproducts. The carbon from the carbon dioxide is made into carbohydrates which are either used or stored. The carbohydrates that are used are converted to energy through the process of respiration; carbon dioxide and water are formed as byproducts. See Respiration. The carbon that is stored in the plant is said to be sequestered. See Carbon Sequestration.
- 11. Respiration:** the process whereby plants and animals convert carbohydrates, water, and oxygen into energy, carbon dioxide and water are released as byproducts of this process. Both photosynthesis and respiration occur in plants. The difference between the carbon uptake through photosynthesis and carbon release through respiration is called net carbon uptake and is the amount of carbon that is sequestered. See Photosynthesis.
- 12. Sequestration:** the act of forming a stable compound so it is not available for chemical reaction. Contrast with Emission. See also Carbon Sequestration definition above.
- 13. Sink and Source:** within the carbon cycle, a sink is any location where carbon is stored. A source is any location in the carbon cycle where carbon is released or made available for chemical reaction. Some examples of carbon sinks are forests, soil, and the ocean. A sink may be temporary. Carbon sinks can turn into carbon sources; for example, fossil fuels are sinks while they are buried in the Earth and wood is a sink. When the fossil fuels or wood are burned, carbon is released into the atmosphere and it is now called a carbon source.



Name _____

Instruct students to work with a partner to identify carbon sinks and carbon sources. How could carbon enter a sink? How could that carbon be released or emitted from that sink to become a carbon source?

Carbon Cycle Sinks and Sources

Carbon Sink	How does it get there?		Carbon Source	How is it emitted?
Plant biomass	Photosynthesis takes in carbon dioxide from atmosphere and incorporates it into sugars that become part of the plant tissue		Burning Fossil fuels	Driving vehicles, coal fired electrical plants, etc

Which ones are both carbon sources and sinks?

Reducing our Carbon Footprint...

1. We often hear about ways to “reduce our carbon footprints”.

2. What does this mean?

Reducing your carbon footprint means that you reduce the amount of carbon dioxide that is emitted due to your daily activities such as driving your car, buying products that are shipped from overseas, etc.

3. Why would we want to do this?

Carbon dioxide is a greenhouse gas. Greenhouse gases play an important role in helping the earth trap and retain heat for life as we know it, however, an increase in the amount of carbon dioxide in our atmosphere could lead to overall warming of our climate. Reducing our carbon footprints will reduce the amount of carbon dioxide that is emitted into the atmosphere as a result of our activities.

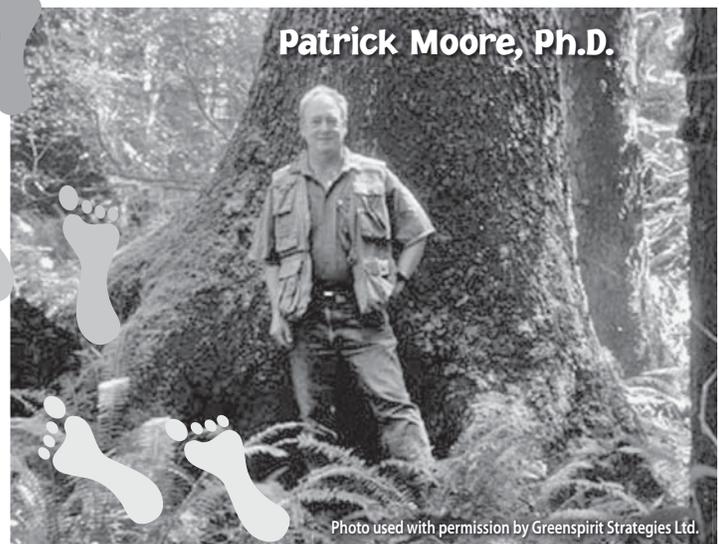
4. How can we reduce our carbon footprints?

Have your class calculate their carbon footprints using this website: http://www.epa.gov/climatechange/emissions/ind_calculator.html
Discuss class results. What activities seem to heavily impact the carbon footprints?
Instruct students to work with a partner to come up with a list of ways to reduce their carbon footprints.

- Plant trees to help store more carbon.
- Use wood products that store carbon from sustainably managed forests.

- Using public transportation, riding a bike or walking when possible rather than driving a car.
- Manage forests to grow healthy trees because healthy trees store more carbon.
- Recycling materials that can be recycled.
- Manage forests to prevent large forest fires that release a lot of carbon into the atmosphere.
- Use renewable energy sources and support development of new renewable energy sources such as biomass energy.
- Decrease use of fossil fuels which release high levels of carbon into the atmosphere.
- Reduce the amount of trash that the family produces.
- Conserving electricity and heating fuels.
 - Use energy-efficient appliances and turn them off when not in use.
 - Use energy-efficient bulbs.
 - Set house temperatures lower in the winter and higher in the summer.
- Use renewable resources which generally release less carbon than nonrenewable resources.

Now show students the graphic: **Forestry Never Looked So Cool** to explore how forests can play a very important role in reducing our carbon footprints. Read the excerpt by Patrick Moore, Ph.D. as a class to help understand the graphic and to facilitate discussion on forestry’s role in mitigating climate change.



Patrick Moore, Ph.D.

Photo used with permission by Greenspirit Strategies Ltd.

The Carbon Cycle

FORESTRY NEVER LOOKED SO COOL

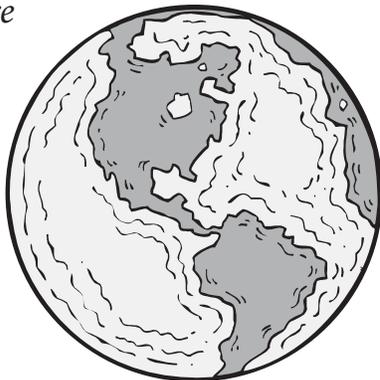


The concepts in *The Carbon Cycle: Forestry Never Looked So Cool* graphic are well summarized in the following excerpt by Patrick Moore, Ph.D. in the Winter 2006 edition of *California Forests*.

Trees are the most powerful concentrators of carbon on Earth. Through photosynthesis, they absorb CO₂ from the atmosphere and store it in their wood, which is nearly 50 percent carbon by weight. The relationship between trees and greenhouse gases is simple enough on the surface. Trees grow by taking carbon dioxide from the atmosphere and, through photosynthesis, converting it into sugars. The sugars are then used as energy and material to build the cellulose and lignin that are the main constituents of wood. When a tree rots or burns the carbon contained in the wood is released back to the atmosphere. Active forest management, such as thinning, removing dead trees, and clearing debris from the forest floor is very effective in reducing the number and intensity of forest fires. And the wood that is removed can be put to good use for lumber, paper and energy.

The impact of forests on the global carbon cycle can be boiled down to these key points:

- On the negative side, the most important factor influencing the carbon cycle is deforestation which results in a permanent loss of forest cover and a large release of CO₂ into the atmosphere. Deforestation—which occurs primarily in tropical countries where forests are permanently cleared and converted to agriculture and urban settlement—is responsible for about 20 percent of global CO₂ emissions.



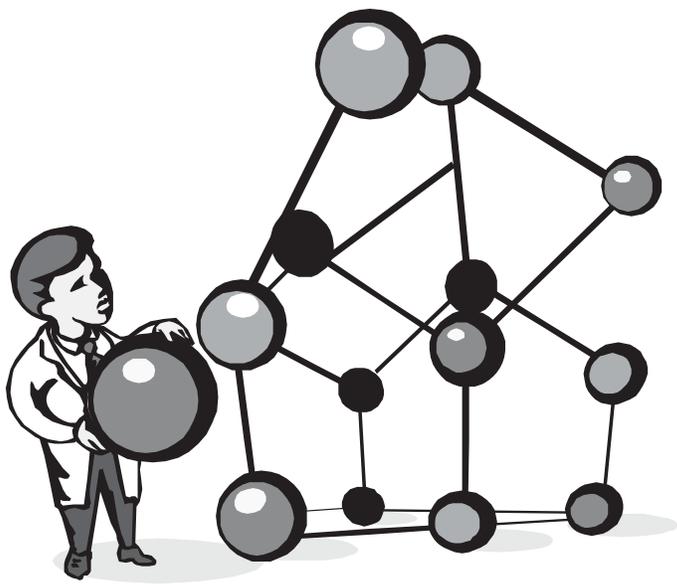
- On the positive side, planting fast-growing trees is the best way to absorb CO₂ from the atmosphere. Many countries with temperate forest have seen an increase in carbon stored in trees in recent years. This includes New Zealand, the United States, Sweden and Canada. Plus, using wood sustainably reduces the need for non-renewable fossil fuels and materials such as steel and concrete – the very causes of CO₂ emissions in the first place.



The good news is that forests in the United States are net carbon sinks, since annual growth exceeds annual harvest. We are currently experiencing an increase in forested land as forests are being re-established on land previously used for agriculture. Catastrophic wildfires are uncommon in managed forests, whereas millions of acres of unmanaged forests burn every year due to excessive build-up of dead trees and woody debris.

Every wood substitute, including steel, plastic and cement, requires far more energy to produce than lumber. More energy usually translates into more greenhouse gases in the form of fossil fuel consumption or cement production.

One of the best ways to address climate change is to use more wood, not less. Wood is simply the most abundant, biodegradable and renewable material on the planet.



As a class, make a list on the board that outlines forest management activities that increase carbon sequestration and reduce carbon emissions. Note that forests in the United States sequester 10 percent of all U.S. carbon emissions. Now have your class come up with ideas to increase carbon sequestration by our forests. The following site from the American Forest Foundation will be very helpful in this task:

http://www.forestfoundation.org/ccs_carbon.html

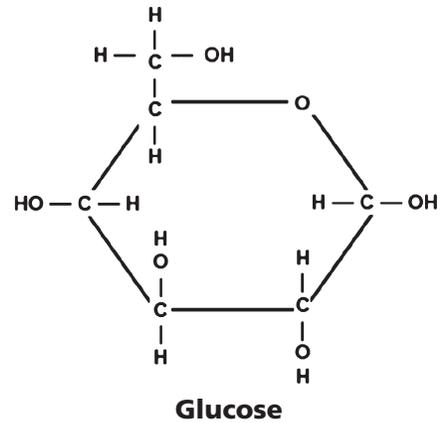
Carbon Creation Activity...

Materials: Colored Marshmallows, Toothpicks

Instructions: Choose one color of marshmallow to represent each of the following elements: carbon, oxygen, hydrogen. Use toothpicks to bond the elements together properly. A dash indicates a single bond (one toothpick) and an equal sign indicates a double bond (two toothpicks). Make one carbon dioxide molecule and one glucose molecule to show how carbon changes as a result of photosynthesis.

(During photosynthesis, water inside the leaf of the plant is stripped of its hydrogen – the two oxygen atoms

combine and are released into the atmosphere as oxygen gas. Carbon dioxide enters through the leaf stomata and goes through changes so the plant can build a large structure of carbon, hydrogen and oxygen called glucose = food and energy for the plant!)



Reinforcement Ideas:

Download the “Carbon Fingerprints” Game from The Forest Foundation Website

<http://www.calforestfoundation.org/pdf/Forests-and-the-Carbon-Cycle.pdf> (Page E1)