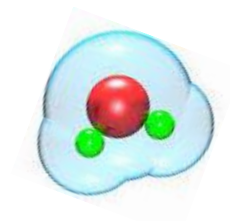
CARBON ON THE MOVE

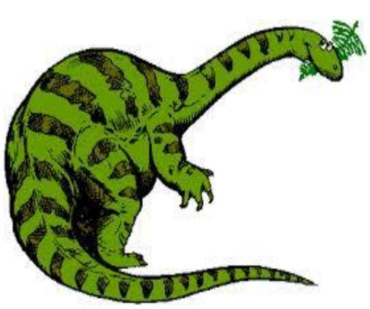
Carbon is found in all living things. Carbon atoms move constantly through living organisms, the oceans, the atmosphere, and the Earth's crust in what is known as the ***carbon cycle***. The directions taken by carbon atoms through this cycle are very complicated and can take millions of years to make a full circle.

All animals, from humans to the dinosaurs are part of the carbon cycle. When animals eat food, they get carbon in the form of carbohydrates and proteins. In animals, oxygen combines with food in the cells to produce energy for daily activity and then gives off carbon. The carbon combines with oxygen to form ***carbon dioxide (CO_2)*** and is released back into the atmosphere as a waste product when animals breathe and exhale.

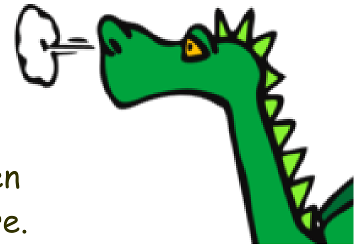
From 145-65 million years ago, Earth was much hotter than today and covered with dense, tropical swamp forests. The trees and other plants were immense and provided an endless supply of food for the giant animals that roamed the land. Somewhere in the air above one of these forests, a lone carbon atom has joined up with two oxygen atoms to form a molecule of CO_2.



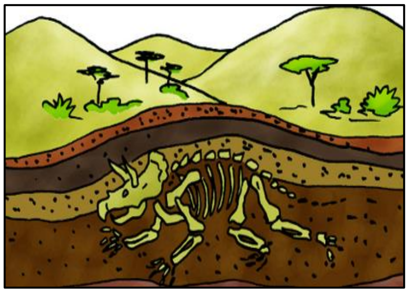
The CO_2 molecule was sucked into the tiny holes (stomata) on the leaf of a fern plant and joined with sunlight, chlorophyll and water to make food and energy in the plant's cells through ***photosynthesis.*** The oxygen (O_2) from the CO_2 molecule was sent back into the atmosphere; the carbon atom (C) was detached and used to make a molecule of sugar.



If that carbon atom had been eaten instead, a totally different situation would have developed. Let's say that a giant plant-eating dinosaur ***(herbivore)*** ate the fern for breakfast, and swallowed the carbon in the fern in the form of carbohydrates and proteins. In the process of ***respiration,*** oxygen combined with the carbohydrates and proteins in the dinosaur's cells to provide energy for its daily activity.



The CO_2 was a waste product and was flushed out from the dinosaur's body when he took a deep breath and exhaled, hours after he digested and was still feeling content from his big breakfast. The carbon that had been a part of the leafy fern was released into the atmosphere.



When the dinosaur died, most of the carbon atoms in his body went into the soil. Tiny organisms, including bacteria, fungi and scavengers, broke down the big carbon molecules into smaller ones. By releasing these nutrients from the dead tissue, the process of ***decomposition*** made them available to other living organisms in the ecosystem. Over many years, layers of soil, water and high temperatures and pressures turned the dinosaur into a ***fossil***. The bones that remained gave up the carbon in them to the atmosphere.

Peat

Soon after, the fern died and sank into the muck at the bottom of the swamp. Over thousands of years, more plants grew in the swamp and their remains also settled into the swamp, forming a layer of dead plant material containing carbon several feet thick called ***peat***.

Soil and other materials slowly covered the ancient swamp and buried the decaying plants under a thick layer of sediment. The sediment hardened, turning into ***sedimentary rock.*** The carbon atom was trapped in the remains of the swamp while the high pressure of the layers slowly compressed the material into ***"coal".***

Today people mine these ancient coal beds and burn the coal in power plants to create electricity to fuel industry, transport goods and people, and to warm homes and businesses. Burning ***(combustion)*** releases the energy stored in the carbon compounds in the coal and reconnects the carbon atom with oxygen in the air to form CO_2 again. Animals do just the opposite of plants: they take in air from the atmosphere, use the oxygen, and exhale the CO_2.

Every so often, CO_2 molecules escaped being buried and floated along with

other CO_2 molecules over the ocean surface. In places where the water was warm, it absorbed these molecules. Oceans soak up huge amounts of carbon and help keep too much CO_2 from staying in the atmosphere. Once our CO_2 molecule was dissolved in the ocean water, it could have been captured by an ocean organism that used it to make its shell. There are trillions upon trillions of ocean creatures of all sizes that capture atmospheric carbon in the form of CO_2 and use it to make ***calcium carbonate ($CaCO_3$) shells*** in the process of ***calcification***.

Most of the carbonate shells are produced by microscopic creatures called ***plankton,*** which float in all oceans of the world. Although they do not live very long, plankton absorb great amounts of carbon in their shell-building activities. By keeping carbon contained within their shells, marine organisms keep it from being returned to the atmosphere, where it would continue to build up. When they die, their shells sink to the bottom of the ocean floor and form sediments of limestone and natural chalk.

Rocks that form through the deposition of sediments and other materials are known as ***sedimentary rocks***; chalk is probably one of the most well-known examples of this type of rock, thanks to its common use. Chalk is a form of limestone and the chemical formula is $CaCO_3$. Its main ingredient is ancient fossilized sea organisms, which

were deposited and exposed to high pressure over centuries, so deposits often occur in areas that were once underwater. Through a simple chemical reaction with vinegar, the carbon stored in this chalk can be released back into the atmosphere, where it will combine with oxygen to form CO_2.

Student Sheet 5

INVESTIGATING QUESTIONS:

1. What the does the term "carbon cycle" mean?
2. How do all animals, from dinosaurs to humans, relate to the carbon cycle?
3. Explain how a carbon atom that existed as carbon dioxide (CO_2) during the Carboniferous Period could have ended up at the bottom of a murky swamp.
4. How did this carbon atom eventually form coal? What is coal used for today?
5. Now explain how the same carbon atom (that existed as CO_2 during the Carboniferous Period) could have ended up in a dinosaur's stomach.
6. How did this carbon atom become re-released into the atmosphere?
7. How did the carbon atom meet a tiny marine organism? What did the carbon atom help the marine organism build?
8. How did the carbon atom become natural chalk?
9. Explain how the carbon contained in the natural chalk, which *could* be from the exhaled breathe of a dinosaur, can be released from the chalk

ASSESSMENT ACTIVITY:

OPTION 1. Describe and draw the carbon pathway using your favorite dinosaur (herbivore or carnivore). Start from the dinosaur to the shell of a marine organism (label it) and then move to chalk. **Show 6-10 steps that carbon must travel through.**

OPTION 2. Draw a dinosaur on the geological carbon cycle diagram and draw arrows to show the steps from how the dinosaur got carbon to how carbon dioxide got from the dinosaur into the chalk.