

Unit 3: Matter & Energy Flow on Earth

Objectives:

E2.3A - Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life within Earth systems and how those forms can be beneficial or harmful to humans.

E2.3b - Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities.

Carbon Cycle

*Some marine animals take carbon dioxide from the atmosphere and combine it with calcium to form hard limestone shells. Clams, mussels, and coral are all examples of marine animals that build protective shells from calcium carbonate, commonly called *limestone*.*

Over time these organisms die and their shells settle to the bottom of the world's oceans. This forms deep sediments of calcium carbonate that eventually form large layers of limestone rock. Limestone sediments store carbon in rocks for millions of years. As a result of plate tectonics, the limestone may become exposed at the Earth's surface once again. Once there, it is weathered and the carbon finds its way back into the atmosphere in the form of carbon dioxide gas once again.



Carbon Cycle

Some limestone rock can be subducted underneath a tectonic plate, and the carbon it contains is blasted back into the atmosphere in a volcanic eruption. *Volcanic eruptions can add millions of tons of carbon dioxide gas into the atmosphere in a short period.*



Carbon Cycle

Carbon dioxide exists in our atmosphere from both natural processes and from human processes.

Respiration from animals and humans contribute carbon dioxide naturally.

Burning petroleum products, natural gas, and wood by humans have added carbon dioxide to the atmosphere.

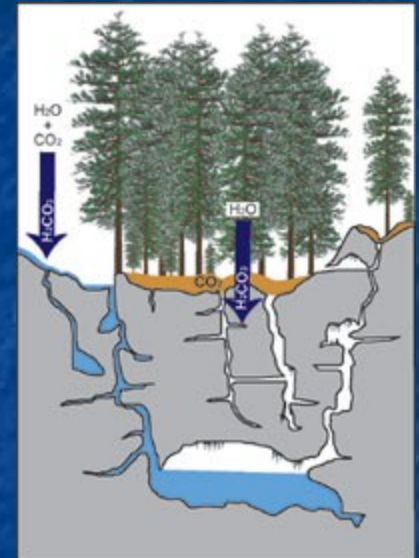


Carbon Cycle

*When rainwater mixes with carbon dioxide found in the atmosphere and in our soils, it forms carbonic acid (H_2CO_3). * Carbonic acid is mildly acidic, which means it will react and dissolve certain materials like limestone, dolomite, gypsum, and marble.

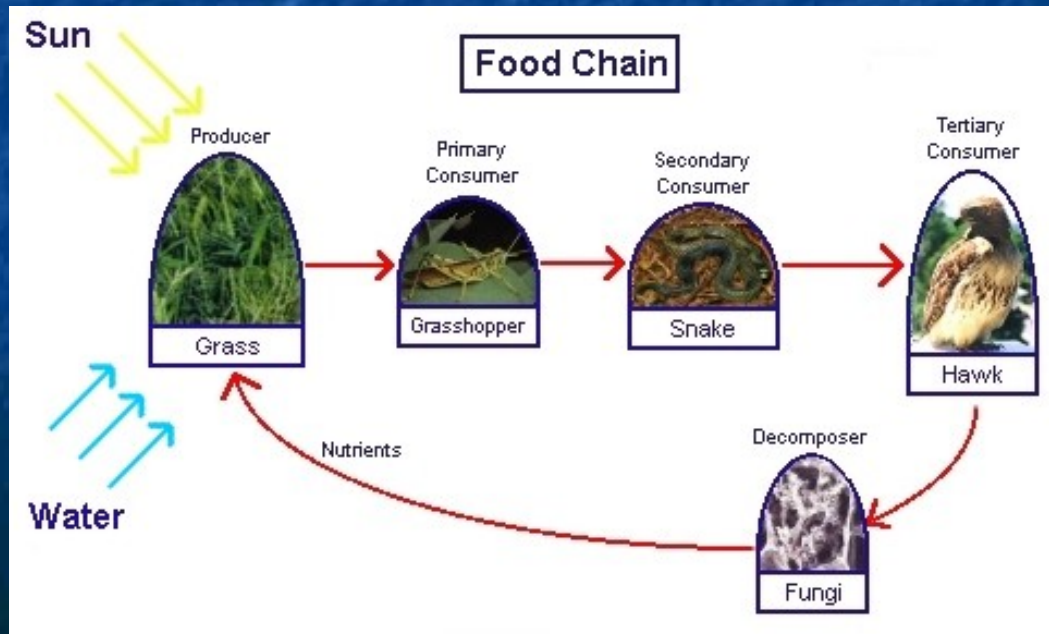
As a result, some areas of the Earth will take on the characteristics of a karst topography.

What is a karst topography? These are areas that contain sinkholes, caves, and underground drainage systems.



Carbon Cycle

Life forms here on Earth are carbon based organisms. Starting with the process of photosynthesis, plants bring in carbon dioxide. Herbivores consume plants, causing carbon to enter into their bodies. Carnivores consume herbivores, causing carbon to enter into their bodies.



Beneficial or Harmful?

Obviously, some forms of carbon are beneficial to humans, while others are harmful.

Carbon dioxide contained within rocks and carbon within animals are beneficial to humans.

However, carbonic acid can break down rocks, and excess carbon dioxide gas may be leading to global warming.



What's the problem?

Sometimes too much of a chemical element causes us big problems. For example, today we are finding a “dead zone” in the Gulf of Mexico. The lack of oxygen, called the Hypoxic Zone, is an area where marine life has been killed. Why?



Scientists believe that the Hypoxic Zone is being caused by nitrogen loads from the Mississippi River. Nitrogen fuels the rapid growth of large populations of algae and plankton. When these organisms die and sink to the bottom, their decay robs the water of oxygen.

Much of the nitrogen in the Mississippi River comes from the use of fertilizer and manure on agricultural lands. Controlling the use of nitrogen fertilizers and restoring wetlands along rivers and streams (to filter out the nitrogen) are two possible solutions to this problem.

What's the problem?

What might happen if too much carbon dioxide (CO_2) enters a body of water? In August, 1986 this problem caused 1700 deaths near Lake Nyos in Cameroon.



Lake Nyos overlies a volcanic source, which appears to release carbon dioxide and other gases. Instead of being released into the atmosphere the CO_2 is dissolved in the bottom of the lake. The weight of the water exerts enough pressure to contain the carbon dioxide within the water. So what went wrong?

What's the problem?

Scientists believe that the rapid accumulation of rainwater in the lake was responsible for overturning the bottom waters. How?



Strong winds may have blown the rainwater to one side of the lake. These waters were more dense than the warmer lake water, causing it to descend down one side of the lake. The descending water displaced the CO₂-rich bottom waters, causing it to rise and decompress. Gas bubbles rose at rapid rates. The escaping carbon dioxide stayed low to the ground and spread, reaching a number of villages, killing unsuspecting people by asphyxiation.

What's the benefit?

Sometimes elements in our environment are a benefit. Fluoride is one such example. Why do we like fluoride in our drinking water?

Fluoride has been found to play an important role in healthy tooth development and in cavity prevention (especially in young children). Fluoride strengthens tooth enamel (so they can better resist the acid formed by plaque) and it also helps teeth that have been damaged by acid to repair, or re-mineralize, themselves.

