Reflect

The story “Goldilocks and the Three Bears” describes how a little girl, Goldilocks, prefers porridge that is neither too cold nor too hot, but “just right.” Much like Goldilocks, certain conditions within an ecosystem cannot tilt too far to one or another extreme. Ecosystems thrive when conditions are balanced, or “just right.”

Take a look at the photograph on the right. What are some of the components of this ecosystem, both living and nonliving? How might conditions in the ecosystem—the amount of rainfall, the nutrients in the soil, the number of organisms within each population—fall out of balance? How might these changes affect the ecosystem?

Elements, Such as Carbon, Cycle Through the Atmosphere and Biosphere

Systems on Earth are healthiest when their various components are balanced. One important element that contributes to this balance is carbon. Carbon moves between living and nonliving things on Earth. These movements make up the **carbon cycle**.

Like all cycles, the carbon cycle has neither a beginning nor end. Instead, it consists of a number of related processes. One part of the carbon cycle is photosynthesis. Carbon exists in Earth’s atmosphere primarily within molecules of carbon dioxide (CO_2). During the **Calvin cycle of photosynthesis**, plants use the carbon (C) from CO_2 to make organic compounds

Carbohydrates, such as this molecule of glucose (left), have a carbon backbone. Foods made from grains, such as bread and pasta (right), are complex forms of carbohydrates.

called carbohydrates. One of the most important of these carbohydrates is glucose ($C_6H_{12}0_6$), a sugar that plants use for food. Plants can store glucose for later consumption in the form of starch, another type of carbohydrate.

Reflect

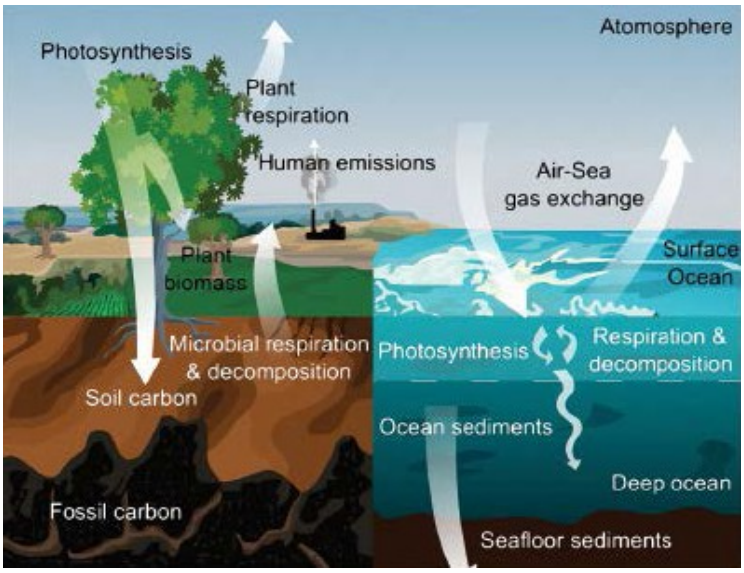
Another important part of the carbon cycle occurs when organisms consume carbohydrates produced by plants. These consumers use the energy held within the chemical bonds of the molecules to fuel their cellular activities. For example, in an animal's cells, carbohydrates undergo a series of chemical reactions that break down the molecule to release energy.

atmosphere: a layer of gases that surround Earth

biosphere: the living things on Earth and their environments

This process is called cellular respiration. One of the waste products of cellular respiration is carbon dioxide. Because animals cannot use carbon dioxide, they exhale it into the atmosphere where plants can once again use it to make carbohydrates. In this way, carbon cycles continue between the atmosphere (as carbon dioxide) and the biosphere (as carbohydrates).

Carbon in **biomass**—the living (or recently living) matter in an ecosystem—is also returned to the environment through decomposition. The bodies of organisms are primarily made up of carbon. When an organism dies, its body is broken down into its component elements by worms, bacteria, and other decomposers. In this process, carbon moves from biomass into the ground, where it can remain buried for a long time. Over a period of millions of years, extreme heat and pressure from Earth's interior transformed buried plants and animals from the Carboniferous period (approximately 300–350 million years ago) into **fossil fuels** such as coal, petroleum, and natural gas. When humans burn fossil fuels to power machines, generate electricity, and heat buildings, the carbon cycles back to the atmosphere, where it can be used again by plants during photosynthesis.



Photosynthesis, respiration, and decomposition happen in the oceans as well as on land. In the oceans, carbon cycles between the surface ocean, the deep ocean, and the seafloor. These movements are part of the carbon cycle.

Look Out!

Humans contribute to the carbon cycle by burning fossil fuels and other forms of biomass, such as wood. (Biomass also burns through natural processes. For example, a bolt of lightning can spark a forest fire.) However, over the past few centuries, humans have released large quantities of carbon into the atmosphere—more than can be absorbed through photosynthesis and other natural processes. Scientists have evidence that this excess of carbon dioxide is trapping heat at Earth's surface, leading to global climate change.

Did you know that the main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis? Remember that photosynthesis is the process of converting carbon dioxide and water molecules into glucose and oxygen.

Everyday Life: Disruptions in the Carbon Cycle

As previously mentioned, ecosystems thrive when conditions are balanced. The carbon cycle is crucial to maintaining this balance. Disruptions to this cycle can have devastating effects on an ecosystem. Unfortunately, disruptions occur too often from human activities.

The total amount of carbon actively moving through the carbon cycle decreases when people bury organic materials in landfills rather than allow them to decompose naturally outdoors. Ideally, fallen leaves and discarded food should be used for **compost**, which allows nutrients in the decomposing biomass to return to the ecosystem.

A much larger problem, however, is excessive carbon in the atmosphere. Recall that burning fossil fuels releases carbon dioxide gas into the air. In the last 150 years, there has been a dramatic increase in the burning of coal, oil, and natural gas for factories, cars, airplanes, and other technologies invented by humans. Not only does this excessive consumption of fossil fuels deplete Earth of its natural resources, but it also pollutes the air and creates imbalance in the carbon cycle. During the last few decades, governments and individuals in the United States and other countries have work to reduce the amount of CO_2 emissions from refineries, factories, and automobiles. Additionally, efforts are made to make homes and office buildings more energy-efficient with "green" technology.

compost: a mixture of decaying organic matter, air, and water that may be used to fertilize soil

Exhaust from vehicles releases a lot of carbon dioxide into the atmosphere.

Connecting With Your Child

Your Role in Nutrient Cycles

To help your child learn more about the carbon cycle and how human activities effect it, work together to develop carbon recycling programs around your home, school, or community.

You can begin by creating a place to store a compost pile. Have your child choose a convenient place that is shaded, well drained, and not too close to any tree roots or wooden fences. For a home compost pile, 1 square meter is an acceptable size. A larger area may be appropriate for compost piles at school or in a community location. Begin the compost pile with a thick layer of organic materials such as dead leaves, yard clippings, or vegetable scraps. Then, add a thin layer of fertilized soil to activate the compost. Next, layer a thin covering of topsoil, which may include microorganisms. All organic waste from uneaten food, including leftovers, eggshells, and peelings, can be added to a compost pile. Important note: Never include human or animal waste products in any compost on food plants.

You can recycle biomass at home by making a compost pile.

You will need to water the compost and turn it every couple of weeks. To turn the compost, use a garden tool to move the inside material to the outside and vice versa—all parts should be exposed to oxygen. Within a couple of months, the compost pile should be ready to use.

You can also research your carbon footprint and find ways to reduce it. Encourage your child to think about ways he or she can personally reduce fossil fuel emissions into the atmosphere. Suggestions include walking or riding a bike instead of driving and recycling materials made in factories such as plastics. Encourage your child to expand a personal program to the entire family, the school, or the community.

Here are some questions to discuss with your child:

- How does the carbon cycle keep nutrients balanced between the atmosphere and biosphere?
- What roles do humans play in the carbon cycle?
- What can you do to help maintain balance in the nutrient cycles?