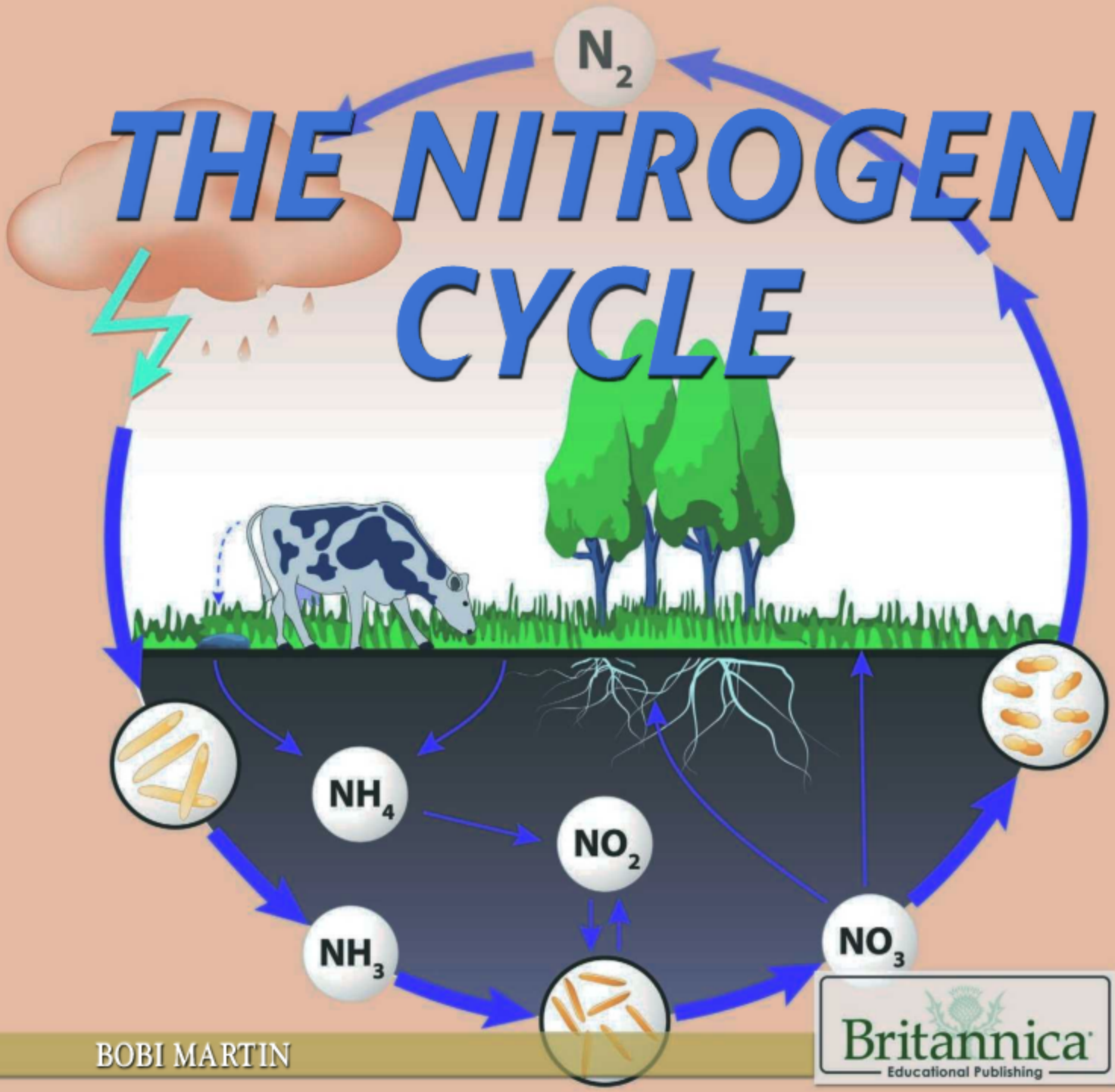
LET'S FIND OUT! OUR DYNAMIC EARTH

THE NITROGEN CYCLE



BOBI MARTIN

Britannica
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THE NITROGEN CYCLE

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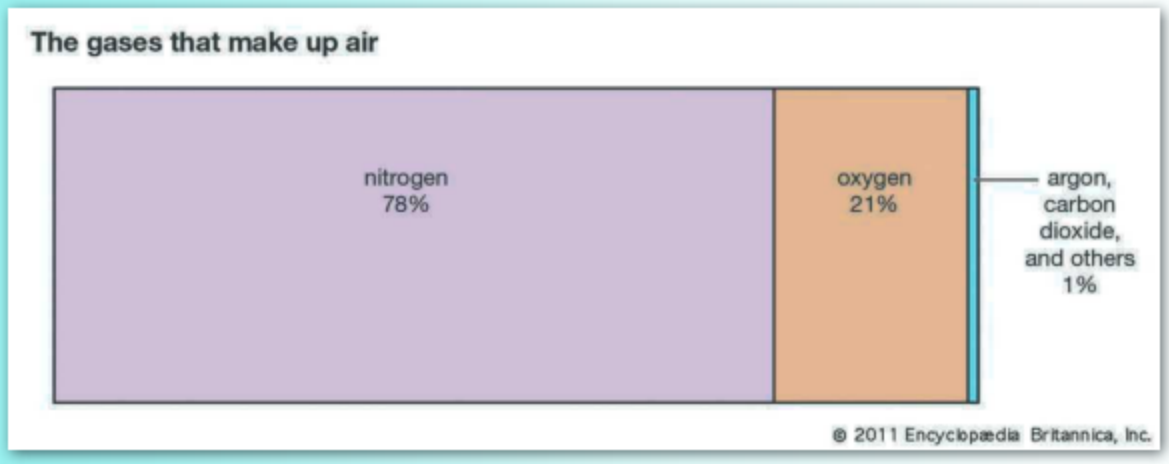
Contents

Every Living Thing Needs Nitrogen

From tiny insects to plants and people, all living things need nitrogen to survive. Nitrogen is a **chemical element** that has no color, taste, or smell. Scientists use symbols to stand for the names of chemical elements.

Vocabulary

A **chemical element** is a basic substance that cannot be broken down into simpler substances.



Air is a mixture of several gases, mostly nitrogen and oxygen.

Nitrogen is found in all living things, including people and animals!

The symbol for nitrogen is N.

Nitrogen is a gas that makes up about 78 percent of Earth's atmosphere. This gas form is sometimes called free nitrogen. In addition, free nitrogen is found in many meteorites and in some stars. It is also in the gases of volcanoes, mines, and some mineral springs.

Nitrogen is one of the main chemical elements found in all living things. But living things cannot use nitrogen in its gas form. The nitrogen that is found in living things must first be combined with other elements. Such combinations are called compounds.

Plants, such as these bluebell flowers, need nitrogen in order to make chlorophyll.

Most plants get the nitrogen they need from compounds in the soil or water. Nitrogen is what helps green plants make chlorophyll, a substance that plants use to make their own food. The process that plants use to do this is called photosynthesis.

Animals, including people, get the nitrogen they need by eating plants that have nitrogen or by eating other animals that eat plants. Animals need nitrogen to make the proteins that help them have strong, healthy bodies. When plants and animals die, they decompose,

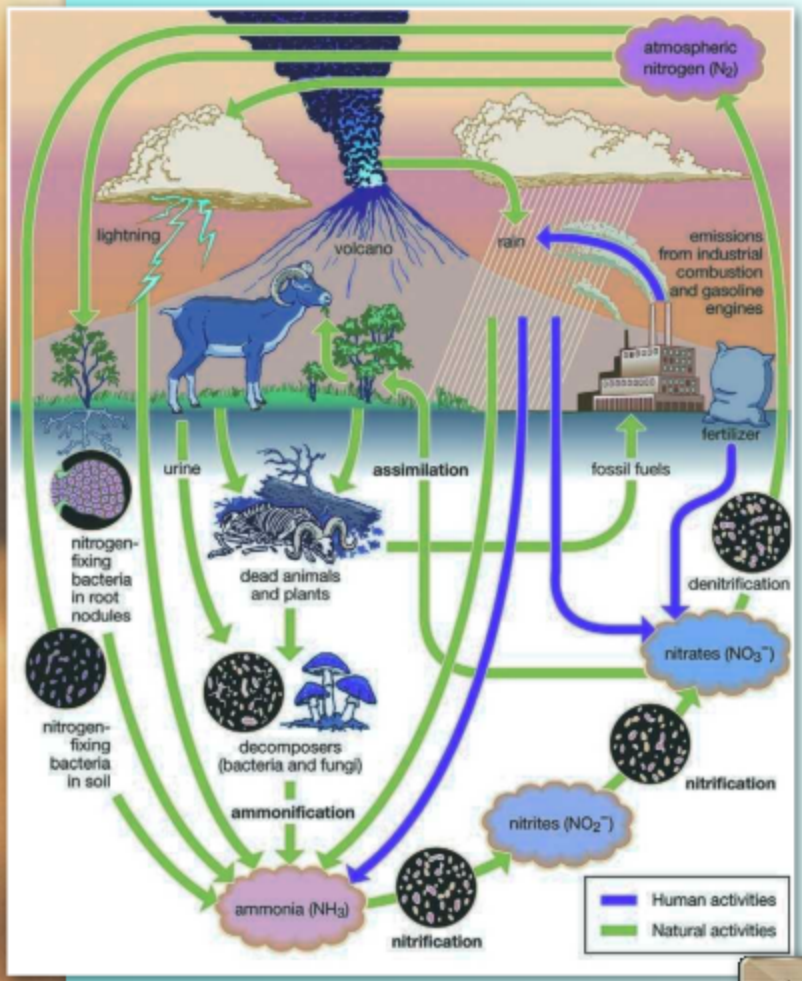
Compare and Contrast

Plants and animals need nitrogen. Compare the ways that living things use nitrogen. How do plants and people get nitrogen differently?

or break up. This process returns nitrogen to the soil. Nitrogen in various forms constantly circulates through nature. This process is called the nitrogen cycle.

Children need nitrogen in their diet to be healthy and active.

What Is the Nitrogen Cycle?



A cycle is a sequence of events, or steps, that repeats itself regularly. In the nitrogen cycle, nitrogen moves from the soil to plants and then to animals and finally back to the soil. When it returns to the soil from a decaying plant, it can be used again by another plant. The

The nitrogen cycle repeats itself regularly.

The nitrogen cycle is one of the things that helps maintain a balance in nature.

Think About It

Spring, summer, fall, and winter are a cycle of seasons. Can you think of other cycles in nature?

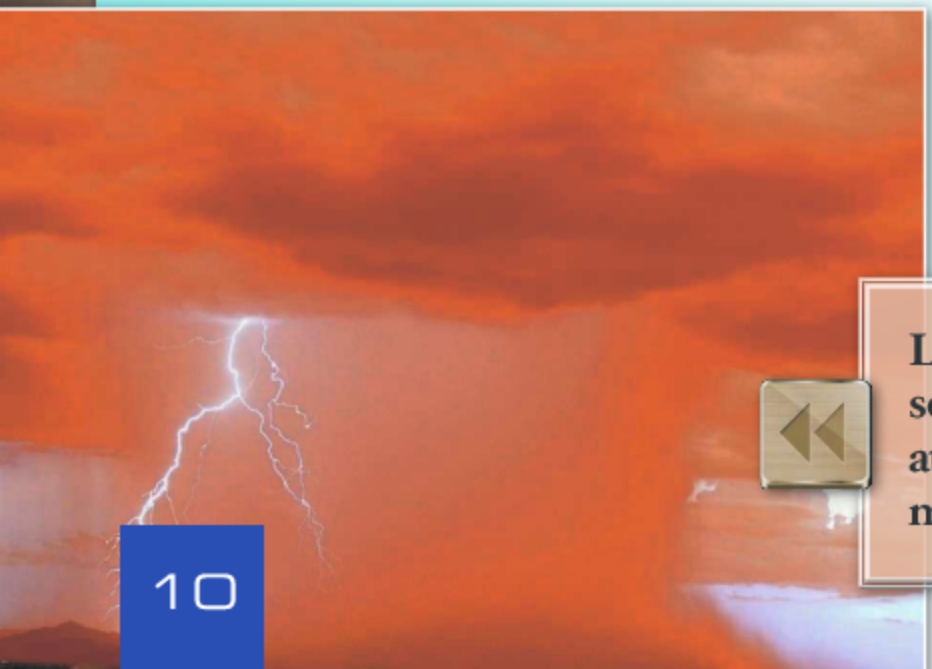
nitrogen cycle has five general steps: nitrogen fixation, nitrification, denitrification, nitrogen assimilation, and ammonification. These steps do not always happen in the same order.

Over many years, the actions of people began changing how nitrogen cycled through nature. This changed the amount of nitrogen found in living organisms and in the air, soil, and water. The balance of nature was upset. By understanding how the nitrogen cycle works, people can change their actions and protect the environment.

Nitrogen Fixation

Most living things cannot use free nitrogen. It must be changed, or fixed, first. Nitrogen fixation is the process that changes nitrogen gas in the air into compounds that organisms can use.

Nitrogen fixation happens in several ways. In nature, it can happen when lightning or ultraviolet radiation (a kind of energy that is beamed out by the sun) passes through nitrogen in the air. Each nitrogen molecule, or



Lightning can separate the atoms in nitrogen molecules.

Rain contains nitrogen compounds. These combine with compounds in the soil to make new compounds, called nitrates.

Vocabulary

Atoms are tiny particles that cannot be divided into smaller parts by ordinary means. They combine with other atoms to form molecules.

unit, has two **atoms**. These atoms are stuck together so tightly that it takes a lot of energy to separate them. The energy created by lightning or ultraviolet radiation breaks the nitrogen atoms apart. Next, the atoms combine with oxygen and water and fall to the ground in rain. Then they mix with minerals in the soil to make compounds called nitrates. Nitrates are a form of nitrogen plants can use.

Many people and animals in the world eat soybeans or soybean products.

The main way nitrogen becomes useable happens in the soil. Tiny organisms called bacteria change nitrogen present in soil into a compound called ammonia. This is another form of nitrogen that plants use.

Special bacteria found in legumes and in some cereal grasses create ammonia in a different way. Legumes are flowering plants of the pea family. Beans, peas, soybeans, and peanuts are types of legumes people eat. Soybeans, alfalfa, and clover are legumes used for livestock feed. Special soil bacteria live in the root systems of legumes. These bacteria can take free nitrogen from air spaces

Clover is a type of legume that is grown to feed livestock, such as horses, sheep, and cattle.

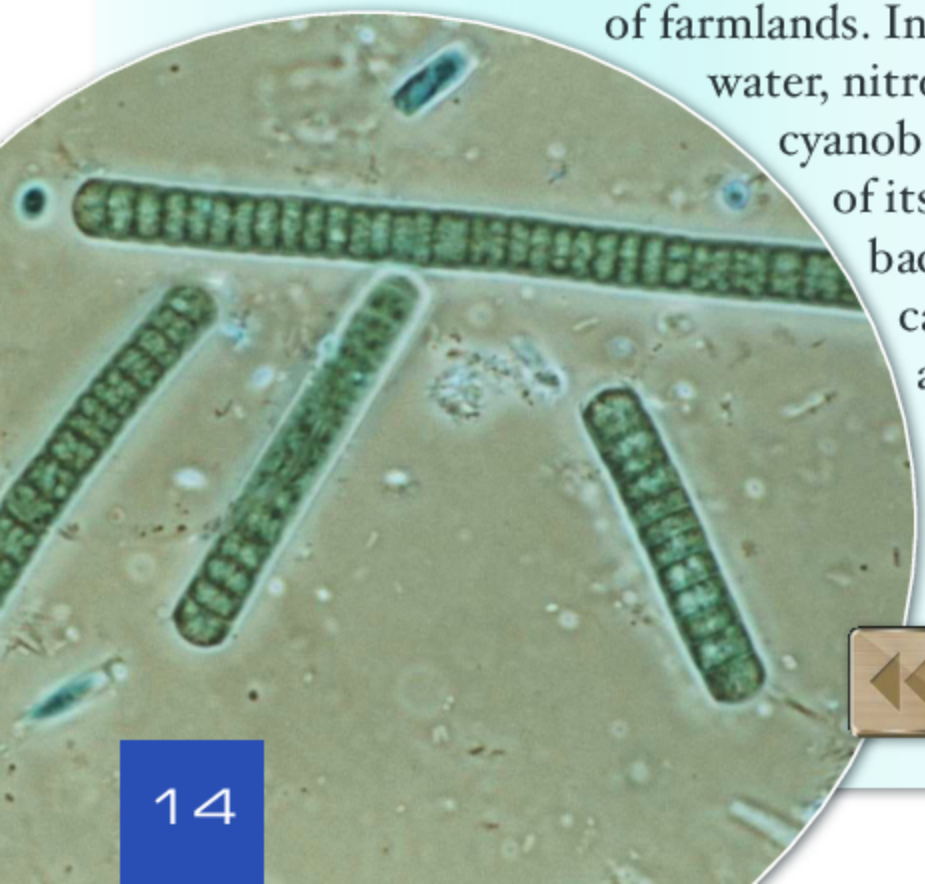
in the soil and turn it into ammonia. The ammonia is then used by both the bacteria and the legume plant. After legume crops are harvested, the remaining plant parts are plowed into the earth. This returns nitrogen to the soil where it can be used by other kinds of plants.

Compare and Contrast

The word "legume" means "seedpod." How are the seedpods of peanuts, beans, and peas alike? In what ways are they different?

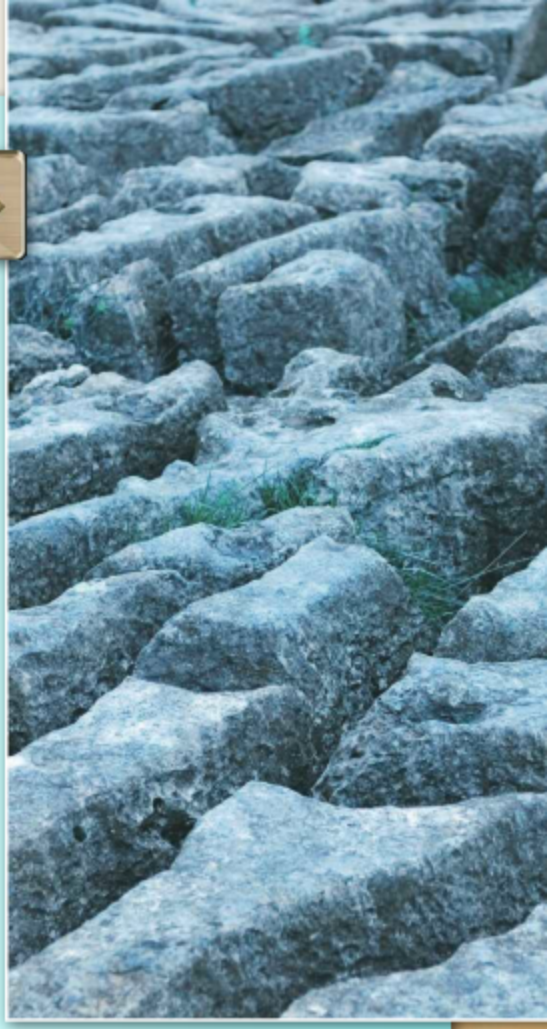
In the Water

The plants and animals that live in water also depend on nitrogen. The steps of the nitrogen cycle for those plants and animals are similar to those of the land cycle. When nitrogen gas is fixed by lightning or ultraviolet rays, rain carries nitrates to oceans, lakes, and streams. Some nitrogen reaches water systems when it runs off of farmlands. In oceans and fresh water, nitrogen is fixed by cyanobacteria. Because of its color, this bacteria is often called "blue-green algae" though it is not actually algae.



This is what cyanobacteria looks like when viewed under a microscope.

Limestone is a type of sedimentary rock that may be pushed up from the ocean floor onto land.



Like bacteria on land, marine bacteria help move nitrogen through the steps of assimilation, nitrification, denitrification, and ammonification. Some nitrogen compounds drift to the ocean floor and become sediment. Over many years, these sediments **compress** and become sedimentary rock. Sometimes this sedimentary rock is pushed up and moved onto land.

Vocabulary

Compress means to press something tightly together to make it fit into a smaller space.

Nitrification and Denitrification

Nitrification and denitrification are steps in the nitrogen cycle that help keep things in balance. Nitrification happens when certain bacteria in the soil change ammonia into nitrates. Like ammonia, nitrates are a form of nitrogen that can be taken up and used by plants. Nitrification prevents some nitrogen from returning to the atmosphere.

Sometimes soils have too much water and too little oxygen. Or soil

Nitrification and denitrification are both the result of bacteria in the soil.

Healthy soil has the balance of oxygen, nitrogen, and moisture that plants need to grow.

may have too much ammonia and not enough oxygen. Plants cannot grow in this type of soil. When this happens, denitrifying bacteria go to work. The job of these bacteria is to break down nitrates. This helps release oxygen into the soil. It also turns some of the nitrates back into free nitrogen gas that is released into the atmosphere.

Think About It

Nitrification keeps nitrogen in the soil in a form plants can use. Denitrification releases nitrogen back into the atmosphere. Why are both of these steps important?

Nitrogen Assimilation and Ammonification

Plants take in nitrates and ammonia from the soil through their roots. Then they assimilate, or absorb, the nitrogen into their tissues. Next, plants turn these forms of nitrogen into amino acids and proteins that help them grow and reproduce. Animals assimilate nitrogen by eating plants or other animals that contain nitrogen. Since proteins contain nitrogen, foods rich in protein are

People get nitrogen by eating protein-rich foods such as eggs and cheese.

Decaying plants, like these on a forest floor, play an important role in the nitrogen cycle.

Think About It

How does the nitrogen cycle help Earth? Why is this important?

good sources of nitrogen. These include plants like legumes, as well as fish, meat, eggs, and milk.

Ammonification is part of the decaying process. When living things die, bacteria and other microorganisms help break down their waste products and decaying tissues into simpler forms. This step in the nitrogen cycle releases ammonia. Usually this ammonia changes into other nitrogen compounds used by plants and animals. Sometimes it turns into nitrogen gas and is released into the atmosphere.

Fertilizers

Many years ago, the only way nitrogen returned to the soil was through the decay of plants or animals. In places where legumes and cereal grasses grow naturally, the soil had nitrogen from those plants. Farmers could grow crops. After the farmers harvested their crops, though, nothing was left to decay. This meant that no nitrogen was returned to the soil. Without nitrogen, the soil became too weak to grow healthy plants. In other places the soil did not have enough nitrogen to begin with. Farmers could not grow enough food to feed everyone.

When crops are harvested in a way that leaves little to decay, the soil loses nitrogen.

Vocabulary

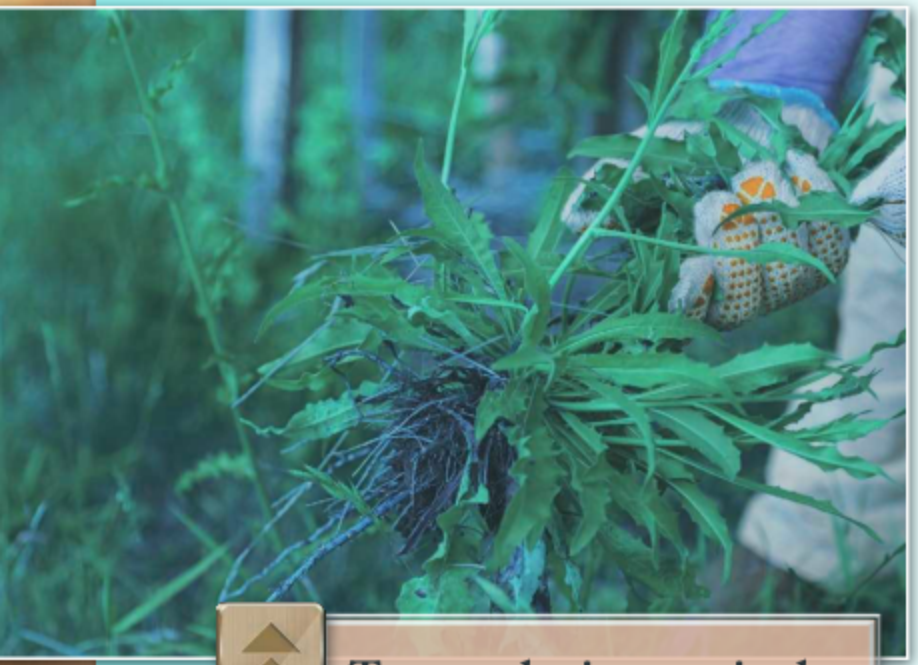
Things made **artificially** are made by human skill rather than by nature.

To solve this problem, scientists learned how to fix nitrogen **artificially**. They created ammonia and nitrate compounds in laboratories. Farmers added these artificial compounds, called fertilizers, to their fields so that crops could grow better. Fertilizers also allowed people to farm land that had not been productive before. Now farmers could grow enough food to feed everyone.

Many farmers add artificial fertilizers to fields to put nitrogen back into the soil.

The Overuse of Fertilizers

Fertilizers help people grow food where the soil is weak. But, over time, the widespread use of fertilizers has caused new problems. Too much nitrogen in the soil can help weeds grow faster than crops. It helps some plants crowd out, or even kill off, other plants. Increasing the amount of nitrogen in the soil can also upset the nitrogen cycle.



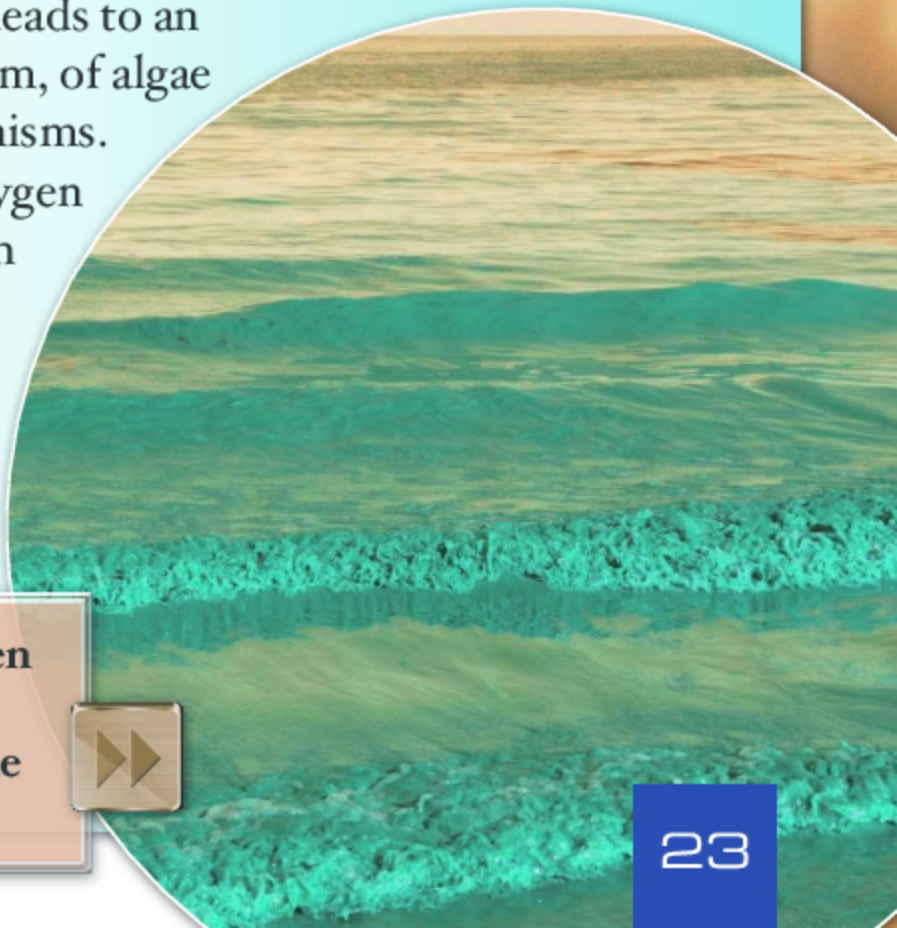
Too much nitrogen in the soil can help weeds grow, which crowds out crops.

Compare and Contrast

Compare the good effects of using fertilizers with the harmful effects.

Denitrification speeds up and unused nitrogen is washed out of the soil through a process called run-off.

When the run-off sends too much nitrogen into streams and rivers, it can create another problem. The extra nitrogen leads to an overgrowth, or bloom, of algae or other microorganisms. The algae use up oxygen in the water that fish and other animals need, causing them to die. This creates a "dead zone" in the water.

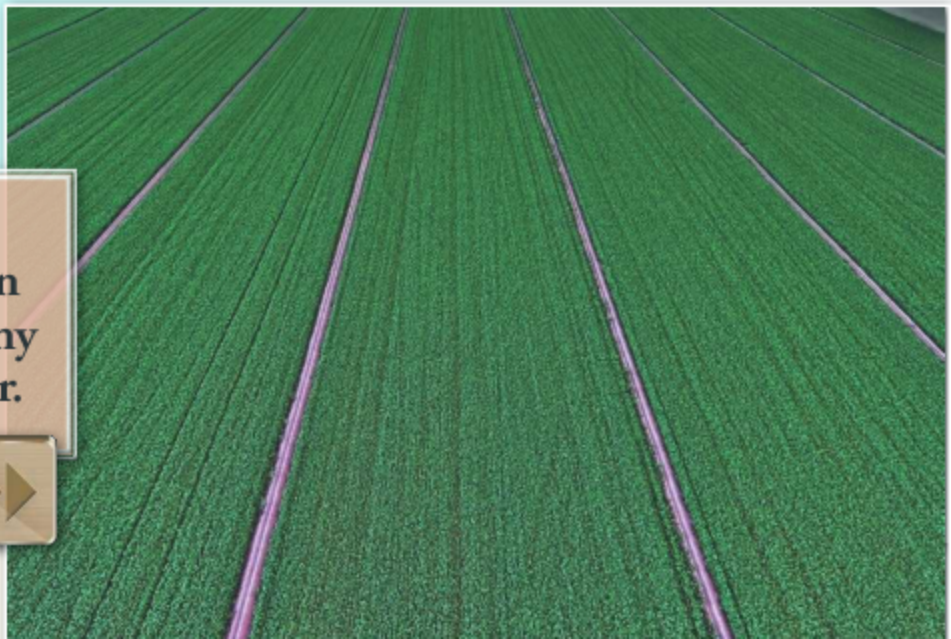


Algae blooms happen when there is too much nitrogen in the water.

Improving Soil Naturally

One way farmers can use less artificial fertilizer is to change their crops from one year to the next. This is called crop rotation. For example, planting legume crops such as clover, alfalfa, and soybeans adds nitrogen to the soil. Crops like corn and potatoes take nitrogen from the soil. By planting soybeans one year and corn the following year, farmers can keep their soil and crops healthy without using much, if any, artificial fertilizer.

Composting is a way that people who grow small family



By practicing crop rotation, farmers can keep their soil healthy and use less fertilizer.

Composting is easy and can be done even in small backyards. It creates a nutrient-rich mixture that can be used in gardens.

gardens can help their soil. Dead or "brown" materials like leaves, pine needles, or shredded paper are layered with "green" materials such as fresh vegetable and fruit scraps, grass clippings, and coffee grounds. Over time, the materials break down and become crumbly, like soil. Compost gives plants food and improves the soil.

Think About It

Crop rotation and composting help the soil stay healthy. How are these activities like the nitrogen cycle?

Acid Rain

The widespread use of fertilizers has led to more nitrogen gas in the air. Burning fossil fuels like coal and gasoline also adds nitrogen gas to the air. In both cases the nitrogen is mixed with oxygen in a form that can be harmful. When water in the air falls as rain or snow, it carries these gases to Earth. This

Vocabulary

Fossil fuels are nonrenewable fuels, such as coal, oil, or natural gas, that are formed from the remains of plants or animals that lived long ago.

Burning fossil fuels such as gasoline or coal adds unhealthy amounts of nitrogen into the atmosphere.

Acid rain made the branch on the left turn yellow and lose some of its needles.

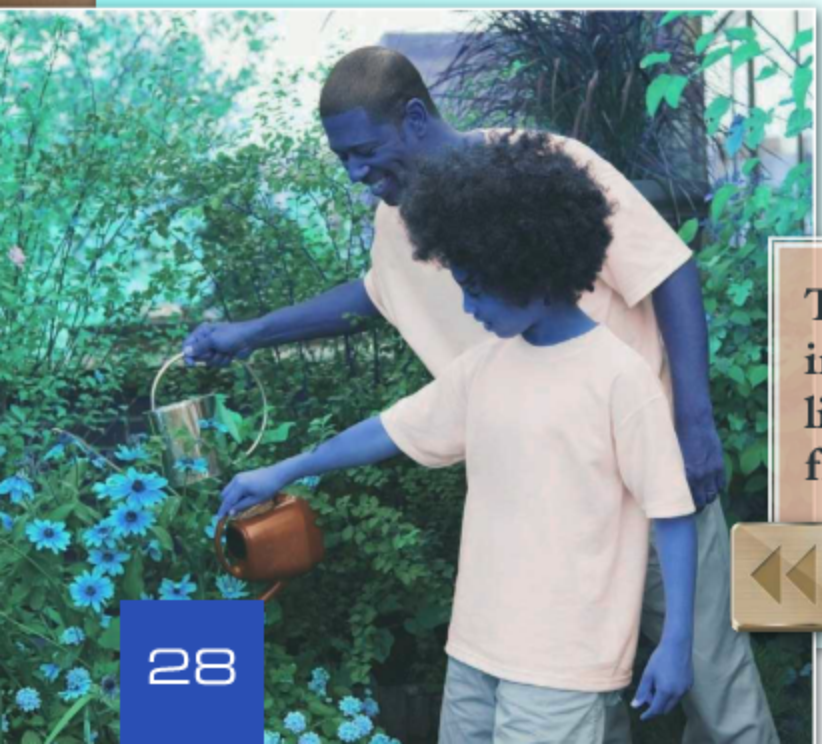
is known as acid rain. Acid rain is very damaging to all life forms, including plants and animals.

Using less artificial fertilizer is one way to help prevent acid rain. Crop rotation and composting reduce the need for fertilizer. Farmers can also improve their soil naturally by growing a nitrogen-rich crop such as alfalfa or clover and then plowing the entire crop back into the soil. Understanding the nitrogen cycle can help people grow food without creating problems like acid rain.

An Important Element

There would be no life on Earth without nitrogen. It is an important part of every living thing. Without nitrogen, plants could not produce chlorophyll and perform photosynthesis. Nitrogen compounds make amino acids, the building blocks of proteins that animals and people need for strong, healthy bodies.

Nitrogen is useful in other ways too. Nitrogen becomes liquid at very low



The nitrogen cycle is important to every living thing on Earth, from plants to people.

These blood samples are being preserved in liquid nitrogen so that they can be used later for research.

temperatures. In that state, it is useful for freeze-drying food and for keeping foods cold when they are transported over long distances. In medicine, liquid nitrogen is used to preserve blood, bone marrow, and tissue so they can be used later. Liquid nitrogen is also used to make some drugs that help people. Understanding how the nitrogen cycle works will help people use nitrogen in ways that keep the nitrogen cycle balanced in nature.

Think About It

Think about the steps in the nitrogen cycle. How might upsetting one step in the cycle affect the other steps?

Glossary

algae Plant-like organisms, such as seaweed, that are commonly found in water.

amino acid The basic building blocks of proteins, which make up the body's cells.

ammonia A colorless, strong-smelling gas made up of nitrogen and hydrogen.

atmosphere The layer of gases that surrounds Earth or another planet.

bacteria Tiny living things found in nature that are made of a single cell.

cereal grass A grassy plant that produces grain, such as oats or wheat.

chlorophyll The substance in green plants that helps them make food using photosynthesis.

cyanobacteria A blue-green bacteria that can fix free nitrogen.

dead zone An area where there is no life of any kind.

decay To rot, decompose, or break down.

legume A plant from the pea family, such as beans, peanuts, or soybeans.

marine Having to do with the ocean or sea.

meteorite A meteor (small rocky body from space) that has reached Earth's surface.

microorganism An organism too small to be seen without a microscope.

mineral A chemical compound that occurs naturally. Rocks are made of minerals.

protein A nutrient necessary for living things to grow.

reproduce To produce new individuals of the same kind.

sediment Material from a liquid that settles to the bottom.

substance A basic type of material.

ultraviolet radiation A type of radiation from the sun that travels in waves.

For More Information

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Websites

Because of the changing nature of internet links, Rosen Publishing has developed an online list of websites related to the subject of this book. This site is updated regularly. Please use this link to access the list:

http://www.rosenlinks.com/LFO/Nitrogen

Book Index

The Nitrogen Cycle

The Nitrogen Cycle *Bobi Martin. Let's Find Out! Our Dynamic Earth New York, NY: Britannica Educational Publishing with Rosen Educational Services, 2018. 32 pp.*

This book explores the nitrogen cycle, including why nitrogen is an essential nutrient for growth, where nitrogen is found, and the important role legumes play in the nitrogen cycle.

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