

Soil and Nutrients

You have learned about many different living things that scavenge and decompose organic materials. You have learned that the process of decomposition leaves nutrients in the soil. You have observed healthy plants grow in nutrient-rich soil.

If you walked around outside, would you know nutrient-rich soil if you saw it? Would you know if you touched it or smelled it?



Making Healthy Soil

Soil Fact

Soil might appear solid, but it's actually full of air. Fresh air moves through the top 20 cm (8 in) of well-drained soil.

Word Connection

There is a scientific term for the smell that comes from soil that has been watered or shoveled. It is called *geosmin*. The word comes from Greek and means "smell of earth." Decomposer bacteria living in the soil make substances that give off the scent.

Scavengers and decomposers help make soil. Invertebrates such as beetles and earthworms break down nature's waste into smaller pieces. They bring the organic matter underground and mix it with the inorganic parts of soil—rocks, water, and air. They leave behind droppings or castings. The remains that are not eaten are left over for fungi and bacteria to finish decomposing.

Tunnels and burrows made by invertebrates also create air spaces where plant roots can reach. Loosening the soil allows air and water to get into the soil.

Fungi and bacteria break down the organic remains further. In the process they leave behind gluey substances that bind the soil particles together, unlike dry sand. These sticky parts allow pockets of air and water in the soil.

Fungi and bacteria also leave behind nutrients in soil, which become available for plants to use. Even though plants get most of their matter from air and water, they still need vitamins and minerals that they can't make themselves. They get these from soil.

What Is Soil?

Soil is a mixture of many different things. In the natural world, these different ingredients are slowly mixed together over hundreds or thousands of years.

Some of these ingredients are the organic remains you've been learning about. The other ingredients are inorganic, meaning they were never part of living organisms.

How Many of Nature’s Recyclers Live in Different Types of Soils?

	Agricultural (farm) Soil	Prairie Soil	Forest Soil
Bacteria (per gram [1 tsp] of soil)	100 million to 1 billion	100 million to 1 billion	100 million to 1 billion
Fungi (per gram [1 tsp] of soil)	Several meters	Tens to hundreds of meters	Several hundred meters
Springtails, mites, and other arthropods (per 950 square centimeters [1 square foot])	Up to 100	500 to 2,000	10,000 to 25,000
Earthworms (per 950 square centimeters [1 square foot])	5 to 30	10 to 50	10 to 50

The Organic Parts of Soil

Soil’s organic ingredients include all of the living or once-living things in the soil. The living organisms are decomposers: bacteria, fungi, and invertebrates.

The once-living things in soil are plant or animal materials in various states of decomposition. They are food sources for the living organisms in soil. After many organisms have fed on, used, and decomposed the once-living organic matter, it forms **humus** (HYOO-muhs).

Making Healthy Soil

Humus is dark brown or black and kind of sticky. It holds the inorganic parts of soil together. It helps keep soil crumbly, so the ground isn't too hard for plants to grow. It absorbs water easily, so the ground doesn't dry out. Humus also has lots of nutrients that plants need to survive, grow, and be healthy.



Adding compost increases the amount of humus in soil.

Have You Ever Seen Humus Being Made? Where? How?

Nature's recyclers make humus. They make crumbly, fertile soil. Fertile soil is rich in nutrients, water, and air. These are the materials needed for healthy plant growth.



A garden compost bin is a good place to watch humus being made. Over time, nature's recyclers break down dead plant matter into smaller and smaller pieces. They release nutrients, which will be available for plants to use when they grow in the soil.



Omar Bose

Fungi and bacteria soften rotting logs. They reduce chunks of wood into crumbs of humus.

Word Connection

weathered—broken down by rain, ice, wind, streams, plant roots, and changes in temperature.



Try This!

Fill a big glass jar about halfway with soil. Fill the rest of it with water. Stir or shake the jar and wait. The soil will separate into layers. The bottom layer will be gravel pieces, because they are the heaviest. The next layer will be sand; then silt, then clay. Any flecks and clumps left floating on top of the cloudy water will be organic materials.

The Inorganic Parts of Soil

The inorganic matter in soil is the nonliving part. One inorganic ingredient is rock. The rocks in soil have been **weathered** into very small bits and pieces over thousands of years.

Besides rock pieces, the other inorganic ingredients in soil are water and air. In fertile soil, half of the volume (the space the soil takes up) is filled with water and air.

Soil scientists look at the sizes of rock pieces, or **particles**, in soil. They figure out how much of each particle size there is. From this information, they determine the **soil texture**. The texture of a soil affects how well it holds water, air, and nutrients. The largest particles in soil are called sand. Smaller particles are called silt and clay.



Soils Fact

If a particle of sand were the size of a basketball, then a particle of silt would be the size of a baseball, and a particle of clay would be the size of a golf ball.

Where Is Fertile Soil?

Soil texture is different in different places. In a muddy riverbed the soil is soft with silt and clay. In a desert the soil is often sandy and dry.

In farms and gardens, the soil is usually an even mix of sand, silt, and clay. This mixture is best for plants because it holds water, air, and nutrients and is not so tightly packed that it's hard for plants to grow.

Where plants grow, other organisms also live and die. Nature's recyclers break down their organic remains. They make humus. They leave nutrients in the soil. With every cycle of life, death, and decomposition, the soil becomes fertile.

Fertile soil usually looks dark from the humus in it. Fertile soil usually feels loose and moist from the even mix of sand, silt, and clay. Fertile soil usually has an "earthy" smell, caused by bacteria. Would you know nutrient-rich soil if you saw (or smelled) it now?

A Compost Community

What Is a Compost Pile?

A compost pile is a place to put organic remains: fruit and vegetable waste from a kitchen, grass clippings and raked leaves from a yard.

But why would people want to put their waste in their backyard? Why not just send the stuff to the dump?

People who keep compost piles know that organic remains are a storehouse for nutrients that plants in the garden need.

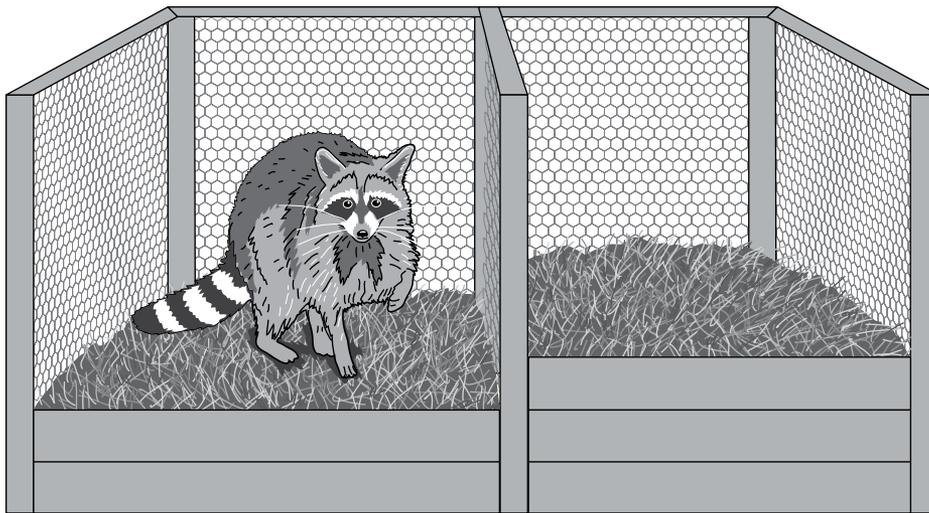
Over time a compost pile breaks down and decomposes. It becomes the dark, sweet-smelling, nutrient-rich ingredients of soil.

What Is a Compost Community?

A compost pile is like a mini ecosystem. A whole community of organisms carries out the decomposition in a compost pile. This community includes all of the different kinds of organisms that come to the compost pile to eat and live. Some decompose the organic matter. Others eat the decomposers! Together, the community stays balanced and healthy.

You may recognize some of these creatures, but most of them are so small that you probably don't notice them. In fact, some of them are so small that you can't even see them without a microscope.

Let's take a look.



A compost pile with a raccoon.

A RACCOON

A raccoon that found its way to a compost pile would have a feast there. Raccoons are scavengers. They are also **omnivores**—they eat both plants and animals. A raccoon would eat not only the fruit and vegetable leftovers, but also any earthworms it found in the compost pile.



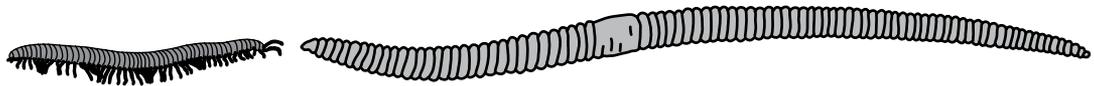
A raccoon eats both plants and animals. It might feed on earthworms, as well as fruit in a compost pile.

EARTHWORMS

When you see earthworms in a compost pile, you know that decomposition is happening. Earthworms burrow through to eat the rotten fruits, vegetables, and leaves. They shred the plant litter, breaking it down.

As earthworms wriggle along, they make tiny pellets called **castings**. The castings help build up the soil and provide nutrients in a form that plants can use.

In healthy soil communities there are about 150 earthworms per square meter (a little more than one square yard).



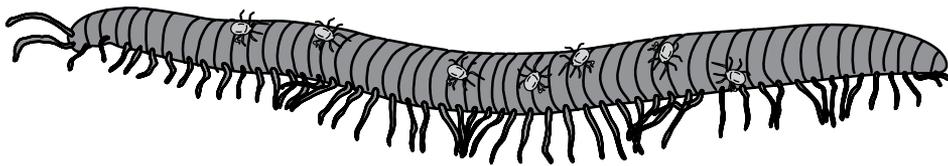
A millipede and an earthworm.

MILLIPEDES

Millipedes are another kind of long, thin creature that lives in compost piles. Like earthworms, they are invertebrates—they don't have any bones.

What they do have is lots of legs. "Millipede" means "thousand feet." Actually, millipedes usually have less than one hundred feet. When a millipede moves, ripples pass down its body from one pair of legs to the next.

Millipedes graze on the dead leaves and grasses in the outer layers of a compost pile. As they travel from place to place, they sometimes carry piggybacking mites. Each mite is smaller than a grain of sand. The mites jump off when they reach a good source of food.

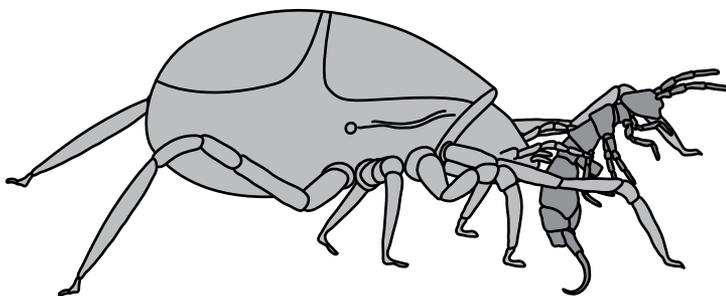


Mites on a millipede.

MITES

Mites, like their spider relatives, have eight legs. Some mites are **herbivores** that feed on decaying plant material. Other mites are **carnivores** that feed on even smaller animals.

Carnivorous mites eat springtails, which also live in compost piles.

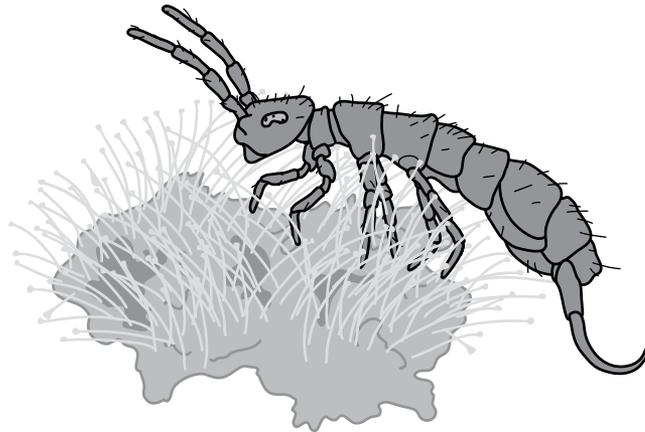


A mite eating a springtail.

SPRINGTAILS

Springtails are so small that they weren't even discovered until the magnifying glass was invented. But they are very abundant—a cubic meter of soil may contain 100,000 springtails. They are able to jump quickly when threatened. They don't directly eat the decomposing plant matter in a compost pile, but they eat other organisms to keep the ecosystem in balance.

Some springtails graze on fungi, like mold. Other springtails eat bacteria, or the droppings of other soil-feeding animals.



A springtail eating mold.

FUNGI

Fungi tend to feed on the tough plant remains in a compost pile, such as leaf litter or woody pieces. Fungi digest the materials outside of their bodies. Where fungi feed, the organic remains decompose into a liquid full of nutrients. Then the fungi take the nutrients in through hairy-looking tubes—the mycelia (more than one mycelium).

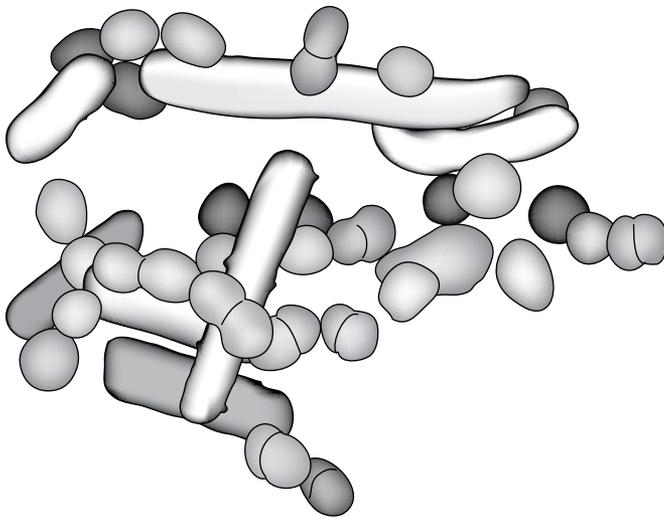
BACTERIA

Bacteria are the smallest organisms. And there are more bacteria than any other kind of decomposer in a compost pile (or anywhere else). In one gram (a single teaspoon) of compost, there may be between 100 million and 100 billion bacteria.

Bacteria are among the first to decompose fresh plant litter and kitchen waste. They cause the smelly, mushy rot that attracts so many other compost organisms.

As bacteria decompose organic waste, they release heat. This is why, on a cool day, you can see steam rising from a compost pile.

The earthy smell of freshly dug compost is another sign of active bacteria.



Soil bacteria.

Glossary

bacteria

Microscopic, single-celled organisms. Some of which work as *decomposers* that feed on dead organisms. (The singular form is bacterium.)

castings

Remains of digested food left by earthworms.

carnivore

A consumer that eats only animals.

fungi

A kingdom of living things that are different from both plants and animals. Fungi break down the remains of the organic material they live in or live on to get nutrients. Mushrooms and molds are fungi. (The singular form is fungus.)

herbivore

A consumer that eats only plants.

humus

The dark brown or black material formed from decomposed plant and animal matter. Humus contains many nutrients.

omnivore

A consumer that eats both plants and animals.

particles

A tiny bit of matter, such as a grain of sand.

soil texture

The relative amounts of different sizes of soil particles.

weathered

Broken down by rain, ice, wind, streams, plant roots, and changes in temperature.

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