KEY CONCEPT

4.2 Weathering and organic processes form soil.

BEFORE, you learned

- Weathering processes break down rocks
- Climate influences the rate of weathering

NOW, you will learn

- What soil consists of
- How climate and landforms affect a soil's characteristics
- How the activities of organisms affect a soil's characteristics
- How the properties of soil differ

VOCABULARY

humus p. 123
soil horizon p. 124
soil profile p. 124

EXPLORE Soil Composition

What makes soils different?

PROCEDURE

1. Spread some potting soil on a piece of white paper. Spread another type of soil on another piece of white paper.
2. Examine the two soil samples with a hand lens. Use the tweezers to look for small pieces of rock or sand, humus, and clay. Humus is brown or black, and clay is lighter in color. Record your observations.

MATERIALS

- potting soil
- local soil sample
- white paper (2 pieces)
- hand lens
- tweezers

WHAT DO YOU THINK?

- How do the two soil samples differ? How are they alike?
- What might account for the differences between the two soils?

Soil is a mixture of weathered rock particles and other materials.

Soil may not be the first thing you think of when you wake up in the morning, but it is a very important part of your everyday life. You have spent your whole life eating food grown in soil, standing on soil, and living in buildings built on soil. Soil is under your feet right now—or at least there used to be soil there before the building you are in was constructed. In this section you will learn more about the world of soil beneath your feet.

CHECK YOUR READING Why is soil important?

Soil Composition

Soil is a mixture of four materials: weathered rock particles, organic matter, water, and air. Weathered rock particles are the main ingredient of soil. Soils differ, depending on what types of rock the rock particles came from—for example, granite or limestone.

Water and air each make up about 20 to 30 percent of a soil's volume. Organic matter makes up about 5 percent. The word *organic* (awr-GAN-ihk) means "coming from living organisms." Organic matter in soil comes from the remains and waste products of plants, animals, and other living organisms. For example, leaves that fall to a forest floor decay and become part of the soil. The decayed organic matter in soil is called **humus** (HYOO-muhs).

VOCABULARY
A description wheel would be a good choice for taking notes about the term *humus*.

All soils are not the same. Different soils are made up of different ingredients and different amounts of each ingredient. In the photographs below, the black soil contains much more decayed plant material than the red soil. The black soil also contains more water. The kind of soil that forms in an area depends on a number of factors, including

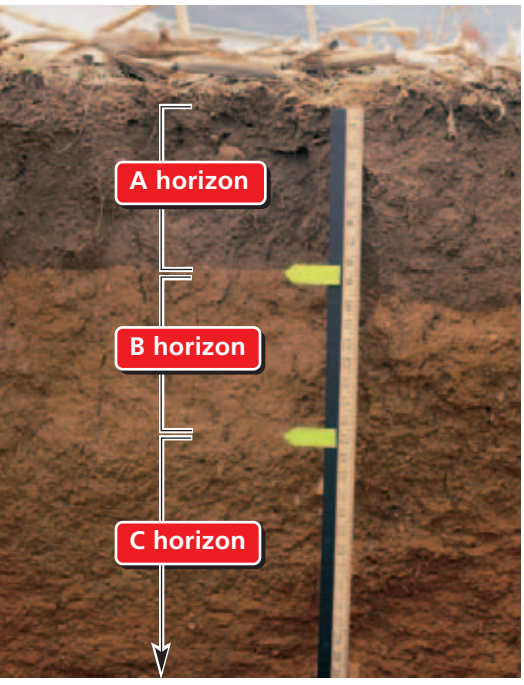
- the kind of rock in the area
- the area's climate, or overall weather pattern over time
- the landforms in the area, such as mountains and valleys
- the plant cover in the area
- the animals and other organisms in the area
- time

The composition of a soil determines what you can grow in it, what you can build on it, and what happens to the rainwater that falls on it.

READING VISUALS **COMPARE AND CONTRAST** These two soils look different because they contain different ingredients. How would you describe their differences?

Soil Horizons

This soil profile in Hagerstown, Maryland, shows distinct A, B, and C horizons.



If you dig a deep hole in the ground, you might notice that the deeper soil looks different. As you dig down, you will find larger rock particles that are less weathered. There is also less organic matter in deeper soil.

Soil develops in a series of horizontal layers called soil horizons. A **soil horizon** is a layer of soil with properties that differ from those of the layer above or below it. Geologists label the main horizons A, B, and C. In some places there may also be a layer of dead leaves and other organic matter at the surface of the ground.

- **The A horizon** is the upper layer of soil and is commonly called topsoil. It contains the most organic matter of the three horizons. Because of the humus the A horizon contains, it is often dark in color.
- **The B horizon** lies just below the A horizon. It has little organic matter and is usually brownish or reddish in color. It contains clay and minerals that have washed down from the A horizon.
- **The C horizon** is the deepest layer of soil. It consists of the largest and least-weathered rock particles. Its color is typically light yellowish brown.

The soil horizons in a specific location make up what geologists call a **soil profile.** Different locations can have very different soil profiles. The A horizon, for example, may be very thick in some places and very thin in others. In some areas, one or more horizons may even be missing from the profile. For example, a soil that has had only a short time to develop might be missing the B horizon.

CHECK YOUR READING What are soil horizons?

Climate and landforms affect soil.

COMBINATION NOTES
Record in your notes four categories of soil that form in different climate regions.

Different kinds of soils form in different climates. The soil that forms in a hot, wet climate is different from the soil of a cold, dry climate. Climate also influences the characteristics and thickness of the soil that develops from weathered rock. Tropical, desert, temperate, and arctic soils are four types of soil that form in different climate regions.

The shape of the land also affects the development of soil. For example, mountain soils may be very different from the soils in nearby valleys. The cold climate on a mountain results in slow soil formation, and the top layer of soil continually washes down off the slopes. As a result, mountain slopes have soils with thin A horizons that cannot support large plants. The soil that washes down the slopes builds up in the surrounding valleys, so the valleys may have soils with thick A horizons that can support many plants.

World Soil Types

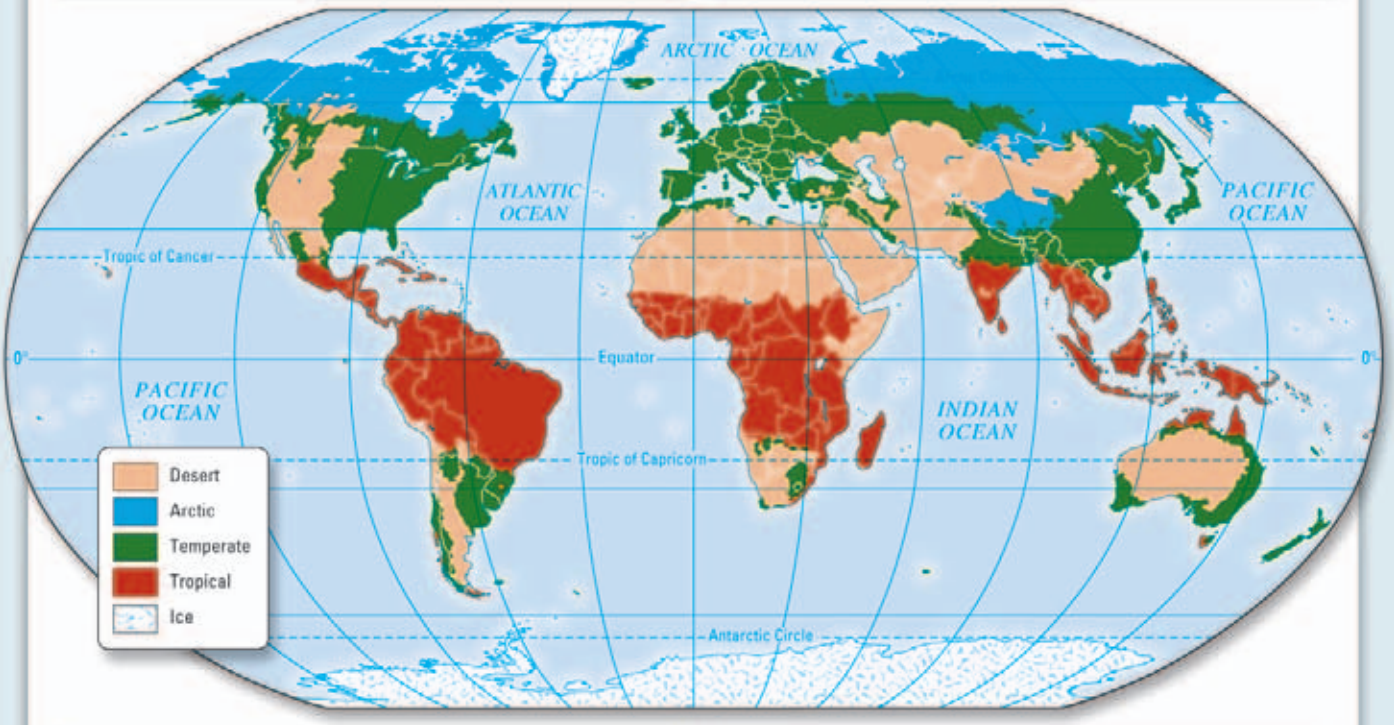
Different types of soils form in different climates.

Tropical Soils

Tropical soils form in warm, rainy regions. Heavy rains wash away minerals, leaving only a thin surface layer of humus. Tropical soils are not suitable for growing most crops.

Desert Soils

Desert soils form in dry regions. These soils are shallow and contain little organic matter. Because of the low rainfall, chemical weathering and soil formation occur very slowly in desert regions.



Temperate Soils

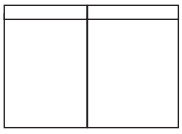
Temperate soils form in regions with moderate rainfall and temperatures. Some temperate soils are dark-colored, rich in organic matter and minerals, and good for growing crops.

Arctic Soils

Arctic soils form in cold, dry regions where chemical weathering is slow. They typically do not have well-developed horizons. Arctic soils contain a lot of rock fragments.

The activities of organisms affect soil.

COMBINATION NOTES
Record in your notes three types of organisms that affect soil characteristics.



Under the ground beneath your feet is a whole world of life forms that are going about their daily activities. The living organisms in a soil have a huge impact on the soil's characteristics. In fact, without them, the soil would not be able to support the wide variety of plants that people depend on to live. The organisms that affect the characteristics of soils include plants, microorganisms (MY-kroh-AWR-guh-NIHZ-uhmz), and animals.

Plants, such as trees and grasses, provide most of the organic matter that gets broken down to form humus. Trees add to the organic matter in soil as they lose their branches and leaves. Trees and other plants also contribute to humus when they die and decompose, or break down.

CHECK YOUR READING How are plants and humus related?

READING TIP
A decomposer is an organism that decomposes, or breaks down, dead plants and animals.

Microorganisms include decomposers such as bacteria and fungi (FUHN-jy). The prefix *micro-* means "very small." Microorganisms are so small that they can be seen only with a microscope. A spoonful of soil may contain more than a million microorganisms! These microorganisms decompose dead plants and animals and produce nutrients that plants need to grow. Plants absorb these nutrients from the soil through their roots. Nitrogen, for example, is one of the nutrients plants need to grow. Microorganisms change the nitrogen in dead organic matter—and nitrogen in the air—into compounds that plants can absorb and use. Some bacteria also contribute to the formation of soil by producing acids that break down rocks.

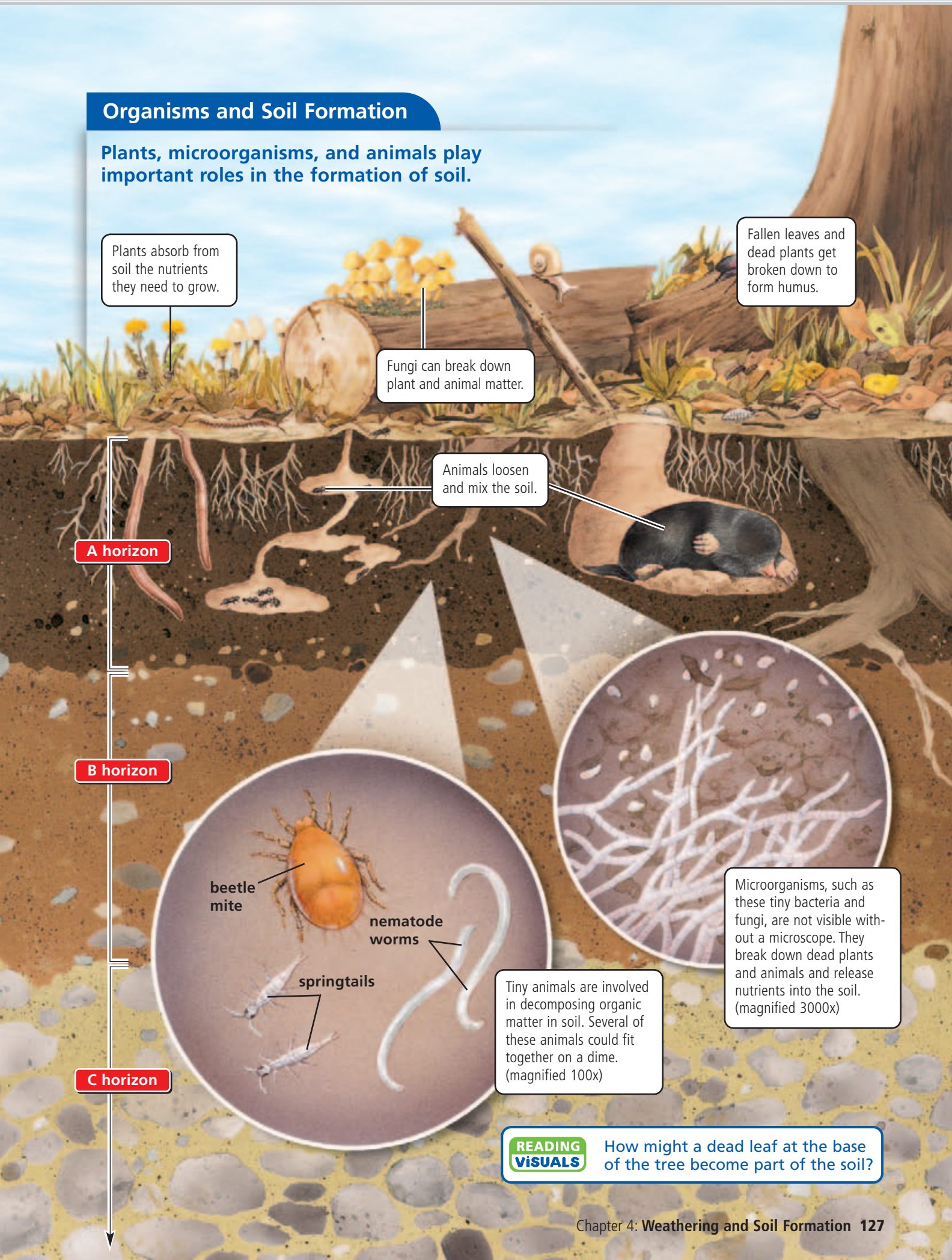
The cycling of nutrients through the soil and through plants is a continual process. Plants absorb nutrients from the soil and use those nutrients to grow. Then they return the nutrients to the soil when they die or lose branches and leaves. New plants then absorb the nutrients from the soil and start the cycle over again.

Animals such as earthworms, ants, termites, mice, gophers, moles, and prairie dogs all make their homes in the soil. All of these animals loosen and mix the soil as they tunnel through it. They create spaces in the soil, thereby adding to its air content and improving its ability to absorb and drain water. Burrowing animals also bring partly weathered rock particles to the surface of the ground, where they become exposed to more weathering. Just like plants, animals return nutrients to the soil when their bodies decompose after death.

CHECK YOUR READING How do animals affect soil? Name at least three ways.

Organisms and Soil Formation

Plants, microorganisms, and animals play important roles in the formation of soil.



READING VISUALS How might a dead leaf at the base of the tree become part of the soil?

Properties of soil can be observed and measured.

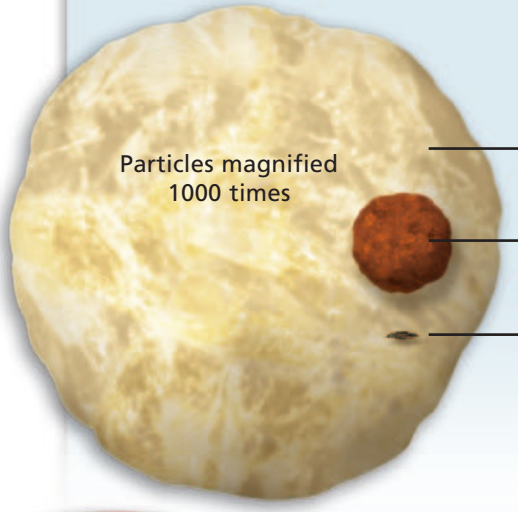
Observations and tests of soil samples reveal what nutrients the soils contain and therefore what kinds of plants will grow best in them. Farmers and gardeners use this information to improve the growth of crops and other plants. Soil scientists study many soil properties, including texture, color, pore space, and chemistry.

Texture

The texture of a soil is determined by the size of the weathered rock particles it contains. Soil scientists classify the rock particles in soils into three categories, on the basis of size: sand, silt, and clay. Sand particles are the largest and can be seen without a microscope. Silt particles are smaller than sand particles—too small to be seen without a microscope. Clay particles are the smallest. Most soils contain a mixture of sand, silt, and clay. The texture of a soil influences how easily air and water move through the soil.

Soil Texture

The texture of a soil is determined by the amounts of sand, silt, and clay it contains.



Properties of Sand, Silt, and Clay

	Size	Feel	Drainage
Sand	largest—can be seen without microscope (0.05 mm–2 mm)	gritty	does not hold water well—water moves through quickly
Silt	smaller—need microscope to see (0.002 mm–0.05 mm)	smooth and silky when wet, forms clumps when dry	holds more water than sand
Clay	smallest—need microscope to see (less than 0.002 mm)	sticky when wet, forms hard clumps when dry	absorbs most water—water moves through very slowly

Color

The color of a soil is a clue to its other properties. Soil colors include red, brown, yellow, green, black, and even white. Most soil colors come from iron compounds and humus. Iron gives soil a reddish color. Soils with a high humus content are usually black or brown. Besides indicating the content of a soil, color may also be a clue to how well water moves through the soil—that is, how well the soil drains. Bright-colored soils, for instance, drain well.

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Pore Space

Pore space refers to the spaces between soil particles. Water and air move through the pore spaces in a soil. Plant roots need both water and air to grow. Soils range from about 25 to 60 percent pore space. An ideal soil for growing plants has 50 percent of its volume as pore space, with half of the pore space occupied by air and half by water.

Chemistry

Plants absorb the nutrients they need from the water in soil. These nutrients may come from the minerals or the organic matter in the soil. To be available to plant roots, the nutrients must be dissolved in water. How well nutrients dissolve in the water in soil depends on the water's pH, which is a measure of acidity. Farmers may apply lime to make soil less acidic. To make soil more acidic, an acid may be applied.

CHECK YOUR READING How does soil acidity affect whether the nutrients in soil are available to plants?

This gardener is adding lime to the soil to make it less acidic.

4.2 Review

KEY CONCEPTS

1. What are the main ingredients of soil?
2. How do climate and landforms affect soils' characteristics?
3. How do the activities of organisms affect the characteristics of soil?
4. Describe four properties of soil.

CRITICAL THINKING

5. **Compare and Contrast** How would a soil containing a lot of sand differ from a soil with a lot of clay?
6. **Infer** Which would you expect to be more fertile, the soil on hilly land or the soil on a plain? Why?

CHALLENGE

7. **Synthesize** What kinds of roots might you expect to find on plants that grow in arctic soils? Why?