Bacteria

HOW THEY AFFECT OTHER LIVING THINGS

Dorothy Hinshaw Patent

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HOLIDAY HOUSE · New York

PHOTO ON PAGE 74: from *Science*, Vol. 189, pp. 637-639, Fig. 1, 22 August 1975.
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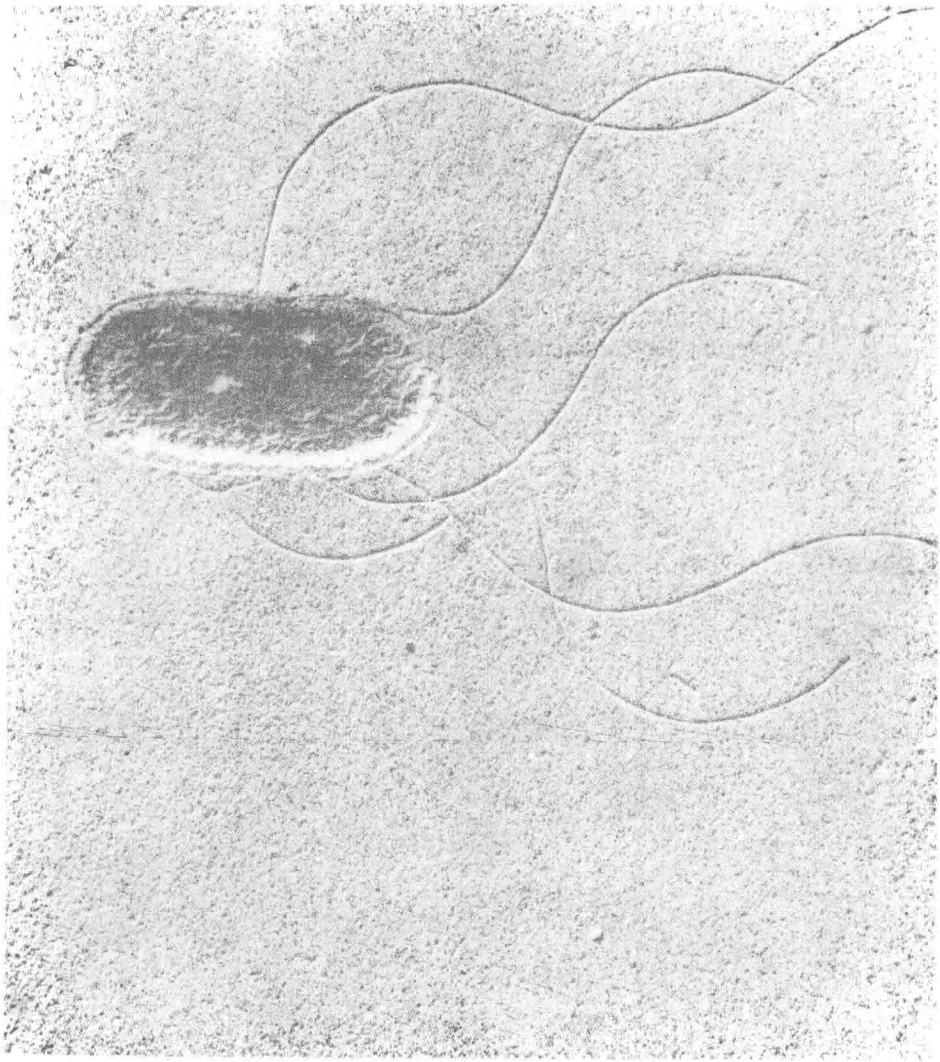

Even when magnified greatly, bacteria reveal little of their structure. This rod-shaped bacterium, magnified 30,000 times, is called Erwinia amylovora *and causes a pear disease called fire blight. Several flagella, which allow the cell to move about, can be seen.* SHERMAN V. THOMSON

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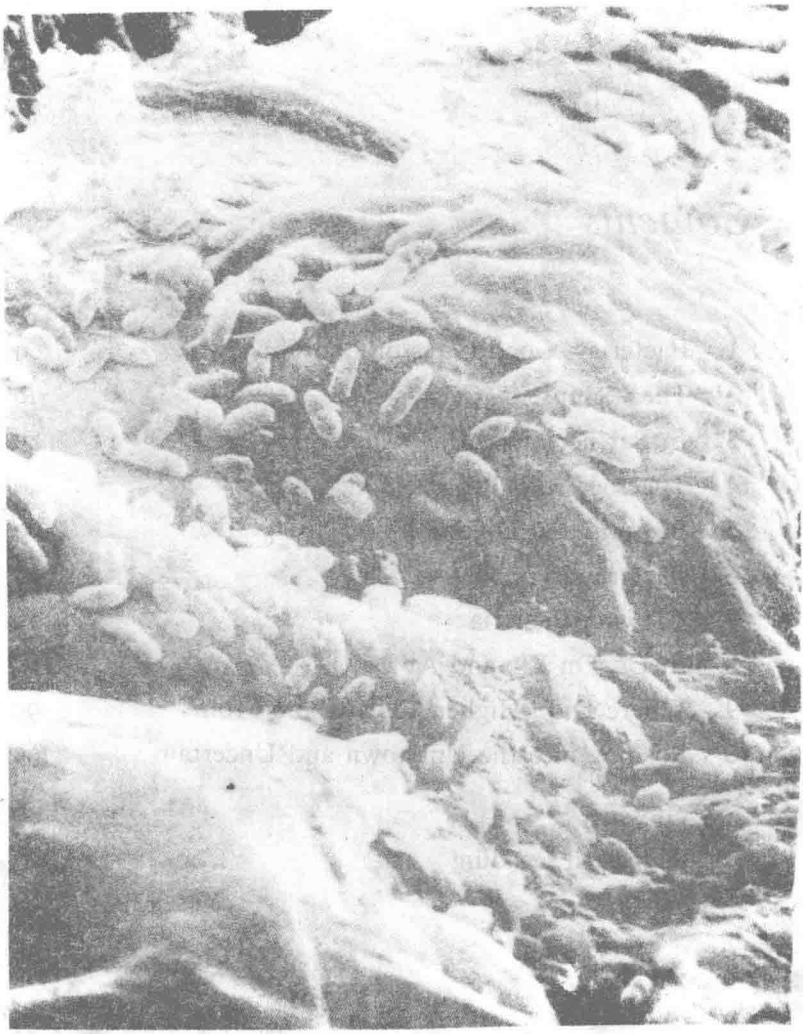
Contents



This picture of E. amylovora *was taken with a scanning electron microscope, a remarkable machine which allows us to view the microscopic world in a three-dimensional way. The bacteria are growing on the pistil of a pear flower. To us, the flower pistil is a smooth, tiny stalk inside the flower. But to the pear blight bacteria, it is a vast, bumpy surface on which to grow.* SHERMAN V. THOMSON

One

Bacteria—
Good Guys or Bad Guys?

What is the first word to pop into your mind when you hear the word "bacteria?" The chances are that your answer is "germ." Most people know of bacteria only as nasty germs that give them strep throat or food poisoning and that should be gotten rid of when at all possible.

But the vast majority of bacteria are not disease-causing germs; they are harmless or helpful organisms that we need not discourage. This is a good thing, for bacteria are so numerous almost everywhere that it would be just about impossible to eliminate them all, no matter how hard we tried. There are millions of bacteria on our skin, even after a thorough soapy shower, and the human intestine swarms with bacteria. There are countless bacteria floating about on dust particles in the air and thriving in the garden soil. Bacteria may thrive where few other living things can even survive—in boiling hot springs of Yellowstone Park; in the windswept arctic tundra; in the salty waters of the Great Salt Lake. Bacteria have been collected from ocean troughs eleven kilometers (almost seven miles) deep and from air samples taken at a height of 75 kilometers (almost 47 miles). Some bacteria can survive for many years in a dried or frozen state and "come back to life" as soon as conditions improve.

For most of human history, people have been unaware that such a thing as bacteria existed, for these organisms are much too small to be seen without a microscope. When

Anton van Leeuwenhoek made his simple but highly effective single-lens microscopes just over 300 years ago, human eyes saw bacteria for the first time. But despite the lively and informative letters which Leeuwenhoek sent to the distinguished scientists of the Royal Society of London, the further study of bacteria had to wait for another 150 years after Leeuwenhoek's death. So it is no wonder that today many aspects of bacterial life remain mysterious. These organisms exist in such amazing variety and are of such small size that studying them, especially under natural conditions, can be very difficult.

The Size of Bacteria

Bacteria are extremely small living things. While we measure our own sizes in inches or centimeters, bacterial size is measured in microns. One micron is a thousandth of a millimeter; a pinhead is about a millimeter across. Rod-shaped bacteria are usually from two to four microns long, while rounded ones are generally one micron in diameter. Thus, if you enlarged a rounded bacterium a thousand times, it would be just about the size of a pinhead. If an adult human were magnified by the same amount, he would be over a mile (1.6 kilometers) tall.

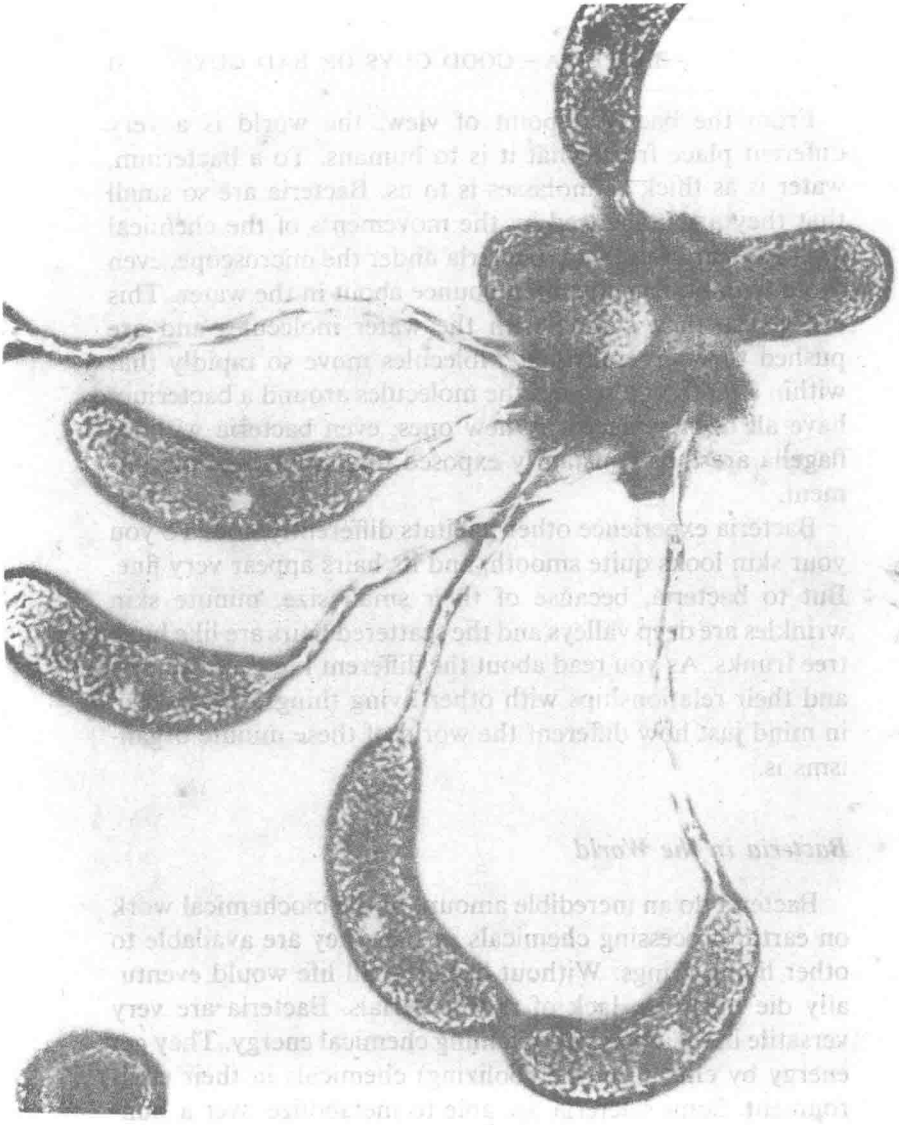
Even with an ordinary microscope, you must look closely to see bacteria. Using a magnification of 100 times, one finds that bacteria are just visible as tiny rods or dots. One cannot make out anything of their structure. Using special stains, one can see that some bacteria have attached to them wavy-looking "hairs" called flagella. Others have only one flagellum. The flagella rotate, pushing the bacteria through the water. Many bacteria lack flagella and cannot move about by their own power, while others can glide along over surfaces by some little-understood mechanism.

From the bacterial point of view, the world is a very different place from what it is to humans. To a bacterium, water is as thick as molasses is to us. Bacteria are so small that they are influenced by the movements of the chemical molecules around them. Bacteria under the microscope, even those with no flagella, often bounce about in the water. This is because they collide with the water molecules and are pushed this way and that. Molecules move so rapidly that within a tenth of a second the molecules around a bacterium have all been replaced by new ones; even bacteria without flagella are thus constantly exposed to a changing environment.

Bacteria experience other habitats differently, too. To you your skin looks quite smooth, and its hairs appear very fine. But to bacteria, because of their small size, minute skin wrinkles are deep valleys and the scattered hairs are like huge tree trunks. As you read about the different kinds of bacteria and their relationships with other living things, try to keep in mind just how different the world of these minute organisms is.

Bacteria in the World

Bacteria do an incredible amount of the biochemical work on earth, processing chemicals so that they are available to other living things. Without bacteria, all life would eventually die out from lack of raw materials. Bacteria are very versatile in their ways of obtaining chemical energy. They get energy by changing (metabolizing) chemicals in their environment. Some bacteria are able to metabolize over a hundred different kinds of chemicals, while others are more limited in their abilities. Some can live without organic material, using the sun's energy in ways similar to plants. Other bacteria can survive only within the bodies of living things



These bacteria, magnificd 25,000 times, are called Caulobacter. *They are found commonly in decaying materials.* A. E. RITCHIE, NATIONAL ANIMAL DISEASE CENTER, AMES, IOWA

and need a great variety of organic materials for their survival.

Bacteria are vital in the process of decay. They help break down dead plants and animals, returning them to their basic components so that plants can recycle them again. While many bacteria help in the decay processes in the soil and on the floors of lakes and oceans, others carry out similar functions in the digestive systems of animals. Because of their biochemical versatility, bacteria are the only living things able to break down many natural chemicals. These abilities form the basis of many of their relationships with other living things.

How Bacteria "Eat"

How does a minute cell without a mouth or stomach feed itself? Bacteria absorb their nutrients directly from the environment around them. They have in them proteins called enzymes that help break down nutrient molecules and so enable the bacteria to extract energy from them. Most enzymes are quite specific and can act on only one substance or a few related substances. When bacteria are placed in a culture with one particular nutrient, the cell is stimulated to produce the enzyme that helps break down that nutrient. In this way, the cell is making only the enzymes needed at a particular time. It doesn't waste energy making enzymes that have no use at the moment.

When they are making use of some substances, bacteria must secrete the enzymes into whatever the cell is lying on or in. Materials such as cellulose exist in long, tough molecules and cannot be brought into the cell. The bacteria must attach themselves closely to the material so that, as the enzymes break it down, the resulting smaller molecules can be absorbed.