membrane-bound organelles but also differ from **eukaryotes** in the circular shape of the DNA molecules that encode their genetic information, the size of their ribosomes, and a number of other ways.

Despite their similarities, the two prokaryotic domains, **Bacteria** and **Archaea,** also have important differences, including the chemistry of their cell walls (see Table 5.2, p. 100), cell membranes, and the cellular machinery that manufactures proteins. In fact, genetic analyses indicate that bacteria and archaea are as different from each other as they are from humans.

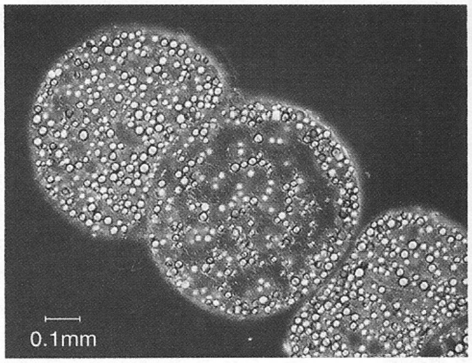

FIGURE 5.3 Three cells of *Thiomargarita namibiensis,* the largest known bacterium. Cells can be 0.75 mm (0.03 in.) wide. The round, yellowish structures are sulfur granules. *Thiomargarita* lives in oxygen-poor water.

Bacteria

Bacteria (domain **Bacteria**) appear to have branched out very early on the tree of life and are genetically distant from both archaea and eukaryotes. Because they are structurally simple, bacteria (singular, **bacterium**) are classified as prokaryotes. Nevertheless, they have evolved a great range of metabolic abilities. They are abundant in all parts of the ocean.

Bacterial cells have many shapes, including spheres, spirals, rods, and rings (Fig. 5.2), depending on the species. The unique chemistry of bacterial cell walls (see Table 5.2, p. 100) makes them rigid and strong. A stiff or slimy covering often surrounds the cell wall as additional protection or a means of attaching to surfaces. The cells are very small (see Appendix A for relative size), much smaller than those of single-celled eukaryotes. About 250,000 average bacterial cells would fit on the period at the end of this sentence. There are exceptions, however, such as a sediment bacterium discovered off southwest Africa, with cells as wide as 0.75 mm (0.03 in), large enough to be seen with the naked eye (Fig. 5.3). Another giant bacterium (0.57 mm, or 0.02 in, long) is found inside the intestines of coral reef fishes. In large numbers, marine bacteria are sometimes visible as whitish hairs on rotting seaweed or iridescent or pink patches on the surface of stagnant pools in mudflats and salt marshes.

Bacteria can grow to extremely high numbers in favorable environments such as **detritus. Decay bacteria** break down waste products and dead organic matter and release nutrients into the environment. They are vital to life on Earth because they ensure the recycling of essential nutrients, as in the recycling of dissolved organic matter in oceanic food webs (see "The Microbial Loop," p. 349). Most organic matter is sooner or later decomposed, though in very deep, cold water the process is slower than elsewhere (see "Microbes in the Deep Sea," p. 378). Decay and other types of bacteria play another crucial role because they constitute a major part of the organic matter that feeds countless bottom-dwelling animals. Even many organic particles in the water column are composed mostly of bacteria. Some marine bacteria are also involved in degrading oil and other toxic pollutants that find their way into the environment. The same process of decomposition is unfortunately involved in the spoilage of valuable fish and shellfish catches. Other types of marine bacteria cause diseases in marine animals and humans.

Bacteria are found everywhere in the marine environment, on almost all surfaces and in the water column. In fact, the most abundant forms of life on the planet seem to be bacteria, found in surprisingly high numbers in open water. Their role, though probably highly significant due to their vast numbers, remains unknown. Bacteria have also been found in seemingly harsh environments, such as in sediment more than 3 km (1.9 mi) below the sea floor (see "Life Below the Sea Floor," p. 28).

Bacteria are structurally simple microorganisms that are particularly significant as decomposers, breaking down organic compounds into nutrients that can be used by other organisms, and as primary producers. They are also an important food source.

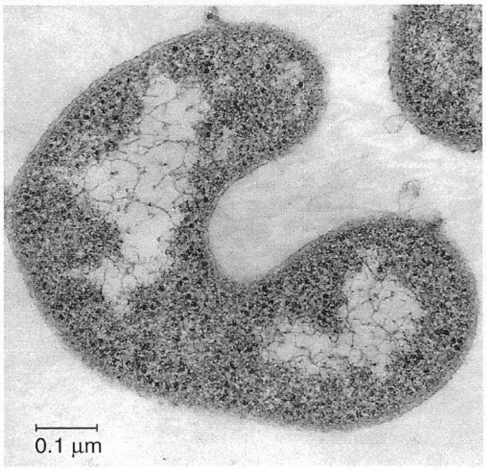

FIGURE 5.2 A high-magnification photograph taken with an electron microscope showing *Cyclobacterium marinus,* a ring-forming marine bacterium.

Cyanobacteria, once known as blue-green algae, are a group of **photosynthetic** bacteria (see "Autotrophs," p. 91). In addition to having chlorophyll *a,* as do eukaryotic photosynthetic organisms, most contain a bluish pigment called **phycocyanin.** Most marine cyanobacteria also have a reddish pigment, **phycoerythrin.** The visible color of the organism depends on the relative amounts of the two pigments. When phycocyanin predominates, the bacteria appear blue-green; when phycoerythrin predominates, they appear red.

Cyanobacteria were among the first photosynthetic organisms on Earth. They are thought to have had an important role in the accumulation of oxygen (O_2) in our atmosphere. Fossil **stromatolites,**