

massive **calcareous** mounds formed by cyanobacteria, are known to date back some 3 billion years. Stromatolites are still being formed in tropical seas (Fig. 5.4).

Cyanobacteria are widely distributed in the marine environment. *Prochlorococcus*, a minute cyanobacterium, is thought to be the most abundant photosynthetic organism in the ocean. It is particularly common in tropical and subtropical waters. Many species can tolerate wide ranges of salinity and temperature, while others are found in unexpected places, like inside the hair of polar bears! Some cyanobacteria, called **endolithic**, burrow into calcareous rocks and coral skeletons. Others form thick, dark crusts along the wave-splashed zone of rocky coasts. Some exploit oxygen-poor sediments, which may include polluted sites. **Planktonic** species may rapidly multiply and change the color of the water. Some so-called **red tides** (see “Red Tides and Harmful Algal Blooms,” p. 338) are caused by cyanobacteria that contain a red pigment. A few species can cause skin rashes on swimmers and divers.

Some cyanobacteria live on the surface of seaweeds and seagrasses. Photosynthetic organisms that live on algae or plants are called **epiphytes**. Some biologists, however, use this term to refer to *all* organisms living on algae or plants. Other cyanobacteria live inside algae and are called **endophytes**.

Cyanobacteria are photosynthetic bacteria. They were one of the first groups of photosynthetic organisms on Earth.

## Archaea

**Archaea** (domain **Archaea**) are among the simplest, most primitive forms of life. Some look very similar to the oldest fossils ever found, cells estimated to be at least 3.8 billion years old. Archaea are thought to have had an important role in the early evolution of life. Like bacteria, their cells are small and may be spherical (Fig. 5.5), spiral, or rod-shaped. In fact, until recently archaea (singular, **archaeum**) were thought to be bacteria. Despite being prokaryotic, however, there is evidence that archaea are more closely related to eukaryotes than to bacteria.

Some groups of archaea were discovered only recently, first in extreme environments on land, such as hot sulfur springs, saline lakes, and highly acidic or alkaline environments. Archaea were thus named “extremophiles,” meaning “lovers of extremes.” Archaea were subsequently found in extreme marine environments, such as in very deep water, where they survive at pressures of 300 to 800 atmospheres. Some archaea live at the high temperatures of **hydrothermal vents** (Fig. 5.5). Some of these cannot grow in temperatures less than 70° to 80 °C (158° to 176 °F), and one hydrothermal vent archaeum can live at 121 °C (250 °F), the highest of any



**FIGURE 5.4** Stromatolites, calcareous mounds deposited by cyanobacteria, are frequently found as fossils. These, however, are living stromatolites growing in shallow water in the Exuma Cays, Bahama Islands.

known organism. Other archaea depend on extremely salty environments, such as coastal salt pans and deep ocean basins. Others are found in highly acid or alkaline conditions.

Because the first groups of microorganisms to be classified as archaea were extremophiles, it was thought that *all* archaea were extremophiles; indeed, the two terms became almost synonymous. New techniques based on detecting **nucleic acid** sequences, however, have shown that archaea are common in many marine environments, not only in the water column

**Nucleic Acids** DNA and RNA, complex molecules that store and transmit genetic information.

**Gene** A sequence of *nucleotides* in the DNA molecule that directs the production of a particular protein.

• Chapter 4, p. 65

**Genome** The complete genetic information contained in the DNA of an organism.

• Chapter 4, p. 65

**Plankton** Primary producers (*phytoplankton*) and consumers (*zooplankton*) that drift with the currents.

• Chapter 10, p. 220; Figure 10.11

**Prokaryotes** Organisms with cells that do not have a nucleus or most other organelles.

• Chapter 4, p. 69; Figure 4.7

**Eukaryotes** Organisms with cells that contain a nucleus and other organelles that are enclosed by membranes.

• Chapter 4, p. 69; Figure 4.8

**Detritus** Particles of dead organic matter.

• Chapter 10, p. 223

**Calcareous** Made of calcium carbonate ( $\text{CaCO}_3$ ).

• Chapter 2, p. 31