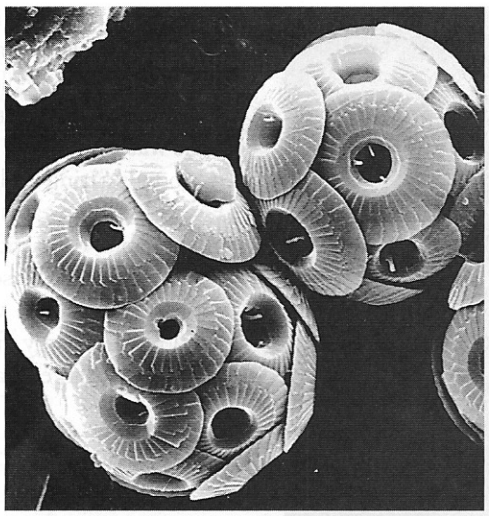

FIGURE 5.10
Coccolithophorids, such as *Umbilicosphaera sibogae* from Australia, are tiny, single-celled phytoplankton that can be significant primay producers in the open ocean. The plates that cover the cell are made of calcium carbonate.

the sediments. Typical **coccolithophorids** (division, or phylum, **Haptophyta**) are flagellated, spherical cells covered with button-like, ornamented structures called **coccoliths** made of calcium carbonate (Fig. 5.10). Coccoliths can be found in sediments as fossils. **Cryptophytes** (division, or phylum, **Cryptophyta**) have two flagella and lack a skeleton. Like other eukaryotes, cryptophytes have a chloroplast derived from a prokaryote (see "From Snack to Servant: How Complex Cells Arose," p. 73), but the chloroplast is contained within a reduced eukaryotic cell that lives symbiotically inside the cryptophyte cell. Members of these three groups of algae are so small that hundreds could fit into a large diatom or dinoflagellate cell.

PROTOZOANS: THE ANIMAL-LIKE PROTISTS

Protozoans are structurally simple and very diverse eukaryotic organisms that are traditionally considered to be animal-like. Most biologists agree that protozoans (meaning "first animals") actually comprise several groups of unrelated origins. Having a single cell is about the only thing that protozoans—which show an enormous diversity in structure, function, and lifestyle—have in common. Though a few form colonies, most are single-celled, unlike true animals, and are visible only under a microscope. Like animals, protozoans are heterotrophs and ingest food. Some, however, also contain chlorophyll and photosynthesize.

There is considerable disagreement as to how to classify the estimated 50,000 species of protozoans, though they are generally considered to be protists along with unicellular algae and seaweeds.

Protozoans are the most animal-like of the protists. They are eukaryotic and unicellular. They are essentially heterotrophic and ingest food, as animals do.

The minute size and apparent simplicity of protozoans disguise a complex nature. As in all unicellular organisms, each cell might be described as a "super cell" because it can perform many of the same functions carried out by the multitude of cells in structurally more complex organisms.

Protozoans inhabit water everywhere, living not only in marine and freshwater environments but even inside other organisms. Many kinds of marine protozoans can be readily collected from sediments rich in organic debris, the surface of seaweeds, the guts of animals, and plankton samples.

Foraminiferans

Foraminiferans (phylum **Granuloreticulosa**), often called **forams,** are marine protozoans that usually have a shell, or **test,** made of **calcium carbonate ($CaCO_3$).** The test is usually microscopic and may have several chambers (Fig. 5.11*a*), which increase in size as the foram grows. Foraminiferans have long, thin, retractable **pseudopodia**—extensions of the **cytoplasm.** The pseudopodia protrude through pores in the shell and form a network used to trap diatoms and other organisms suspended in the water (see Fig. 15.5). Food is then moved into the interior of the cell as if on a conveyor belt.

Most foraminiferans live on the bottom, either free or attached. Attached forams may develop into conspicuous growths as much as 5 cm (2 in) in diameter (Fig. 5.11*b*). Each growth consists of a single cell that forms a shell, though some may be covered with sand grains or other materials instead. The shells of bottom-living foraminiferans can be important contributors of calcareous material on coral reefs and sandy beaches. Relatively few species are planktonic, but these can be very abundant. Their shells are smaller and thinner than those that live on the bottom and may have delicate spines that aid in flotation. The shells of planktonic foraminiferans eventually sink to the bottom in such high numbers that large stretches of the ocean floor are covered by **foraminiferan ooze,** a type of calcareous ooze. Many limestone and chalk beds around the world, such as the white cliffs of Dover in England, are products of foraminiferan sediments that were uplifted from the ocean floor.

Foraminiferans (forams) are protozoans characterized by a shell usually made of calcium carbonate. Most live on the bottom. The shells of planktonic species are important components of marine sediments.

Most species of forams are known only as microfossils (see Fig. 2.18). The distribution of these microfossils in sediments is important to geologists. Shells of warm-water species are slightly larger and more porous than those from colder water. Past water temperatures can be estimated from the distribution of certain marker species. Their distribution is a good indicator of the right type of environment for the formation of oil, as well as the age of sediments.

Biogenous Sediments Sediments made of the skeletons and shells of marine organisms; *siliceous ooze* is made of silica, *calcareous ooze* of calcium carbonate.

• Chapter 2, p. 31

Cellulose A complex carbohydrate characteristic of plants and other primary producers.

• Chapter 4, p. 65