(plant biologists) and zoologists (animal biologists). These unicellular organisms are collectively called protists for convenience, although most biologists no longer consider the traditional kingdom **Protista** to be a separate kingdom because various groups of protists have different evolutionary histories. Multicellular seaweeds are also considered to be protists, mostly because they lack the specialized tissues of plants. Seaweeds, together with other multicellular primary producers, the marine plants, are discussed in Chapter 6.

Algae are protists. They are mostly aquatic primary producers that lack the specialized tissues of plants. They range in size and complexity from single cells to large, multicellular seaweeds.

Diatoms

Diatoms (division, or phylum, **Bacillariophyta**) are unicellular, though many species aggregate into chains or star-like groups. Diatom cells are enclosed by cell walls made largely of **silica (SiO_2),** a glass-like material. This glassy shell, or **frustule,** consists of two tightly fitting halves often resembling a flat, round, or elongated box (Fig. 5.6). The frustule typically has intricate perforations and ornaments such as spines or ribs, making diatoms strikingly beautiful when seen under a microscope. The frustule allows light to pass through, so that the conspicuous golden brown chloroplasts can capture light energy for photosynthesis. The minute perforations allow dissolved gases and nutrients to enter and exit. The sinking of open-ocean diatoms below the well-lit surface layer is often slowed by oil droplets in their cells and spines on the frustules (see "Staying Afloat," p. 341).

The characteristic color of diatoms is due to yellow and brown **carotenoid** pigments, in addition to two types of chlorophyll, *a* and *c*. Diatoms are efficient photosynthetic factories, producing much-needed food (the food being the diatoms themselves), as well as oxygen, for other forms of life. They are a potential source of biofuels as alternatives to fossil fuels (see "Marine Algae as Biofuels," p. 110). Diatoms are very important open-water primary producers in temperate and polar regions (see Table 15.1, p. 336; "Epipelagic Food Webs," p. 348). In fact, the huge number of diatom cells in the ocean account for a hefty share of the organic carbon and oxygen produced on planet Earth.

Around half the estimated 12,000 living species of diatoms are marine. Most are planktonic, but many produce a stalk-like structure for attachment to rocks and other surfaces in shallow water, where they contribute significantly to primary production. The brownish scum sometimes seen on mudflats or glass aquaria often consists of millions of diatom cells. Some are able to glide slowly on surfaces. A few are colorless, having no chlorophyll, and live as heterotrophs on the surfaces of seaweeds. Some planktonic diatoms produce a potent toxin, **domoic acid,** which accumulates in shellfish and plankton-feeding fishes that eat the diatoms. The toxin causes a serious, sometimes fatal, illness of the nervous system in humans and marine mammals that eat contaminated shellfish or fish.

Diatoms are unicellular organisms that live mostly as part of the plankton. A silica shell is their most distinctive feature. They are important open-water primary producers in cold waters.

Diatoms reproduce mostly by cell division, a type of **asexual reproduction.** The overlapping halves of the frustule separate, and each secretes a new, smaller half. The smaller, lower frustule of the parent cell becomes the larger frustule of a daughter cell, which then secretes a new, smaller frustule (Fig. 5.7). Full size may be regained by the development of resistant stages known as **auxospores.** Auxospores eventually give rise to larger cells that display the frustule characteristic of the species.

Favorable environmental conditions, such as adequate nutrients and light, trigger periods of rapid reproduction called **blooms.** This is a general phenomenon that also occurs in other algae. During blooms most diatoms get progressively smaller, not only because of asexual reproduction but also as a result of depletion of silicate from the water by the growing population.

The glassy frustules of dead diatoms eventually settle to the bottom of the sea floor. Here they may form thick deposits of siliceous material that cover large portions of the ocean floor. Such **biogenous sediments** are known as **diatomaceous ooze,** a type of **siliceous ooze.** Huge fossil deposits of these sediments can be found inland in various parts of the world. The siliceous material, or **diatomaceous earth,** is mined and used in products such as filters for swimming pools, for clarifying beer, as temperature and sound insulators, and as mild abrasives in toothpaste.

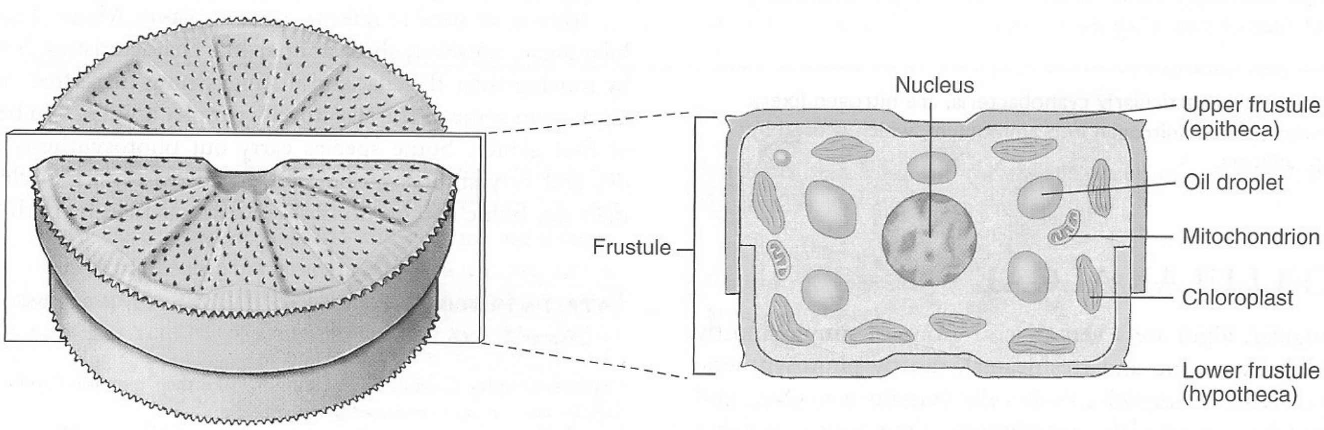

FIGURE 5.6 Diagrammatic representation of a diatom cell (also see Fig. 15.3).