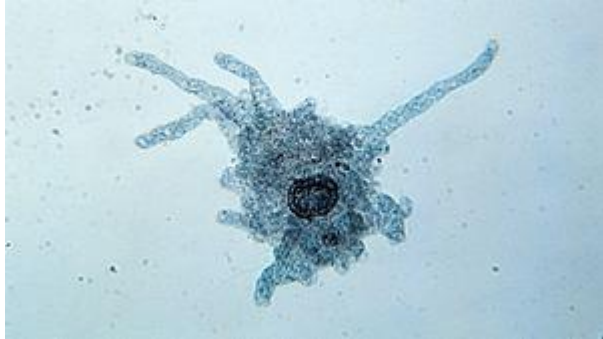


Protozoan, organism, usually single-celled and heterotrophic (using organic carbon as a source of energy), belonging to any of the major lineages of protists and, like most protists, typically microscopic. All protozoans are eukaryotes and therefore possess a “true,” or membrane-bound, nucleus. They also are nonfilamentous (in contrast to organisms such as molds, a group of fungi, which have filaments called hyphae) and are confined to moist or aquatic habitats, being ubiquitous in such environments worldwide, from the South Pole to the North Pole. Many are symbionts of other organisms, and some species are parasites.

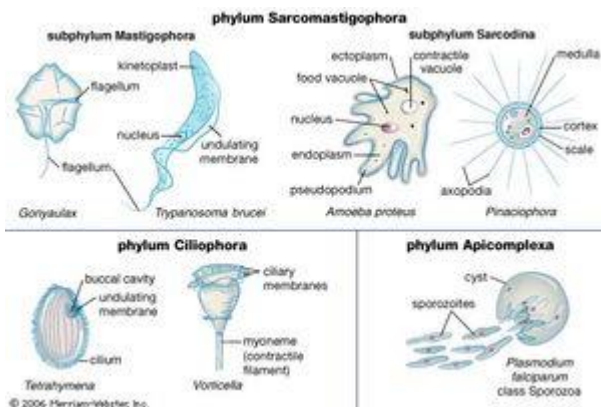


amoeba
Amoeba (magnified).

Modern ultrastructural, biochemical, and genetic evidence has rendered the term *protozoan* highly problematic. For example, *protozoan* historically referred to a protist that has animal-like traits, such as the ability to move through water as though “swimming” like an animal. Protozoans traditionally were thought to be the progenitors of modern animals, but contemporary evidence has revealed that this is not the case for most protozoans. In fact, modern science has shown that the protozoans represent a very complicated grouping of organisms that do not necessarily share a common evolutionary history. This unrelated, or paraphyletic, nature of the protozoans has caused scientists to abandon the term *protozoan* in formal classification schemes. Hence, the subkingdom Protozoa is now considered obsolete. Today the term *protozoan* is used informally in reference to nonfilamentous heterotrophic protists.

Commonly known protozoans include representative dinoflagellates, amoebas, paramecia, and the malaria-causing *Plasmodium*.

Features of protozoans



representative protozoans

Representative protozoans. The phytoflagellate *Gonyaulax* is one of the dinoflagellates responsible for the occurrence of red tides. The zooflagellate *Trypanosoma brucei* is the causative agent of African sleeping sickness. The amoeba is one of the most common sarcodines. Other members of the subphylum Sarcodina, such as the radiolarians, heliozoans, and foraminiferans, usually possess protective coverings. The heliozoan *Pinaciophora* is shown covered with scales. The phylum Ciliophora, which includes the ciliated *Tetrahymena* and *Vorticella*, contains the greatest number of protozoan species but is the most homogeneous group. The malaria-causing *Plasmodium* is spread by the bite of a mosquito that injects infective spores (sporozoites) into the bloodstream.(more)

Although protozoans are no longer recognized as a formal group in current biological classification systems, *protozoan* can still be useful as a strictly descriptive term. The protozoans are unified by their heterotrophic mode of nutrition, meaning that these organisms acquire carbon in reduced form from their surrounding environment. However, this is not a unique feature of protozoans.

Furthermore, this description is not as straightforward as it seems. For instance, many protists are mixotrophs, capable of both heterotrophy (secondary energy derivation through the consumption of other organisms) and autotrophy (primary energy derivation, such as through the capture of sunlight or metabolism of chemicals in the environment). Examples of protozoan mixotrophs include many chrysophytes. Some protozoans, such as *Paramecium bursaria*, have developed symbiotic relationships with eukaryotic algae, while the amoeba *Paulinella chromatophora* remarkably appears to have acquired autotrophy via relatively recent endosymbiosis of a cyanobacterium (a blue-green alga). Hence, many protozoans either perform photosynthesis themselves or benefit from the photosynthetic capabilities of other organisms. Some algal species of protozoans, however, have lost the ability to photosynthesize (e.g., *Polytomella* species and many dinoflagellates), further complicating the concept of “protozoan.”

The most important groups of free-living protozoans are found within several major evolutionary clusters of protists, including the ciliates (supergroup Chromalveolata), the lobose amoebae (supergroup Amoebozoa), the filose amoebae (supergroup Rhizaria), the cryptomonads (supergroup Chromalveolata), the excavates (supergroup Excavata), the opisthokonts (supergroup Opisthokonta), and the euglenids (Euglenozoa). These groups of organisms are important ecologically for their role in microbial nutrient cycles and are found in a wide variety of environments, from terrestrial soils to freshwater and marine habitats to aquatic sediments and sea ice. Significant protozoan parasites include representatives from Apicomplexa (supergroup Chromalveolata) and the trypanosomes (Euglenozoa). Organisms from these groups are the causative agents of human diseases such as malaria and African sleeping sickness. Owing to the prevalence of these human pathogens, and to the ecological importance of the free-living protozoan groups mentioned above, much is known about these groups. This article therefore concentrates on the biology of these comparatively well-characterized protozoans. At the end of this article is a summary of the contemporary protistan classification scheme.