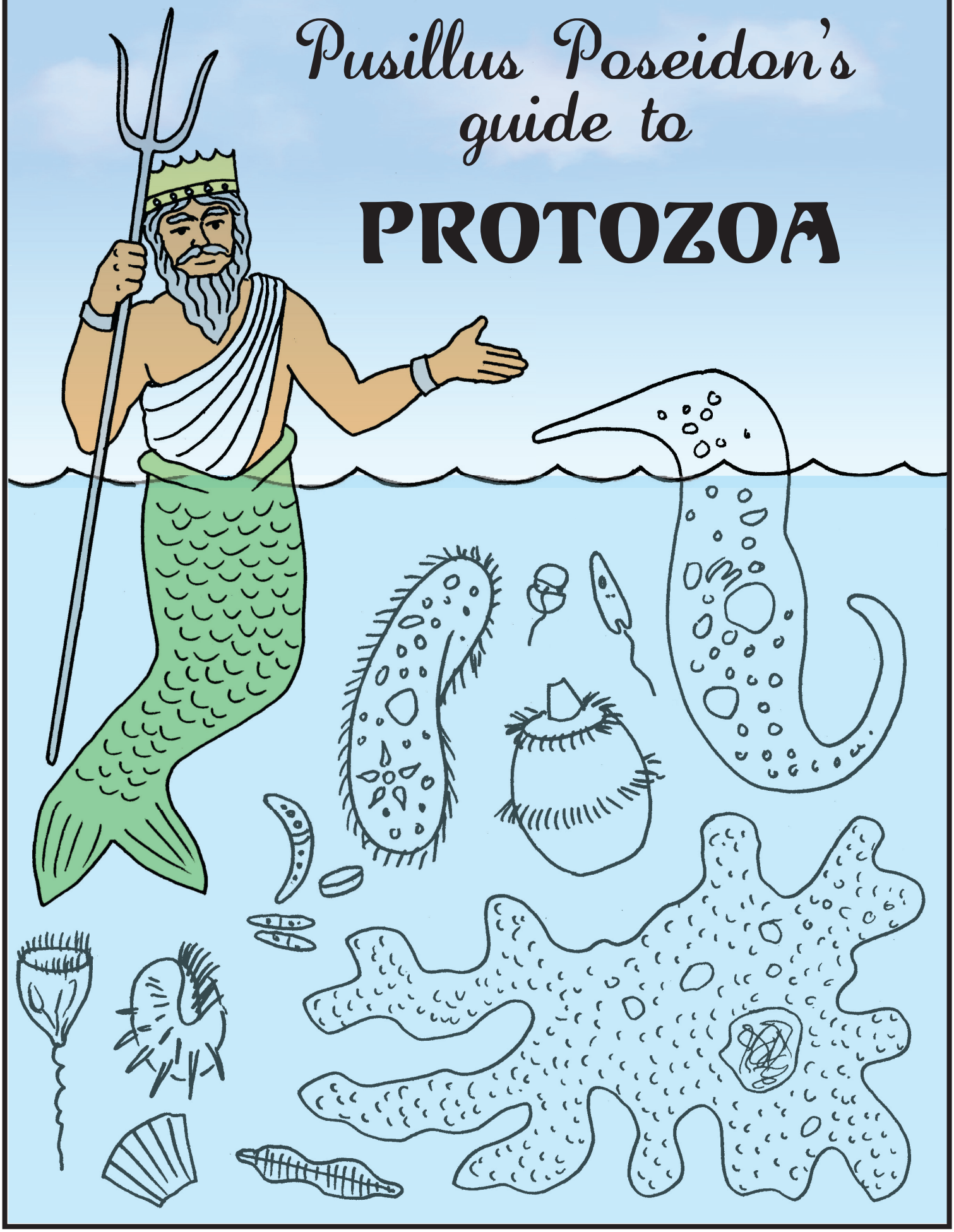
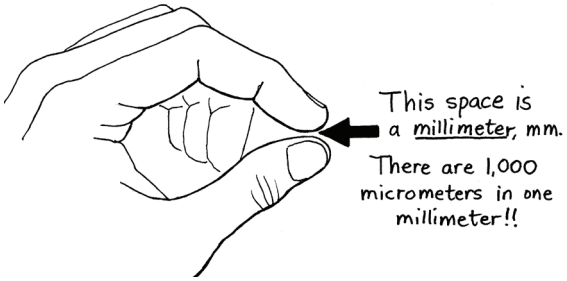
Pusillus Poseidon's guide to PROTOZOA



GENERAL NOTES ABOUT PROTOZOANS

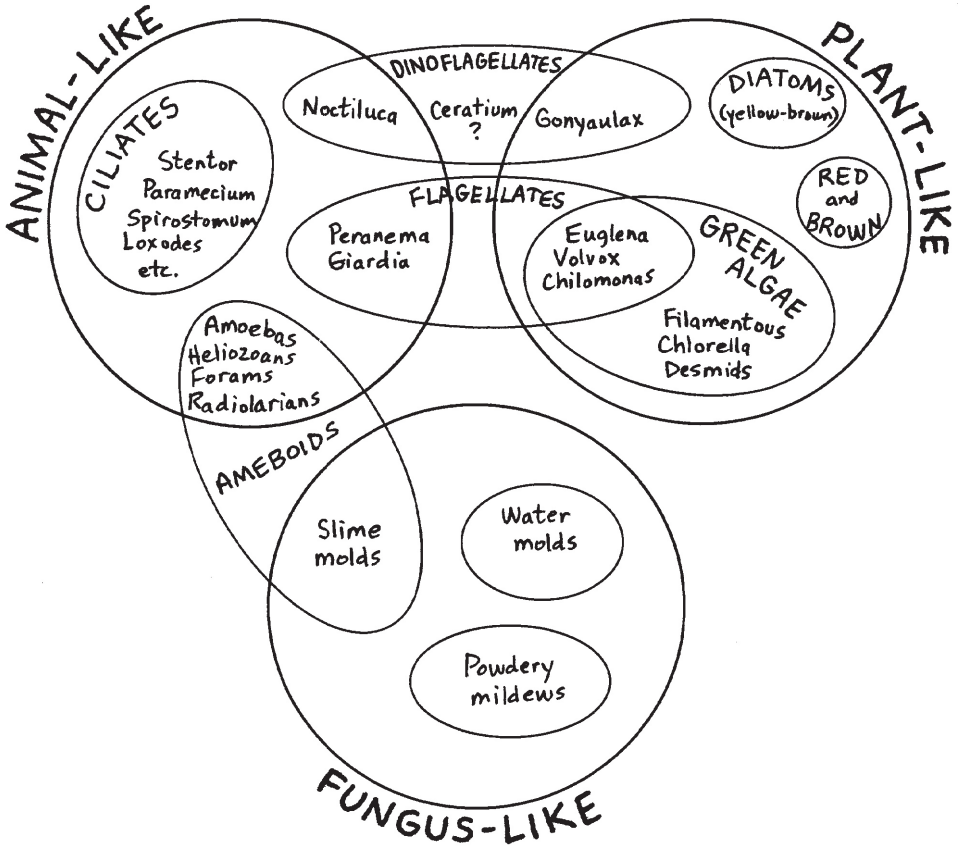
Protozoa are also called protists. The word “protist” is the more general term and includes all types of single-celled eukaryotes, whereas “protozoa” is more often used to describe the protists that are animal-like (as opposed to plant-like or fungi-like).

Protists are measured using units called microns. There are 1000 microns in one millimeter. A millimeter is the smallest unit on a metric ruler and can be estimated with your fingers:

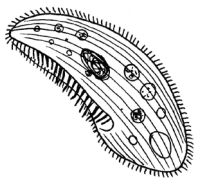
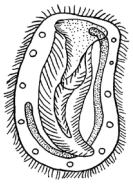
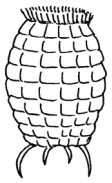
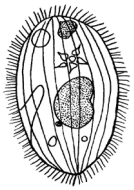
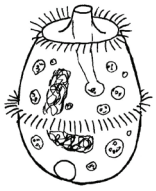
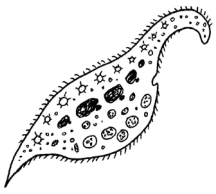
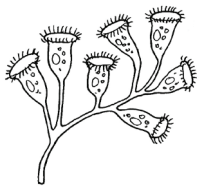
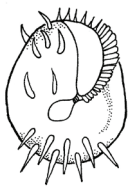


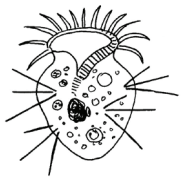
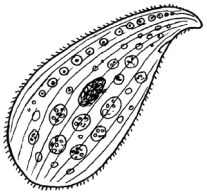
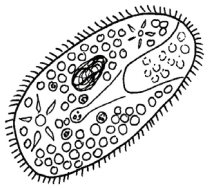
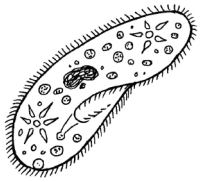
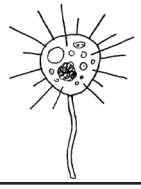
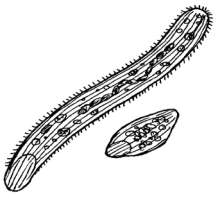
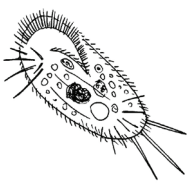
The traditional way of classifying protists is by the way they look (morphology), by the way they move (motility), and how and what they eat. This gives us terms such as ciliates, flagellates, ameboids, and all those colors of algae. Recently, the classification system has been overhauled and has become immensely complicated. (Information about DNA is now the primary consideration for classification, rather than how a creature looks or acts.) If you research these creatures on Wikipedia, you will see this new system being used. Bear in mind, however, that the categories are constantly shifting as we learn more and more about protist DNA.

Here is a visual overview that might help you understand the wide range of similarities and differences. Some organisms fit into more than one category and some don’t fit well into any category. Always remember that classification is an artificial construct made by humans. The organisms don’t know anything about it and they don’t care what we think!

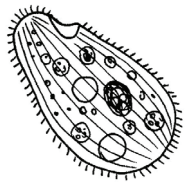


CILIATES

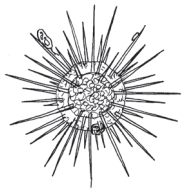
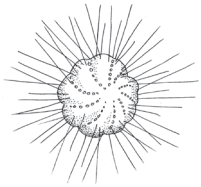
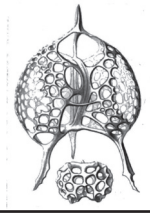
	***Blepharisma*** 150-200 µm	Eats anything smaller than itself, even smaller *Blepharismas.* (Cannibalism causes them to double their normal size. The reason for this is unknown.)	*Blepharisma* looks slightly pink because it makes a red pigment that senses light (similar to the pigment in *Euglena*'s red eye spot). *Blepharisma* hides from light. The cilia are much longer on one side, as you can tell from the picture.
	***Bursaria*** 500-800 µm	Eats smaller ciliates, and particularly enjoys eating the *Paramecium* species *Paramecium bursaria*.	Has a huge gullet opening, large enough to swallow *Paramecia*. When environmental conditions are bad, *Bursaria* can form a tough cyst and "hibernate" in this form until conditions are good again.
	***Coleps*** 50-80 µm	Will try to eat just about anything. Is equipped with trichocyst darts that it can use to paralyze prey. Will take "bites" out of large prey (even ostracods).	Has armor plates made of calcium carbonate, the same material that clam shells are made of. Has thick barbs at one end.
	***Colpidium*** 50-70 µm	Eats bacteria.	Can reproduce by binary fission every 4-6 hours. Often used for experiments in labs. *Colpidium* can survive in polluted water so the presence of many *Colpidium* might indicate poor water quality.
	***Didinium*** 100-200 µm	Eats other ciliates, especially *Paramecia*. (*Didinia* can digest 2 *Paramecia* per hour.)	*Didinia* have trichocysts to help it capture prey. Like *Blepharisma*, a *Didinium* can "hibernate" by making itself into a cyst (a tough little lump that will not dry out).
	***Dileptus*** 200-400 µm	Eats other ciliates and also rotifers.	*Dileptus* has a proboscis lined with toxins. It can stun its prey by hitting it with the proboscis. The mouth of a *Diletpus* is located at the base of the proboscis.
	***Epistylis*** 50-150 µm	Eats small particles and bacteria that it sweeps in with its top ring of cilia.	Lives in colonies. It might look like *Vorticella*, but *Epistylis* can't spring up and down because it does not have myonemes, the fibers that act like muscles. *Epistlylis* doesn't move much. Colonies are often attached to plants, shells or insects.
	***Euplotes*** 80-100 µm	Eats anything smaller than itself.	Euplotes has long cirri on its "bottom" end, which it can use not only for swimming but for walking along surfaces.

	***Halteria*** 25-50 µm	Eats bacteria, algae and tiny protists.	Halteria looks like it is jumping around as it moves. This jumping motion is caused by the groups of long cilia on the middle of its body.
	***Loxodes*** 700 µm	Eats bacteria, algae and small protists.	*Loxodes* is known for its ability to sense which way is "up." This ability comes from the "Müller body" structures along its dorsal (back) side. (The Müller bodies contain a crystal of barium sulfate.) *Loxodes* has a rostrum (beak-like structure).
	***Paramecium bursaria*** 100-200 µm	Eats mostly bacteria and algae, but also gets some nutrition from the algae that live in its cytoplasm as endo-symbionts.	*Paramecium bursaria* is the only species of paramecium that has a symbiotic relationship with algae. It takes in *Zoöchlorella* algae cells that then live in its cytoplasm, doing photosynthesis. Both organisms benefit from the sugars the algae makes.
	***Paramecium caudatum*** 200-250 µm	Eats bacteria, algae and small protists.	*Paramecia* have weapons called trichocysts that function like tiny harpoons. The darts contain a toxin that can stun or partially paralyze attackers or prey.
	***Podophyra*** 10-30 µm	Sucks cytoplasm out of other protists, especially ciliates.	The "hairs" sticking out are actually sucking tentacles that can suck cytoplasm out the ciliates it preys upon. Often, *Podophrya* will not take all the cytoplasm and will release the ciliate alive. *Podophrya* is sessile (does not swim).
	***Spirostomum*** 800-1000 µm	Eats bacteria, single-cell algae and tiny bits of debris. The mouth is very small.	When startled, *Spirostomum* contracts quickly to less than half its length. The contraction is caused by myonemes, fibers that act like muscles. This contraction is the fastest cell movement in the world, as far as we know. (*Vorticella* does it, too.)
	***Stentor*** 500-2000 µm	Eats anything it can sweep into its gullet.	The ring of cilia on the top moves to create a current that will bring food particles in toward the gullet opening (mouth). *Stentor* can attach itself to a surface, or it can swim around freely. They often look green, due to symbiotic algae living inside them.
	***Stylonychia*** 150 µm	Eats anything smaller than itself.	One of the most common ciliates, as common as *Paramecium*. The long, thick, cirri help it to move along surfaces, similar to the way *Euplotes* moves.

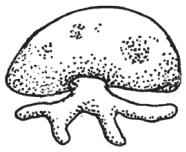
CILIATES, continued

	***Tetrahymena*** 40-80 µm	Eats bacteria and tiny particles.	This is one of the most studied ciliates. It is commonly used in labs to do genetics studies and physiology experiments because it is easy to grow and won't die easily.
	***Vorticella*** 50-150 µm	Eats anything small enough to get swept into its gullet by the ring of cilia.	Feeds in a manner similar to *Stentor*. When startled, it contracts its stalk. The stalk contains myonemes that act like muscles fibers (similar to those you find in *Spirostomum*). *Vorticella* like to live in groups, but they <u>don't</u> actually connect like *Epistylis*.

AMEBOIDS

	***Amoeba proteus*** 300-600 µm	Eats anything it can catch.	Feeds by using pseudopods, which are long extensions that it "oozes" out. The pseudopods close around the food, creating a vacuole that it brings inside. The ameba has no definite shape and changes all the time. Its name means "changeable changer."
	***Entamoeba histolytica*** (hist-o-LIT-i-cah) l5-60 µm	Lives inside the intestines of humans and other mammals. Eats bacteria and small food particles.	One of the most common parasites in the world. Infections can be so mild that people are even unaware they have it. Symptoms include diarrhea, weight loss and fatigue. The parasite is most often contracted by drinking dirty water.
	**Heliozoan** 200-300 µm	Eats anything it can catch with its long axopods. (Prey is usually small.)	When first discovered, they were called "sun animacules" because they looked so much like a little sun with rays shining out. Their axopods are used not only for capturing food but also for sensing the environment and for attachment to surfaces.
	**Foraminiferan** l00-1000 µm	Eats anything it can capture with its long axopods. (Prey is usually small.)	Foraminiferans (or "forams") make shells out of calcium carbonate, the way clams do. There are thousands of different kinds of forams, some large enough to see without a microscope. Some species live in the deepest part of the ocean (the Mariana Trench).
	**Radiolarian** l50-300 µm	Eats anything it can capture with its pseuodopods and and/or axopods (depending on species). Prey is usually small. Some speciers have dinoflagellates living inside.	Radiolarians can take the element silicon out of the water and use it to make complex "skeletons" made of silicon dioxide (glass). There is a thin layer of cytoplasm that flows around the outside of the glass skeleton. Radiolarians come in many different shapes.

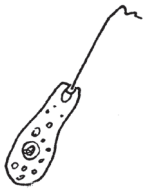
AMEBOIDS, continued

	***Arcella*** (Ar-SELL-ah) 30-100 µm	Eats anything it can catch with its pseudopods, usually diatoms, algae, and tiny protists.	*Arcella* is a shelled ameba. The shell is called a "test" and is made out of a protein called chitin.
	***Difflugia*** (Dif-FLU-gee-ah) 100-150 µm	Eats anything it can catch with its pseudopods	This is a shelled ameba. Makes a shell ("test") out of grains of sand and tiny bits of debris and dirt.
	***Fuligo*** (yellow slime mold) Colonies can be the size of a plate.	In its cellular form, the individual amebas eat mostly bacteria. In its "slug" from, it gobbles any small organic particles in its path.	*Fuligo septica* is a bright yellow slime mold. In its "slug" form (millions of individuals all joined together) it can slowly creep along.
	***Physarum*** (Fi-SARE-um) Colonies can be the size of a plate.	Eats bacteria, fungal spores, and other microorganisms.	Physarum is a large group of slime molds, with many different species. They are found in cool, moist places like damp forests that have many decaying logs.

SINGLE-CELL FLAGELLATED GREEN PROTISTS

	***Chilomonas*** 20-40 µm	Uses sunlight for photosynthesis.	*Chilomonas* is a very common algae, found in fresh water and ocean water. *Chilomonas* is a member of the "cryptomonads" group, who have special structures near the flagella that allow them to jet away from irritants very quickly.
	***Chlamydomonas*** 10-30 µm	Uses sunlight for photosynthesis.	*Chlamydomonas* is found in many places including fresh water, ocean water and in damp soils. Chloroplast is bowl-shaped.
	***Phacus*** 40 µm .	Uses sunlight for photosynthesis.	Is flat and leaf-shaped. Has small chloroplasts (unlike Chilomonas and Chlamydomonas which have a very large one). Found in fresh water ponds. Has a red eye spot.

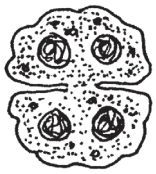
SINGLE-CELL FLAGELLATED PROTISTS (not necessarily green)

	***Euglena gracilis*** 100-200 µm	Can make its own food using photosynthesis. However, if conditions are poor for photosynthesis, it can also catch and eat bacteria and small protists.	Has a red eye spot that helps it go toward sunlight. The red spot itself does not detect light, but filters light onto a light sensitive spot. The end of the body with the flagella can also engulf prey and bring it inside. This species is often used in laboratories.
	***Euglena acus*** 50-175 µm	Can make its own food using photosynthesis. However, if conditions are poor for photosynthesis, it can also catch and eat bacteria and small protists.	*Euglena* do not have a cell wall like algae do. They have a flexible pellicle. *Euglena* are very nutritious and can be used as a powdered food supplement.
	***Peranema*** 20-70 µm	Eats bacteria, algae and small protists. (It captures and eats its prey in a manner similar to *Euglena*.)	Though it is similar to *Euglena* in some ways, *Peranema* does not have chloroplasts and can't do photosynthesis. It is easy to identify because it keeps its flagella very straight and only wiggles the very end.

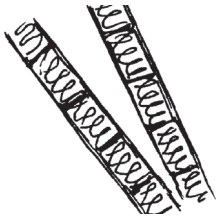
SINGLE-CELL GREEN PROTISTS

	***Chlorella*** 5-10 µm	Uses sunlight for photosynthesis.	Is one of the smallest but most common types of algae. Can be found anywhere there is moisture, even on damp trees and rocks. It is very nutritious and is used as a powdered food supplement.

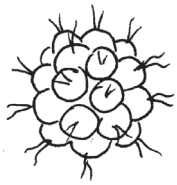
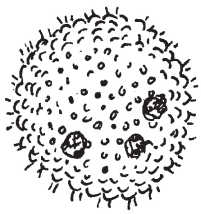
DESMIDS (single-cell green protists that look like diatoms but are actually green algae)

	***Closterium*** 100-400 µm	Uses sunlight for photosynthesis.	Has a vacuole at each end. (The lines of dots are not vacuoles but are involved in photosynthesis.) Movement is restricted to slowly pivoting, by pushing fluid out of pores (similar to diatom movement). It usually green or yellowish-green.
	***Cosmarium*** 30-70 µm	Uses sunlight for photosynthesis..	Looks like two cells, but is actually just one cell with two halves. The narrow middle part is often called the isthmus. Other species of desmids have more intricate shapes.

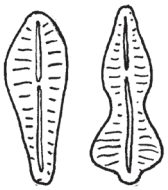
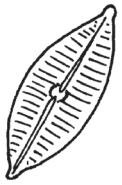
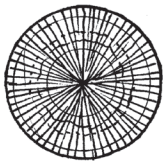
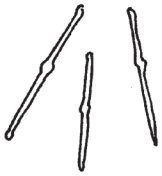
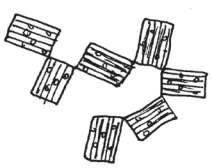
FILAMENTOUS GREEN PROTISTS

	***Oedogonium*** (Oh-do-GO-nee-um) 10-20 µm wide	Uses sunlight for photosynthesis.	Specialized Oedogonium cells swell up and produced an egg. Other cells make sperm. The eggs and sperm fuse to form zygotes.
	***Spirogyra*** 35-45 µm wide	Uses sunlight for photosynthesis.	Known for its spiral-shaped chloroplasts. The nucleus is suspended in the middle of the cell. In ponds, mats of green scum are often made of Spirogyra.
	***Vaucheria*** (Vow-chair-ee-ah) 40 µm wide	Uses sunlight for photosynthesis.	Life cycle is similar to Oedogonium. Very large bumps are clearly visible when viewed under the microscope.
	***Zygnema*** 20-70 µm wide	Uses sunlight for photosynthesis.	Chloroplasts are star-shaped. Life cycle is similar to Spirogyra.

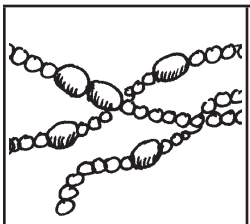
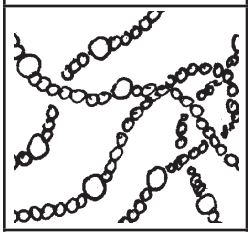
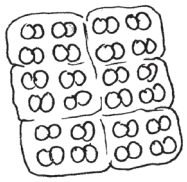
COLONIAL GREEN PROTISTS that live in spherical colonies

	***Gonium*** (Colonies can be up to100 µm.)	Uses sunlight for photosynthesis.	Colonies stay small, only 4-16 cells. The colony is flat (unlike *Volvox*). A thick gel keeps the cells together. Colonies can reproduce by splitting in half, or some cells can specialize to make eggs and sperm that will form a zygote to start a new colony.
	***Pandorina*** (Colonies can be 50-250 µm.)	Uses sunlight for photosynthesis.	Colonies stay fairly small, usually no more than about 32 cells. Each cell has two flagella and an eye spot for detecting light. Colonies can split in half to form a new colony, but can also use sexual reproduction with eggs and sperm.
	***Volvox*** (Colonies can be up to 1000 µm.)	Uses sunlight for photosynthesis.	*Volvox* colonies can grow very large, with hundreds of cells. The colony forms a sphere. Each cell has two flagella and the cells cooperate to move the colony around. Some cells specialize to make eggs or sperm.

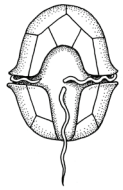
DIATOMS (yellow-brown protists) Note: They can do photosynthesis even though they are not green.

	***Asterionella*** Each cell is 40-80 µm long	Uses sunlight for photosynthesis.	Their name means “little star.” Each arm of the star is one cell, and they are all joined at the center. Colonies consist of 8-20 cells.
	***Fragilaria*** Each cell is 40-60 µm long (width of colony)	Uses sunlight for photosynthesis.	Cells are joined in the middle to form long colonies that look like a row of books on a shelf. There are many different kinds of *Fragilaria*, living in both fresh water and ocean water.
	***Gomphonema*** 20-80 µm	Uses sunlight for photosynthesis.	Has H-shaped chloroplast. Can tolerate water rich is nitrates and phosphates (considered to be pollution), so the presence of many *Gomphonema* might be an indication that the water is becoming polluted.
	***Meridon*** Each cell is 40-50 µm long (width of colony)	Uses sunlight for photosynthesis.	To the naked eye, *Meridon* would look like a brown scum on the bottom of a ditch or puddle. *Meridon* is often found in water that contains many cyanobacteria.
	***Navicula*** 100-200 µm	Uses sunlight for photosynthesis.	The name means “small boat.” You can see that the shape resembles the hull of a boat. There are over 1,000 different species of *Navicula* diatoms.
	***Stephanodiscus*** 60-70 µm dia.	Uses sunlight for photosynthesis.	Very common. Found floating freely, not attached to anything. The view here is from the top. The actual shape is a very short cylinder, like a petri dish used in a lab. Sometimes they look like they have little threads hanging of the edges.
	***Synedra*** 100-120 µm	Uses sunlight for photosynthesis.	These diatoms are similar to *Fragilaria* except that they do not join together to form colonies.
	***Tabellaria*** Each cell is 40-50 µm long.	Uses sunlight for photosynthesis.	The name means “little tablets.” A small group of cells makes a tablet, then these tablets stay joined at one corner. Often sticks to plants or rocks, and does not mind slightly acidic water.

CYANOBACTERIA (do photosynthesis, fix nitrogen, and used to be called blue-green aglae)

	***Anabaena*** (An-ah-BANE-ah) Filaments are 8-10 µm wide.	Uses sunlight for photosynthesis.	Not only can this bacteria do photosynthesis, it can also "fix" nitrogen, which makes it important for nearby plant life. (Those circles are where the nitrogen is processed.) Unfortunately, it also makes a toxic chemical that is harmful to people and animals.
	***Nostoc*** Filaments are 5-10 µm wide.	Uses sunlight for photosynthesis.	This species looks very much like *Anabaena*, and is a member of the same family. However, *Nostoc* can grow colonies so large they can be seen without magnification. The colonies look like leaves and hollow berries lying on the ground.
	***Merismopedia*** Cells are 1-3 µm.	Uses sunlight for photosynthesis.	These bacteria are found in both fresh water and salty water. They produce mild toxins that can irritate skin. The cells reproduce in such a way that they form flat sheets held together by a gelatinous substance.
	***Gloeocapsa*** (Glo-ee-o-cap-sa) Cells are 10 µm	Uses sunlight for photosynthesis.	The name means "glue box." This bacteria is responsible for all those black streak stains you see on shingled roofs. The bacteria feed on the limestone that is used to make fiberglass shingles. The black color is the bacteria's protection against UV rays.

DINOFLAGELATES

	***Ceratium*** (Sare-ah-SHE-um) 100-500 µm	Can do photosynthesis or capture small particles of food (similar to Euglena).	Found in both fresh water and ocean water. They have two flagella but move slowly because of their long "arms." They can reproduce quickly to form "blooms" but are not nearly as toxic as other species of dinoflagellates.
	***Gonyaulax*** *(Go-nee-ALL-ax)* 30-50 µm	Uses sunlight for photosynthesis.	Mostly found in ocean, with only a few fresh water species. These are the nasties that cause the toxic red tides. Their toxins can accumulate in ocean animals, causing humans to get sick if they eat them. The name means "knee with a furrow/rut."
	***Noctiluca*** 200-2000 µm	Eats anything it can catch, including bacteria, diatoms, small protists, fish eggs and other dinoflagellates.	Many dinoflagellates glow in the dark to some degree, but this is the one that is famous for it. *Noctiluca* means "night light." The thing that looks like a flagella is actually a tentacle used for feeding. It does have a flagella but it is hard to see.