# THE PROTISTA KINGDOM

**Phylum Caryoblastea**

These are the most primitive of protists, with a membrane around the nucleus but no endoplasmic reticulum, Golgi bodies, mitochondria, chromosomes, or centrioles. To reproduce, the nuclei divide directly into two nuclei with new membranes, as in bacteria. There is no sexual reproduction.

The phylum contains one organism, Pelomyxa palustris, which has a nonfunctioning flagellum with nine-fold symmetry and resembles a giant amoeba. It lives in the mud on the bottom of fresh-water ponds in Europe, the United States, and North Africa. It feeds on algae and bacteria. It survives on a lower concentration of oxygen that other eukaryotes.

It contains three kinds of symbiotic bacteria, two of which produce methane rather than carbon dioxide. One bacteria forms a ring around the nucleus. The other two are in the cytoplasm. These bacteria are necessary for the survival of the organism. If it is treated with antibiotics to kill the bacteria, lactic acid and other metabolites accumulate in the Pelomyxa and it dies. Therefore, it is thought that the bacteria remove this lactic acid and other metabolites from Pelomyxa. It does have vacuoles that store glycogen just like many animals.

This organism is probably not the ancestor of other protists. The absence of mitosis and its symbionts that produce methane make it a unique organism.

Greek: karyon - nucleus or kernel blastos - bud or sprout

**Phylum Sarcodina (Rhizopoda)**

The organisms in this phylum are microscopic, single-celled amoebas. Some have shells called **tests** and others are naked. They live in marine and freshwater environments, and soil and some are parasites in animals. They reproduce by simple **cell division** into two organisms with the same volume.

They have no flagellum, centrioles, or kinetosomes (organelle that forms the flagellum), no sexual reproduction and no meiosis. Some species do have chromosomes and perform mitosis, the nuclear division where the chromosomes divide into two identical sets, one for each new cell.

The amoebas move by the use of **pseudopodia** or false feet, that are extensions of cytoplasm that flow to move the amoeba forward or to surround food particles for absorption. The formation of pseudopodia is apparently sensitive to the amount of the calcium ion present in the water.

Class Tubulina contains amoebas that are cylindrical, naked amoebas with a single nucleus. The family Amoebidae, including Amoeba proteus, form many pseudopodia at a time (**polypodial**). The family Hartmannellidae form one pseudopodium at a time (**monopodial**) and also form desiccation-resistant cysts during times of drought. These cysts have two nuclei. The family Entamoebidae are mostly parasites and are monopodial. The nucleolus contains the beginnings of ribosomes called endosomes, the first phylum to contain **endosomes**. They also form cysts that are resistant to digestion by the host animals they live inside, making them very difficult to eliminate. Within the cysts, the nucleus divides into up to eight nuclei which then germinate in the digestive tracts of the animals or are passed out into the feces. Entamoeba histolytica is an organism that causes amoebic dysentery.

**Phylum Actinopoda (Sarcodina)**

The actinopods are heterotrophic organisms that obtain carbon and energy from organic compounds. They have long, slender **axopoda** made of cytoplasm that are stiffened with elaborate bundles of microtubules called **axonemes** that are characteristic of each group of actinopods.

Class Acantharia are spherical marine plankton. Their skeleton is radially symmetrical and composed of rods of crystalline strontium sulfate formed into 20 or more radial spines called **spicules**. These spicules radiate in precise positions from the center of the cell. The spicules do vary in length and thickness.

The cell is made of distinct layers. The **central capsule** of the cell is the innermost layer with many small nuclei. Surrounding the central capsule are perforated, flimsy interconnecting microfilaments called the **central capsule membrane**. Through the perforations, the central capsule extends the **spicules**, **reticulopoda** (pseudopodia), **filopoda** (very thin pseudopodia), and **axopoda**. There are usually 54 axopoda, but there may be several hundred. The **cortex** is the thin, flexible outside layer of microfilaments, often arranged in intricate designs, and underlain by interconnecting reticulopoda. Filaments called **myonemes** control the tension of the cortex and bind it to the spicules that protrude through the cortex.

The axopoda greatly increase the surface area of the acantharian, slowing the sinking process and allowing for more efficient feeding of their prey, protists and zooplankton, that stick to the axopoda. They feed by engulfing their prey with cytoplasm from the axopoda. The cytoplasm then flows down the axopoda to the inner part of the cell where the food is digested.

They reproduce asexually by producing many small swarmer cells with two flagella, one directed forward and the other trailing, that originate in the kinetosomes of the cell. Each cell also contains a drop of oil and a crystal.

Most acantharians contain symbiotic haptophytes in their cells. The grass green haptophytes photosynthesize, providing energy and food for the acantharian. The acantharian provides nitrogen and phosphorus for the haptophyte.

Class Polycystina or **radiolarians** live in tropical marine environments and have beautiful skeletons of hydrated amorphous silica (opal). The skeleton is solid with very tiny canals and pores. Some have crystals of strontium sulfate in their endoplasm and probably all have these crystals in their swarmer cells. The **central capsule membrane** is made of massive organic material, arranged in side by side plates separated by narrow slits. It can grow larger in size during its life cycle. Many of these organisms have symbiotic zooxanthellae (yellow algae) or zoochlorellae (green algae). There is one large nucleus. The shape of the cell is spherical, ellipsoidal, or flattened. Some form large colonies of hundreds of cells embedded in a shared mass of jelly.

Class Phaeodaria or **radiolarians** also live in tropical marine environments and have beautiful skeletons made of hydrated amorphous silica (opal) and large quantities of unknown organic substances. The skeleton is hollow with tubular spines and a bubbly structure. There is no strontium sulfate in the cell structure. The **central capsule membrane** is made of massive organic material, in the form of a single continuous structure. It cannot grow larger; it can only thicken its wall. There are no symbiotic algae. There is only one large nucleus. During cell division, each new cell may have more than 1000 chromosomes.

Class Heliozoa are part of the plankton in mostly fresh water environments, although some live in marine, estuary, and benthos environments. Many catch their prey with their axopoda, which radiate out into the water. The axopoda are surrounded by the plasma membrane. One heliozoan, Sticholonche, actually rows with microtubular oars as it moves through the water.

Surface scales or spines made of silica or organic material are present in many heliozoans. Some structures resemble cages with bars arranged in a hexagonal pattern through which the axopoda protrude.

Reproduction is asexual by binary or multiple fission or budding. There are no zoospores or swarmer cells. Some heliozoans self-fertilize.

Greek: actinos - ray pous - foot

**Phylum Foraminifera (Sarcodina)**

The **forams** live only in marine environments, living in the sand or attached to algae, rocks, or other organisms, or swimming free. They are microscopic to several centimeters in diameter. Their shells (**tests**) are full of pores and composed of organic materials and minerals such as calcium carbonate or sand grains. Some use the plates of echinoderms or sponge spicules to make their tests. They may be salmon, red, or yellow-brown in color.

Some forams have a single chamber in the test, but most have many chambers of partial spheres.

The pores in the test allow the thin cytoplasm projections called **podia**, to emerge for swimming, gathering materials to make the tests, or feeding. They eat algae, ciliates, actinopods, nematodes, and larvae of crustaceans. Many forams have photosynthetic symbionts such as dinomastigotes, chrysophytes, and diatoms.

Some forams (Textularia) reproduce asexually by budding into several young. Mosthave a very complex life cycle.

The forams have been in the fossil record for some time, but were especially abundant during the Triassic Period, 230 million years ago. The resulting limestone contained fossils of some very large forams: Lepidocyclina elephantina had shells 1.5 cm thick; Camerina laevigata or Nummulites was 10 cm wide. Some of this limestone was used to build the pyramids in Egypt. Forams have been used by geologists as **stratigraphic markers** and as an indicator of possible petroleum deposits.

Latin: foramen - little hole, perforation ferre - to bear

**Phylum Ciliophora**

The **ciliates** are **phagotrophic**, organisms that ingest food particles bacteria-sized and larger, or osmotrophic, organisms that obtain molecule-sized nutrients by absorption across membranes. They move by means of **cilia**, which are short, moveable, whip-like extensions embedded in the outer protein layer of the cortex of the cell. They have two different nuclei, the macronucleus (larger) and micronucleus (smaller), often several in each cell. They live in marine and fresh water environments, feeding on bacteria or water rich in dissolved nutrients. There are about 8000 species, almost exclusively single-celled. Sorogena is an exception that has a many-celled stalk made from aggregates of cells.

Cilia are shorter and more numerous than flagella. They are often modified for locomotion and feeding functions. The cilia may be grouped into bundles, or sheets, that function as mouths, paddles, or teeth.

The **micronucleus** contains the chromosomes and divides by mitosis. The **macronucleus**, which develops from a micronucleus, has its DNA in many little chromatin bodies, each of which contains hundreds or thousands of one or two genes. They are necessary for growth and reproduction. To divide, the macronucleus elongates and constricts. The macronucleus participates in routine cellular functions, such as the production of RNA for protein synthesis.

Reproduction is usually by **transverse binary fission**; the cell divides across the short axis to form two new cells equal in size. Other ciliates reproduce by **asexual budding.**

Sexual reproduction is by means of **conjugation**. Two different cells attach to each other for up to many hours and exchange some of their micronuclei. The nuclei fuse, divide, and some disintegrate until the micronuclei of the two cells are identical.

Subphylum Postciliodesmatophora are hairy or filamentous. Stentor, Gastrostyla, and the tintinnids are examples. The tintinnids are the only ciliates that form shell-like structures from sand and organic cements. They are marine and have been known in the fossil record since the Cretaceous Period, about 100 million years ago. There are two classes: Karyorelictea, and Spirotrichea.

Subphylum Rhabdophora have short flagella. There are two classes: Prostomea and Litostomea. Some of the Litostomea live as **symbionts** in the rumen of mammals.

Ciliates are easily studied by scientists because they have rapid and controllable growth rates, and are easy to handle. Only one ciliate, Balantidium, is a parasite in the human gut. They are of no economic importance.

Latin: cilium - eyelash or the lower eyelid

Greek: phorein - to bear

**Phylum Apicomplexa (Sporozoa)**

The apicomplexans are **heterotrophic** microbes, organisms that obtain carbon and energy from organic compounds. They all form spores that infect their hosts and allow their dissemination and transmission from host to host. All are parasites in animals.

There are two classes: Sporozoasida and Piroplasmasida.

They undergo **sexual reproduction**. The male gamete (microgamete) is smaller with one flagellum. It fertilizes the larger female gamete (macrogamete), forming the zygote and then the thick-walled **oocyst**. This desiccation-, heat-, and radiation-resistant cyst is the method of transport from host to host. The cyst undergoes rapid divisions, to produce **sporozoites**, infective spores.

Many apicomplexans have very complicated life cycles with several different species of hosts, vertebrate and invertebrate. Many live in the bloodstream of their hosts. Only two, Isospora hominis, and Plasmodium are parasites of man. Plasmodium is transmitted to humans by the female Anopheles mosquito and causes malaria. The Plasmodium undergoes fertilization in the gut of the mosquito, the zygote embeds itself in the gut wall, and becomes an oocyst. The oocyst forms sporozoites that migrate to the salivary glands of the mosquito. When the mosquito bites the human, the sporozoites enter the bloodstream and attack the red blood cells, removing the iron. The sporozoites continue to change and reproduce, and escape from the ruined blood cells into the bloodstream. They attack more red blood cells and continue to reproduce. This cycle continues over and over, until the gametes are formed. The human must then be bitten by another mosquito for the Plasmodium to finish its life cycle by fertilization. The periodic attacks of malarial fever are caused by the formation and release of successive generations of these spores.

Many infect the digestive tracts of livestock and fowl, causing diarrhea and dysentery. Infection begins when the oocyst is eaten by an animal. The oocyst germinates, producing sporozoites that enter the epithelial cells, especially the gut lining, where they multiply. They escape to infect more host cells, developing into infective spores. This cycle is repeated several times. Finally, some of these spores develop into male gametes and female gametes that undergo fertilization within the host cells and produce zygotes. The zygotes develop into oocysts, are passed out of the host's body in the feces, and stay in the soil until eaten by another host animal.

Latin: apex - summit complexus - an embrace, enfolding

**Phylum Cnidosporidia**

The cnidosporidians are **heterotrophic** microbes, organisms that obtain carbon and energy from organic compounds. All are parasites in animals. The spores are not infective, but a resting stage for safe dissemination.

Class Microsporida are parasites in the cells of animals, often vertebrates. The spore is thick-walled and made of chitin. It contains the polar filament and the infective body called the **sporoplasm**. The polar filament forms a narrow hollow tube which it forces into the host cell. The sporoplasm squeezes through this tube into the host cell and infects it. Many form large, single-celled tumors in their hosts. Some cause no harm, while others are severe pathogens. Glugea and Ichthyosporidium form tumors on fish; Encephalitazoan are parasites in warm-blooded vertebrates; Nosema causes a devastating disease of silkworm larvae.

Sexual life cycles have not been well documented. They have no mitochondria and some have small ribosomes like prokaryotes. They do reproduce asexually by single or multiple fission inside the host cell. The spores are multicelluar with one or two nuclei per cell. The nuclei fuse, forming zygotes, that form spores with filaments.

Class Myxosporida are parasites of fish and invertebrates, causing serious diseases. The polar filaments of the spores have cnidocysts that anchor the spores to the host cell. The sporoplasm squeezes into the host cell to feed.

The organisms are able to penetrate the skin on almost any part of the host's body and travel to the intestine where they release amoeboid cells called **amoebulinas**. The amoebulinas penetrate the host tissues, enter the blood stream, and travel to target organs, especially the hollow organs such as the urinary and gall bladders. They also infest the gills, muscles, intestines, liver, brain, bone, and skin, causing large, unsightly growths. Examples are Myxobolus pfeifferi which causes boil disease of the European barbel and Myxostoma cerebralis which forms tumors in the cartilage of salmon and exerts pressure on the central nervous system.

There is a possibility that these organisms developed from the cnidarians because of the similarity between the cnidocysts and the nematocysts of the cnidarians. Their morphology, developmental pattern, and function are the same.

Class Actinomyxida are parasites of invertebrates, especially annelids. They form cnidocysts that produce the filaments. The spores have large hooks that they use to attach themselves to their host. Sphaeractinomyxon gigas lives in the worm Limnodrilus and is 40 μm long. Triactinomyxon lives in the gut of Tubifex worms.

Greek: knide - filament, nettle Latin: spora - spore

**Phylum Zoomastigina**

Most of the zoomastigotes are single-celled and have one to thousands of flagella. They are either free-living or parasites. None have plastids and all are **heterotrophs** (organisms that obtain carbon and energy from organic compounds). Some are **osmotroph**s, organisms that obtain nutrients by absorption. Others are **phagotrophs**, organisms that ingest food particles the size of bacteria or larger. They may reproduce either sexually or asexually.

There are eight classes of zoomastigotes. Class Schizopyrenida, commonly called amoebomastigotes, are fresh water organisms or parasites. Naegleria is an example. These organisms can change from a form with flagella to an amoeboid stage and back again. When they need to search for food, they develop flagella and swim away. When they find food, bacteria, they lose the flagella and become amoeboid again.

**Opalinids** have hundreds of flagella, called a falx. Just like euglenoids, they have a **pellicle**, a special protein layer just beneath the plasma membrane, through which dissolved nutrients are absorbed. In sexual reproduction, two different gametes with flagella fuse to form cells. These organisms are parasites in the large intestine or rectum of fish, amphibians, and reptiles. They have flattened bodies and swim with a spiral motion. Protoopalina is the most primitive with two large nuclei in each cell. Zelleriella also has two large nuclei in each cell. Cepedea has very large cells with many small nuclei and a long falx. Opalina is smaller with many nuclei, an extensive falx, and a pleated pellicle.

**Choanomastigotes** are colorless (Monosiga) to green (Desmarella). They have a **lorica**, a hard structure from which the flagellum emerges. There are ribs on the lorica. The tapered and smooth flagellum can be retracted into the cell. Many of these organisms have a cell stalk, called a peduncle, on which the organism stands. The **peduncle** contains longitudinal fibers. Some are colonial. They are very similar to sponges and are thought to be the direct ancestor of sponges.

**Bicoecids** have a shell and two flagella. One flagellum extends forward from the cell and has many tiny appendages. They are colorless, but very similar to chrysophytes. They may have evolved from chrysophytes by losing plastids or some chrysophytes may have evolved from bicoecids by gaining plastids. They are colonial with asexual reproduction.

**Kinetoplastids** all contain a very large mitochondrion. Trypanosoma and Crithidia are parasites and pathogens (disease-causing) of man and domestic animals. Sleeping sickness and Chagas' disease are examples. Some are many-celled and some form colonies attached to a common stalk.

**Pyrsonymphids** are organisms that live in the intestines of wood-eating termites and cockroaches. They have no mitochondria. Reproduction is asexual. Examples are Notila, Oxymonas, Pyrsonympha, and Saccinobaculus.

**Parabasalids** are parasites or symbionts in the intestines of insects. They have a sensitive posterior area through which particles of wood pass. They digest the cellulose, deriving sugars for themselves and their hosts. They have no mitochondria, but they do have at least four flagella. They have special organelles to synthesize RNA and protein. In sexual reproduction, two gametes fuse into a gametocyst that divides into two adults. Many of these organisms have hundreds to thousands of flagella, often associated with many nuclei (two flagella per nucleus).

Greek: zoion - animal mastix - whip

**Phylum Chrysophyta**

These algae have plastids that contain golden yellow pigments. They live in temperate freshwater environments such as lakes and ponds, with a few, the silicoflagellates, living as marine plankton. During some part of their life cycle, they have two flagella of different sizes. They are single-celled, but form huge, complicated, branching colonies.

The primary method of reproduction in chrysophytes is asexual. Chrysophytes may form swarmer cells called zoospores that have two flagella. They swim away to form new colonies. An entire colony may divide into two or more colonies of hundreds or thousands of cells that float away to form new colonies elsewhere. Waves in the ocean stimulate this method of reproduction.

Many of the chrysophytes, such as the silicoflagellates, form complex and beautiful **tests** or shells from the silica in the sea water. Along with the diatoms, actinopods, and glass sponges, these organisms keep the concentration of silica so low at the surface of the ocean, that it cannot be detected by chemical means. The process of making the tests is not understood. These organisms are known as fossils as long ago as 500 million years because of the tests they left behind.

There are three **freshwater** chrysophytes. Class Chrysomonadales contains two orders; one is mainly single-celled, the other is many-celled, forming compact spherical colonies or loosely branched colonies. Examples in the first order are Synura, Chromulina, and Mallomonas. Each of these has a single-celled member with a closely related colonial member.

Class Chrysosphaerales form complex spherical colonies. They reproduce by zoospores that have two flagella of different sizes.

Class Chrysotrichales are filamentous algae. Some have long intertwined threads; others form flaccid, highly branched, tree-like colonies. Examples are Nematochrysis, Thallochrysis, and Phaeothamnion.

In order to survive the winter and/or desiccation, the chrysophytes make **statocysts**. The chrysophyte forms an outer coat of silica around its membrane of cellulose. Often the statocyst becomes encrusted with iron minerals. The cyst also contains two granules of a storage oil. The pore at the top of the statocyst is plugged with a material that dissolves when the chrysophyte is ready to germinate. These cysts have been identified in the fossil record.

Chrysophytes are photosynthetic. Chrysophytes contain chlorophylls a and c and a golden-brown carotenoid in one or two large chloroplasts. Food is stored in a vacuole. Some chrysophytes ingest bacteria, algae, and other organic particles.

Some chrysophytes have cell walls of cellulose and minerals. Some have no cell wall and are amoeba-like. Some have cell walls of overlapping scales of silica.

Greek: chrysos - golden phyton - plant

**Phylum Haptophyta**

Haptophytes or golden algae live in marine and fresh water, and on land. Most haptophytes live in the tropics. Some haptophytes are single-celled flagellates, some are colonial flagellates, and some are nonmotile single cells or colonies.

Haptophytes have two very different stages in their life cycles. One stage is a chrysophyte plankton (alga). The other is a resting stage called the **coccolith**. The **coccolith** is a disc of overlapping plates made of calcium carbonate and organic material formed in intricate patterns over the microorganism. During adverse conditions, these coccoliths are formed to protect the haptophyte. The coccoliths have been producing great quantities of calcium carbonate (chalk) deposits since Cretaceous times, about 100 million years ago.

Each cell has one **haptonema**, a thread that is used to anchor the cell to a stationary object and is a special modification of the flagellum. The haptonema catches food particles and senses obstacles.

There are two flagella also.

Most haptophytes are photosynthetic. They contain two golden yellow plastids, called chrysoplasts, that are surrounded by a plastid endoplasmic reticulum continuous with the nuclear envelope. The plastids contain chlorophylls a and c, alpha, beta, and gamma carotenes, and a brownish yellow pigment called fucoxanthin. They do not store starch, but a glucose polymer called paramylon. One haptophyte, Phaeocystis poucheti, produces large quantities of the atmospheric gas, dimethyl sulfide. Many haptophytes also feed on small particles such as cyanobacteria or absorb dissolved organic carbon.

Greek: haptein - fasten phyton - plant

**Phylum Dinophyta (Dinoflagellata)**

There are several thousand species of dinoflagellates that live in a marine environment as plankton and a few that live in fresh water. They are more abundant in warm water. They are mostly single-celled with some colonial forms. A few are parasites or epiphytes, organisms that live on others for support but not nutrition, on marine animals or other organisms.

Some dinoflagellates produce powerful toxins that accumulate in the bodies of fish and marine invertebrates and produce the toxic red tides. Gonyaulax tamarensis is one of these dinoflagellates.

Many dinoflagellates are bioluminescent, such as Noctiluca miliaris (‘a thousand night lights’), and cause the ocean to twinkle at night. This organism is a large carnivorous cell with a huge feeding tentacle that it uses to capture microorganisms to eat.

Other dinoflagellates form symbiotic relationships within the cells of marine organisms such as coral, sea anemones, and clams. Gymnodinium microadriaticum is the most common photosynthetic symbiont in the reef communities of the world.

Dinoflagellates have a nucleus with a membrane. They have two **flagella** at right angles to each other located in two grooves. One flagellum is in a groove that encircles the cell, a characteristic of these organisms. When both flagella move at the same time, the cell whirls and spins like a top. The outside of the organism has a rigid wall or **test** made of plates of cellulose (**theca**) embedded in the plasma membrane of the cell. The plates are encrusted with silica. Many dinoflagellates have very complex tests.

The photosynthetic dinoflagellates contain brownish plastids with chlorophylls a and c, beta and gamma carotenes, several xanthins, and a carotenoid. Many of these dinoflagellates occur as symbionts within other protists, sponges, cnidarians, and mollusks. They have no theca and are golden spherical cells. These dinoflagellates photosynthesize the nutrients necessary for coral growth in the tropics. They store starch. Other dinoflagellates are heterotrophs, feeding on other organisms. Some absorb organic compounds.

The DNA of dinoflagellates is very different from other eukaryotes. Instead of histone proteins, the DNA combines with a special alkaline protein, similar to that of bacteria. There are chromosomes.

Dinoflagellates reproduce by **longitudinal cell division**, although the actual process is very different from species to species. Each daughter cell receives one flagellum and part of the cell wall. Then each daughter cell reconstructs the missing parts. There is no sexual reproduction.

Some organisms have **eyespots** that detect light. Some of the eyespots contain a layer of light-sensitive bodies with carotenoid pigments. Another, Erythropsidinium pavillardii, has a complex ocellus with a lens, fluid-filled chamber, and a light-sensitive pigment cup that it uses to detect its prey. This lens can change shape, the pigment cup moves freely around the lens, and the whole ocellus can protrude from the cell to point in different directions.

When food levels are low, dinoflagellates form a resting stage, the cysts, that float to the bottom of the lake or ocean until food is again available. Then the cysts develop into swimming cells that feed.

Greek: dinos - whirling, rotation, or eddy

Latin: flagellum - whip Greek: phyton - plant

**Phylum Euglenophyta**

The euglenoids are **flagellates**, moving by means of one whip-like flagellum. A second flagellum moves in reaction to light. Most are unicellular, with some colonial members. They live mostly in fresh and stagnant water rich in organic particles, with some living in marine environments, and some being parasites. There are about 800 species. About one-third of the euglenoids contain chlorophyll and can make their own food. About two-thirds of the euglenoids feed on particles or absorb dissolved organic material. All eat dissolved food or food particles.

The euglenoids that are photosynthetic contain grass green chloroplasts, similar to the green algae, but the pigments are different. The chloroplasts contain chlorophylls a and b, beta carotene, and many carotenoids. They utilize water, sunlight, oxygen, carbon dioxide, and vitamin $B_{12}$ in photosynthesis. Euglenoids store **paramylon**, a glucose polymer. The contractile vacuole collects excess water that is discharged from the cell.

Euglenoids do not have a cell wall. Very flexible outer structures (**pellicles**) made of protein allow the Euglena to change shape easily. Special proteins in an array under the plasma membrane provide support. Euglenoids swim by means of a long flagellum. Euglenoids have an eyespot that senses light.

Euglenoids reproduce asexually. In asexual reproduction, the cell divides lengthwise. The nuclear envelope remains intact during reproduction. The nucleolus contains very primitive ribosomes with RNA and proteins. When a euglenoid is in the dark, its chloroplasts regress, the organism turns white, and it must hunt for its food. When the organism is in the light again, the chloroplasts turn light green within hours, then go through a series of developmental stages over a period of three days to return to their bright green color. The euglenoid, Euglena gracilis, can actually live without its chloroplasts, and must capture its food. It does require vitamin $B_{12}$ to live and can actually be used to test for the presence of this vitamin.

Greek: eu - true glene - eyeball phyton - plant