

## CLASS I. PHYTOMASTIGOPHOREA

It is divided into following seven orders:

### Order 1. Chrysoomonadida

1. Two unequal flagella; one hairy and directed anteriorly, other trailing and smooth.
2. Chloroplasts golden brown containing chlorophyll a and c. Some species lack chloroplasts and feed holozoically.
3. Starch absent. Storage products are **chrysolaminarin** and fat.
4. Cells are either naked or with richly patterned silicified scales (cysts) or with plate-like lorica.
5. Sexual reproduction present.
6. Marine or freshwater animals.

**Examples.** *Chromulina*, *Chrysamoeba*, *Ochromonas*.

### Order 2. Cryptomonadida

1. Cells flattened, naked, without wall or pellicle.
2. They have a gullet that reaches upto the middle of the body.
3. They have two unequal flagella.
4. Chloroplasts brown, red, olive-green, blue or yellow.
5. Reserve food includes starch and fat.
6. Sexual reproduction unknown.
7. Stigma present.
8. Marine or freshwater.

**Examples.** *Chilomonas*, *Cryptomonas*.

### Order 3. Dinoflagellida

1. Cells flattened or of complex symmetry with transverse and ventral grooves and with armour of cellulose plates. Cytoplasm is vacuolated.
2. Two heterodynamic flagella, inserted apically or laterally, one ribbon-shaped with paraxial rod and single row of fine hairs, other smooth or with two rows of stiffer hairs.
3. Chloroplasts typically golden brown (xanthophyll) and green (chlorophyll a and c present).
4. Reserve food includes starch and fat.
5. Nucleus unique among eukaryotes in having permanently condensed chromosomes having less amount of histone proteins.
6. Mitosis intranuclear; asexual reproduction by fission.
7. Sexual reproduction present.
8. Stigma is present in many species.
9. Free living, pelagic, marine, freshwater; some parasitic, some mutualistic (e.g., *Symbiodinium microadriaticum* is symbiont of corals).
10. Nutrition holophytic in most species, holozoic in some.
11. Some are bioluminescent (e.g., *Noctiluca*).

**Examples.** *Ceratium*, *Noctiluca*, *Glenodinium*, *Gymnodinium*.

### Order 4. Euglenida

1. Cells with helical symmetry, naked but with complex and thick pellicle of interlocking proteinaceous strips.
2. Two (rarely more) unequal flagella, one or both arising from an anterior invagination (**reservoir**). The reservoir contains the roots of flagella and receives the contents of the

contractile vacuole. It leads to so-called gullet or cytopharynx which opens to outside as pore (cytostome). Mouth is not used in ingestion of food.

3. One flagellum bears mastigonemes distally.
4. Stigma is present.
5. Chloroplasts grass-green, but absent in many genera.
6. Reserve food is paramylon (secreted by pyrenoids of chloroplasts) in *Euglena*, fat and cyclo-metaphosphates.
7. Non-spindle intranuclear mitosis.
8. Solitary or colonial, most freshwater.

**Examples.** *Euglena*, *Peranema*, *Phacus*.

#### **Order 5. Heterochlorida**

1. Two unequal flagella.
2. Chloroplasts yellow-green.
3. Reserve food is oil and possibly chrysolaminarin.
4. Supposedly related to xanthophyceae algae.
5. Siliceous cysts.

**Examples.** *Heterochloris*, *Myxochloris*.

#### **Order 6. Chloromonadida**

1. Dorso-ventrally flattened forms with delicate pellicle.
2. Gullet present, stigma absent.
3. Two flagella.
4. Chloroplasts are green and numerous.
5. Characteristic ring of Golgi apparatuses at anterior end.
6. Sexual reproduction by fusion of two individuals.

**Examples.** *Coelomonas*, *Vacularia*.

#### **Order 7. Volvocida**

1. Small sized cells with rigid cellulose covering.
2. Mouth and gullet absent.
3. Two or four equal, smooth, apical flagella.
4. Chloroplasts (= chromatophores) are grass-green.
5. Reserve food is starch and fat.
6. Stigma present.
7. Sexual reproduction by syngamy.
8. Mostly freshwater; some form colonies.

**Examples.** *Volvox*, *Chlamydomonas*, *Eudorina*.

### **CLASS II. ZOOMASTIGOPHOREA**

It is divided into following eight orders:

#### **Order 1. Choanoflagellida**

1. A collar (or ring of microvilli) at the base of a single apical flagellum.
2. Cell with membraneous sheath or basket-like siliceous lorica.
3. Nutrition holozoic.
4. They are solitary or colonial and are free-living or stalked.

**Example.** *Proterospongia*.

## Order 2. Rhizomastigida

1. Small and amoeboid.
2. Flagella one to four.
3. Locomotion by flagella and pseudopodia.
4. Freshwater and free-living.

**Examples.** *Mastigamoeba*, *Dimorpha*.

## Order 3. Kinetoplastida

1. One or two flagella arising from depression.
2. Single mitochondrion extending entire length of body as single tube, hoop or network of branching tubes.
3. Gullet is absent.
4. They contain a single large **kinetoplast** which is genetically autonomous, DNA-containing, membrane-bound organelle (mitochondria) associated with the basal body at the base of flagella.
5. Most species are parasitic; some are free-living; freshwater forms are sessile.
6. Solitary or colonial.

**Examples.** *Oikomonas*, *Bodo*, *Trypanosoma*, *Leishmania*.

## Order 4. Retortamonadida

1. Two or four flagella, one turned posteriorly and associated with ventrally located cytostome.
2. Mitochondria and Golgi apparatus absent.
3. Cysts present.
4. Gut parasites of insects and vertebrates.

**Example.** *Chilomastix*.

## Order 5. Diplomonadida

1. Flagella 3 to 8, one of them directed backwards over the body and associated with cytostome or with organelles forming cell axis.
2. Mitochondria and Golgi apparatus absent.
3. One or two karyomastigont (nucleus + mastigont) are present. **Mastigont system** is a complex system formed by groups of flagella which are associated with several microtubular and fibrillar organelles.
4. Cysts present.
5. Free-living or parasitic.

**Examples.** *Giardia*, *Hexamita*.

## Order 6. Oxymonadida

1. Uninucleate or multinucleate forms.
2. One or more karyomastigonts are present, each containing four flagella typically arranged in two pairs in motile stage.
3. Mitochondria and Golgi apparatus absent.
4. Cysts in some species.
5. Sexual reproduction in some species.
6. Parasitic.

**Examples.** *Foaina*, *Oxymonas*.

**Order 7. Trichomonadida**

1. Typically karyomastigonts with four to six flagella, but one genus only with one flagellum and another with no flagella at all.
2. One flagellum recurrent, free, or with proximal or entire length adherent to body surface as undulating membrane.
3. They have a longitudinal supporting structure known as an **axostyle**.
4. No cysts are formed.
5. Parasitic in humans and other animals.

**Examples.** *Trichomonas tenax* (mouth); *T. hominis* (intestine), *T. vaginalis* (vagina), *Chilomastix mesnili* (large intestine).

**Order 8. Hypermastigida**

1. Complex forms with numerous flagella.
2. Flagella bearing kinetosomes distributed in circle, in plates or in longitudinal or spiral rows meeting in a centralized structure.
3. One nucleus per cell.
4. Cysts in some forms.
5. Some species have sexual reproduction.
6. Gut parasites of termites and cockroaches.

**Examples.** *Trichonympha campanula* (termite gut), *Lophomonas* (cockroach intestine).

**SUPERCLASS 3. SARCODINA**

It includes three classes:

**Class 1. Rhizopodea**

1. Locomotory organelles are lobopodia or filopodia but never axopodia.
2. They are creeping forms.

**Class 2. Piroplasmaea**

1. Small, round rod-shaped or amoeboid organisms.
2. Parasites in red blood cells of vertebrates.
3. Spores are not formed.

**Example.** *Babesia*.

(**Note.** Class Piroplasmaea is not divided into orders).

**Class 3. Actinopodea**

1. Pseudopodia are ray-like axopodia. Each of the pseudopodia is supported by a central axial rod comprising a bundle of microtubules. Axopods are commonly used in food capturing.
2. Primarily sessile or floating (planktonic) spherical forms.
3. Test is present or absent. Test is composed of organic matter and/or silica or strontium sulphate.
4. Both asexual and sexual reproduction present.

**CLASS 1. RHIZOPODEA**

This class is divided into four subclasses:

**Sub-class I. Lobosia**

1. Locomotory organelles are lobopodia which are broad and blunt pseudopodia containing both ectoplasm and endoplasm.

2. Usually uninucleate forms.
3. Sporangia absent.

This sub-class is divided into two orders:

**Order 1. Amoebida**

1. Typically uninucleate amoeboid forms.
2. Test (skeleton) absent.
3. Ectoplasm and endoplasm distinct.
4. Mitochondria typically present.
5. No flagellate stage in life cycle.
6. Largely freshwater, some parasitic.

**Examples.** *Amoeba*, *Entamoeba*.

**Order 2. Arcellinida**

1. The body is encased in an one-chambered test having a single aperture through which animal extends or retracts its lobopodia.
2. Test is composed of either organic material (e.g., *Arcella*) or inorganic foreign particles (e.g., *Diffugia*) or both.
3. Free-living and mostly freshwater.

**Examples.** *Arcella*, *Diffugia*, *Euglypha*.

**Sub-class II. Filosia**

1. Pseudopodia are filopodia which are tapering and branching.
2. Body naked or with a shell with single aperture.
3. Ectoplasm is not distinct.
4. No flagellate or spores known.
5. Marine or freshwater.

**Examples.** *Allogromia*, *Penardia*, *Gromia*.

**Sub-class III. Granuloreticulosia**

1. Pseudopodia are reticulopodia which are delicate and finely granular.

This sub-class includes the following significant order:

**Order Foraminiferida**

1. Large sized protozoans with uni-or multichambered perforated calcareous test or shell.
2. Reticulopodia protruding from test's aperture, wall perforation or both.
3. Reproduction with alternation of sexual and asexual generations.
4. Gametes usually flagellate rarely amoeboid.
5. Mostly marine.

**Examples.** *Globigerina*, *Elphidium* (= *Polystomella*), *Pavonina*.

**Sub-class IV. Mycetozoa**

1. Body large, amoeboid and multinucleate.
2. Pseudopodia numerous and blunt.
3. Form sporangia which liberate spores.
4. Nutrition phagocytic.

**Examples.** *Plasmodiophora* and other slime molds.