

# **ALGAL CLASSIFICATION**

**Algal Systematics**

# **The current systems of classification of algae are based on the following main criteria:**

- 1. Kinds of photosynthetic pigments**
- 2. Type or chemical nature of photosynthetic energy storage products**
- 3. Photosynthetic membranes' (thylakoids) organization and other features of the chloroplasts**
- 4. Cell wall composition and structure**
- 5. Presence or absence of flagella (as well as the number and placement of these flagella, when present)**
- 6. Ultrastructure of the flagella (if any)**
- 7. Scheme and path of nuclear and cell division**
- 8. Sexual cycles**
- 9. Presence of an envelope of endoplasmic reticulum around the chloroplast**
- 10. Possible connection between the endoplasmic reticulum and the nuclear membrane**
- 11. Based on the sequence of macromolecules genes and the 5S, 18S, and 28S ribosomal RNA sequences**
- 12. Occurrence of any other special features**

**Based on type of the cell, algae can be grouped basically into two major assemblages prokaryotic and eukaryotic algae.**

**However, There are four distinct groups within the algae**

**Classification:**

➤ **Group 1** Prokaryotic algae include two divisions:  
**Cyanobacteria and Prochlorophyta**

➤ **Group 2** Eukaryotic algae with chloroplasts surrounded only by the two membranes of the chloroplast envelope and includes mainly two divisions; **Chlorophyta and Rhodophyta**

➤ **Group 3** Eukaryotic algae with chloroplasts surrounded by one membrane of chloroplast endoplasmic reticulum and include two divisions; Dinophyta and Euglenophyta

➤ **Group 4** Eukaryotic algae with chloroplasts surrounded by two membranes of chloroplast endoplasmic reticulum and include four divisions; Heterokontophyta, Haptophyta, Cryptophyta and Chlorarachniophyta

**Some of the algae have been classified according to their habitats with special emphasis on the occurrence of fresh water algae**

### **1. Hydrophytes:**

**They are more or less completely submerged or free floating on the surface of the water. The hydrophytes may be subdivided into following heads**

**(i) Benthophytes: Several fresh water and marine algae are found in attached condition. The fresh water such as Chara, Nitella, Cladophora, Gongrosira, Chaemosiphon, etc., are found attached to some substratum in the bottom of the water. Almost all of brown algae (Phaeophyceae) are found in attached condition to some substrata in the sea**

**(ii) Epactiphytes:** Such algae grow along the shores of lakes and ponds, and may be delimited from benthophytes with some difficulty

The most important fresh water forms are – Oedogonium, Chaetophora, some species of Spirogyra, Mougeotia, some diatoms, Scytonema and Rivularia

**(iii) Thermophytes:** Many algae are reported from hot springs. These algae may tolerate the temperature upto 70°C or more than that. According to Copeland, 53 genera and 153 species of Chroococcaceae may survive upto 84°C

Some Oscillatoriaceae may survive upto 85°C. This supports that Myxophyceae (blue-green algae) are primitive

**(iv) Planktophytes: The algae which float on the surface of the water**

**(a) Euplanktophytes: They are never attached and mostly fresh water forms Ex. Diatoms, Cosmarium, Closterium, Microcystis, Sphaeroplea, Scenedesmus, Pediastrum, Chlamydomonas, Volvox, some Volvocales and some members of Chroococcales**

**(b) Tychoplanktophytes: In the beginning, such algae are attached, but later on they become detached and free floating, Ex. Spirogyra, Zygnema, Cladophora, Oedogonium, Cylindrospermum, Tetraspora, Rivularia, Nostoc, Gloeotrichia, Sargassum**

**(v) Halophytes: The algae occur in saline waters are known as 'halophytes'**

**Ex. Dunaliella and Chlamydomonas which occur in salt lakes**

**The species of Scenedesmus, Aphanocapsa, Pediastrum and Oscillatoria, many species of Ulvales and Ulotrichales are found near the sea**

**(vi) Epiphytes: Many algae are found upon other living plants and bigger species of algae. Ex. Aphanochaete, Bulbochaete, Oedogonium and Microspora, are found as epiphytes upon larger species of Oedogonium, Cladophora, Rhizoclonium, Vaucheria and Hydrodictyon species**

**Coleochaete nitellarum is epiphytic upon species of Chara and Nitella**

**Some of the species of Coleochaete are epiphytic upon grasses grown on the banks of the ponds and the hydrophytes such as Vallisneria, Typha, Ipomoea and several other aquatic plants**

**Chaetonema is found epiphytic on the mucilaginous masses of Tetraspora and Batrachospermum**

**(vii) Epizoophytes: Certain algae are found on living aquatic animals such as turtles, mollusc shells, fishes, etc.**

**Species of Cladophora grow upon mollusks shells**

**Protoderma and Basycladia occur on the back of turtles**

**Characiopsis and Characium occur on the posterior and anterior legs of Branchipus respectively**

**2. Edaphophytes:** Also called terrestrial algae. Found upon or inside the surface of the earth/ soil

**(i) Saphophytes:** They are surface algae. Ex. Most of the species of Myxophyceae Mesotaenium, Botrydium, Protosiphon, Oedocladium, Vaucheria and many others grow on wet soil

**(ii) Cryptophytes:** Such algae are subterranean in habit and occur inside the soil. Some species of Myxophyceae, some species of Nostoc and Anabaena reported from the paddy fields, where they also fix the atmospheric nitrogen in the soil to enrich the fertility of the fields

### **3. Aerophytes:**

**Such algae are aerial in habitat. They are found upon the trunks of trees, walls, fencing wires, rocks, and animals and so many other aerial substrata**

#### **(i) Epiphyllphytes:**

**Such algae are epiphytic upon leaves of trees. Species of Trentepohlia are commonly found upon the bark of trees. They also occur upon rocks and fencing wires. They are abundantly found on the fencing wires of Calcutta botanical gardens. Phycopeltis occurs upon Rubus; Phyllosiphon on Arisaema; Rhodochytrium on Asclepias and Solidago**

**(ii) Epiphloephytes:**

**These algae grow on the bark of trees mixed with many mosses and liverworts. Phormidium, Scytonema, Haplosiphon and Schizothrix grow on the bark of trees mixed with liverworts.**

**(iii) Epizoophytes:**

**These algae are found even on the bodies of land animals. Certain Chaetophorales are found even on the hairs of sloth.**

**(iv) Lithophytes:**

**Many algae grow on the rocks and walls. The species of Scytonema grow on the walls in rainy season and the whole wall becomes black spotted. Vaucheria, Nostoc and many other algae are also found on wet rocks.**

#### **4. Cryophytes:**

**These algae are found on ice and snow.**

**These algal forms cause red snow, green snow, yellow snow, yellowish green snow and violet snow.**

**In European countries, especially in arctic region the green snow is caused by Chlamydomonas, Ankistrodesmus and Mesotaenium red snow is caused by species of Chlamydomonas Scotiella, Gloecapsa and diatoms**

## **5. Symbionts or endophytes:**

Many algae grow in symbiotic association of other plants. The most striking example of symbiosis are lichens, here the algae are found in symbiotic association of fungi. Various Myxophyceae, e.g., Chroococcus, Nostoc, Microcystis, Gloeocapsa, Scytonema, Rivularia, etc., have been separated from lichens. Some green algae, e.g., Coccomyxa, Chlorella, Protococcus, Palmella, etc., are also found as symbionts in lichens.

Besides, several algae are endophytes in the tissue of other plants. *Anabaena azollae* is found inside the leaves of *Azolla* (a pteridophyte). *Anabaena cycadae* is found in the coralloid roots of *Cycas*. *Nostoc* has been reported from the tissues of *Anthoceros* and *Notothylas*. *Nostoc* is found in the leaves of *Sphagnum* (Bryophyta) and several angiosperms. *Chlorochytrium* is endophytic inside *Lemna*, *Ceratophyllum* and certain mosses.

## **6. Endozoophytes:**

Certain algae occur inside the body of animals. *Zooxanthella* is found inside fresh water sponges; *Zoochlorella* is found inside *Hydra viridis*. According to Langeron about 14 species of *Oscillatoriaceae* are found in the digestive and respiratory tracts of various vertebrates.

## **7. Parasites:**

Certain algae are parasites upon other plants. The most striking example is *Cephaleuros virescens* which causes the disease of tea foliage in Assam and neighboring areas, called 'red rust of tea'

## **8. Fluvial algae:**

Such algae are found in rapidly flowing waters; *Ulothrix* occurs in mountain falls. *Stigeoclonium*, *Batrachospermum* are reported from the swift running streams of Dehradun and other hilly tracts.

## **9. Thermophytes:**

**Many algae are reported from hot springs**

**They tolerate the temperature upto 70<sup>0</sup>C or more**

**Some Oscillatoriaceae members may survive upto 80<sup>0</sup>C, supporting primitiveness of BGA**

## Some Common Algae

Division	Common Name	Characteristics	Example
Chlorophyta	green algae	contain chlorophyll and accessory pigments	spirogyra
Chrysophyta	golden-brown algae and diatoms	frequently contain silica in their cell walls	diatoms
Dinoflagellata	dinoflagellates	give off light when agitated in the water	dinoflagellates
Phaeophyta	brown algae	contain the brown pigment fucoxanthin	fucus
Rhodophyta	red algae	contain the red pigment phycoerythrin	chondrus

# Division Chlorophyta

- **Green algae**
- **7000 diverse species**
- **Biologist reason that green algae give rise to land plants.**
- **Both green algae and land plants have chlorophyll a and b as well as carotenoids and store food as starch inside chloroplast**
- **Both have walls made of cellulose**
- **Mitochondria with flattened cristae**

**Class: Chlorophyceae**

**Primarily fresh water Ex. Chlamydomonas, Oedogonium, Volvox**

**Class: Charophyceae**

**Macroscopic stoneworts Ex. Chara**

**Class: Ulvophyceae**

**Primarily marine Ex. Acetabularia, Caularpha, Ulva**

**Class: Bacillariophyceae**

**Silica cell walls, commonly planktonic, radially symmetrical,  
pennate (Diatoms)**

**Usually attached or gliding over solid surface**

**Fresh water, marine or soil environment**

**Ex. Bacillaria, Navicula, Pinularia**

**Class: Chrysophyceae (golden algae)**

**Unicellular or colonial flagellates**

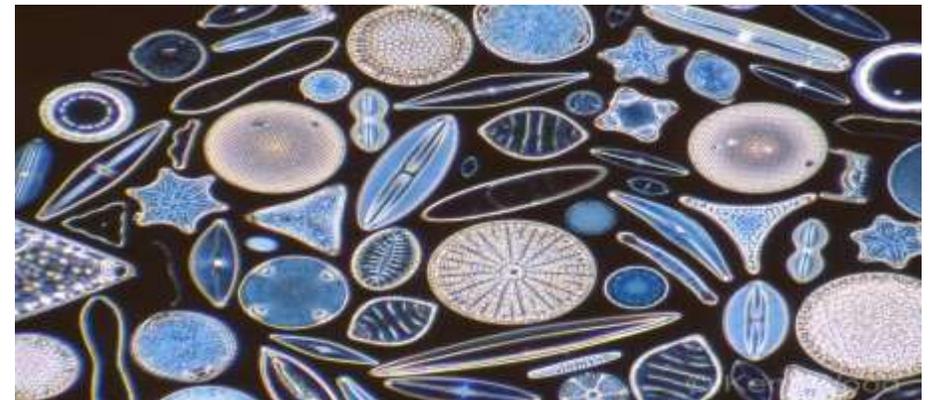
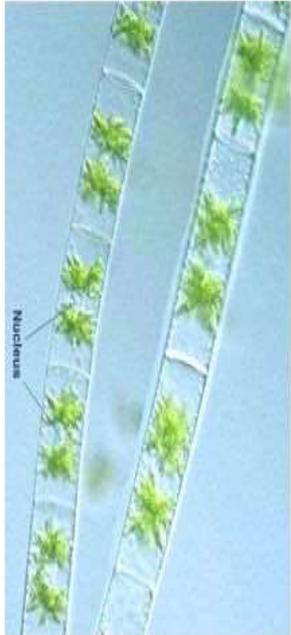
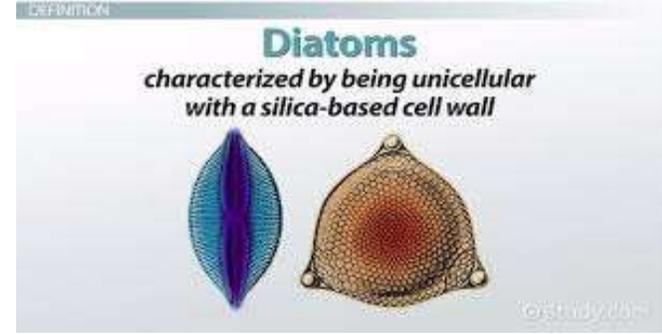
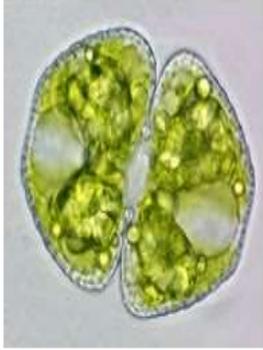
**Caploid, amoeboid or filamentous**

**Class: Dictyochophyceae**

**Predominantly marine**

**Common in diatomite deposits**

# Green Algae (Chlorophytes)



# Division Chromophyta

- **Most with Chlorophyll a and Carotenoids**
- **Storage product beta 1-3 polysaccharide out side chloroplast**
- **Mitochondria with tubular cristae**
- **Biflagellate cells, zoospores with hairs on one flagellum**
- **Mucous organelles common**

# Class: Phaeophyta

- 1500 species of Brown algae
- Mostly marine and include seaweed
- All are multicellular and large (often reaching lengths of 147 feet)
- Individual alga may grow to a length of 100m with a holdfast, stipe and blade
- Used in cosmetics and most ice creams

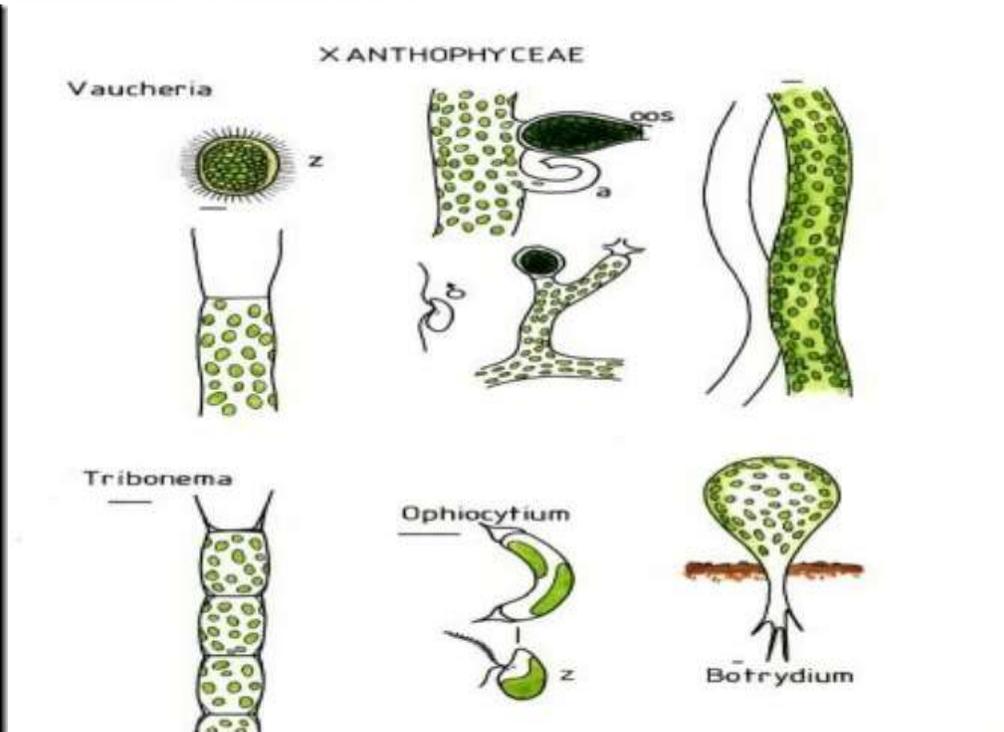
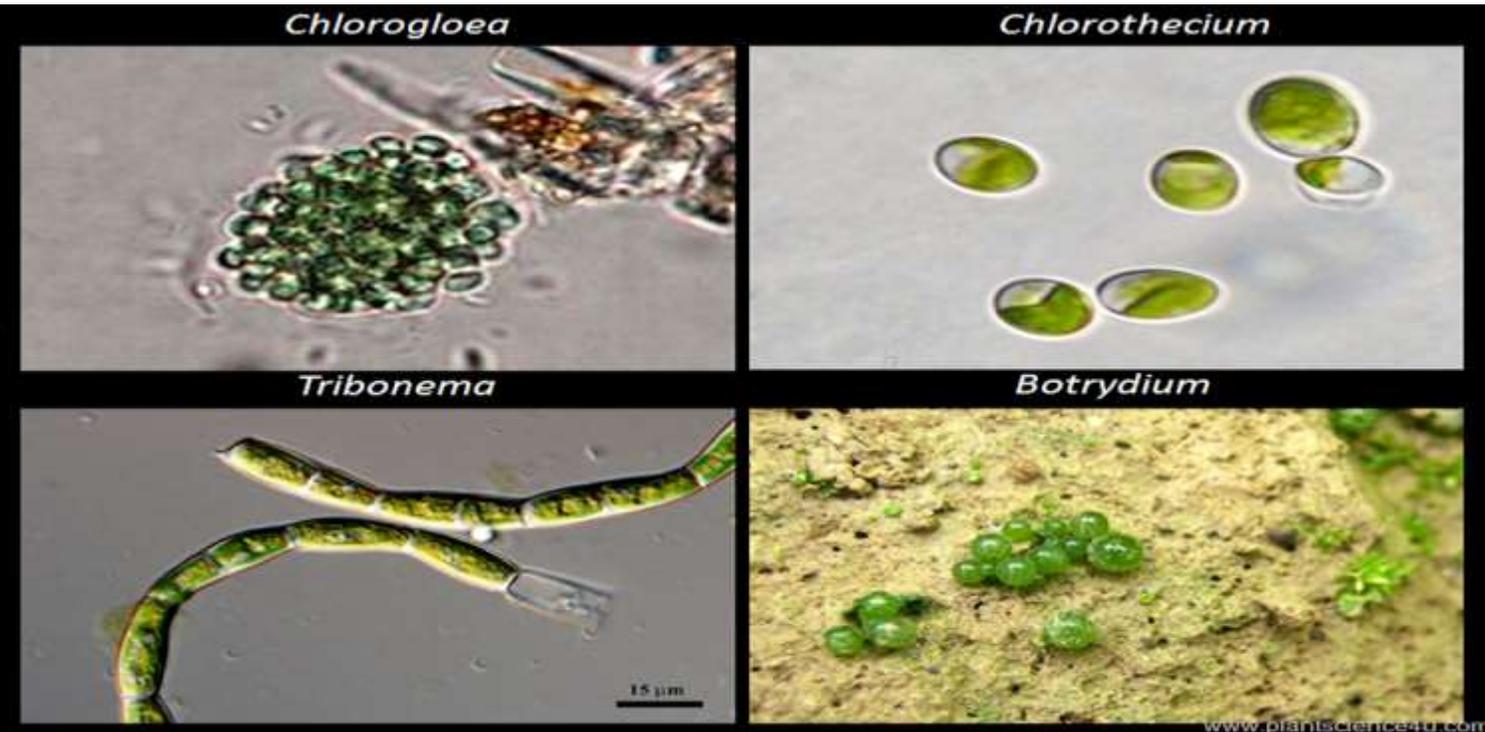
Ex. Fucus, Laminaria, macrocystis, Sargassum



- **Class Xanthophyceae: (Yellow green algae)**

**Primarily coccoid or filamentous freshwater**

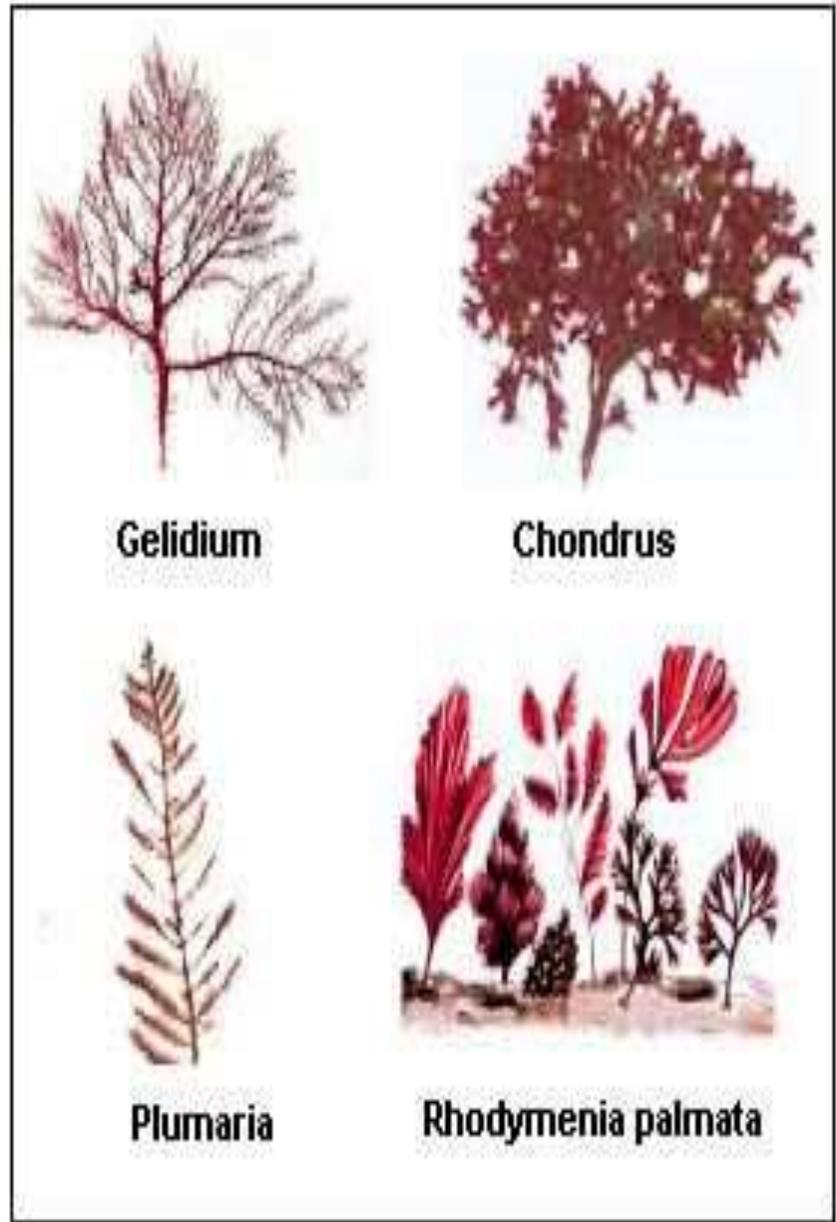
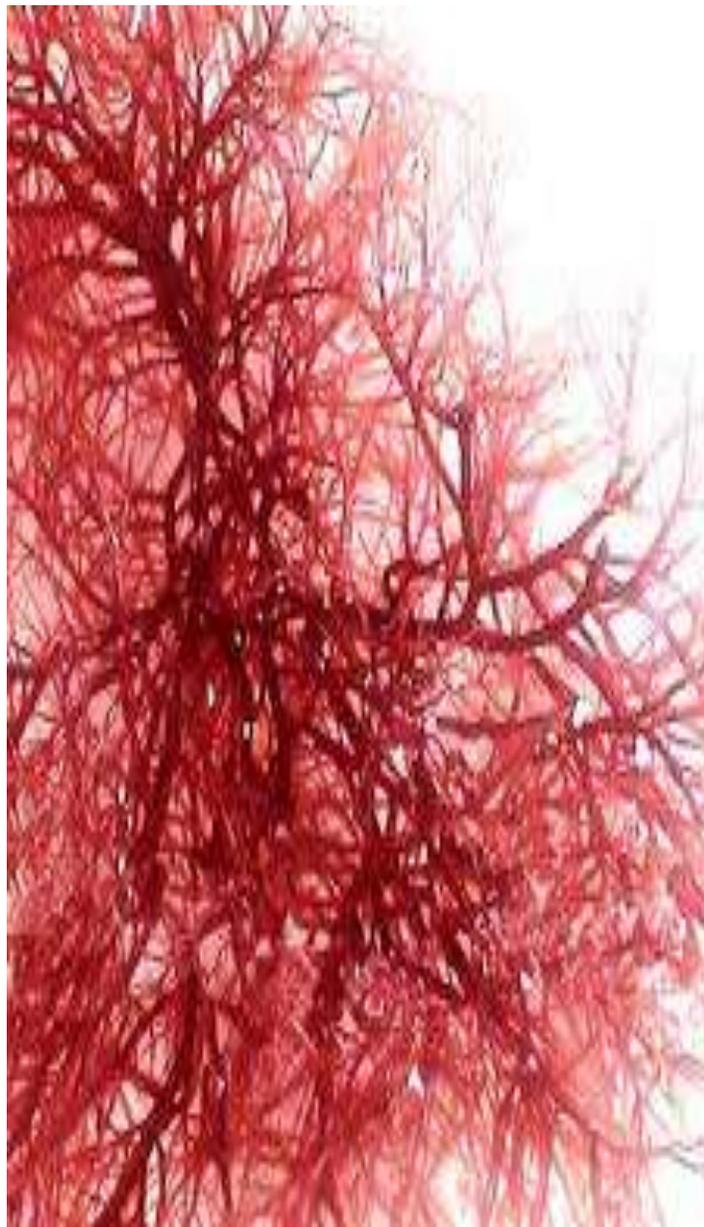
**Ex. Vaucheria, Botrydium**



# Division Rhodophyta

- **4000 species of RED Algae**
- **Most are marine**
- **Smaller than brown algae and are often found at a depth of 200 meters.**
- **Contain chlorophyll a and C as well as phycobilins which are important in absorbing light that can penetrate deep into the water**
- **Have cells coated in carageenan which is used in cosmetics, gelatin capsules and some cheeses**
- **Starch stored outside chloroplast**
- **Mitochondria with flattened cristae**
- **Flagella absent**
- **Contribute to coral reefs**

**Ex. Polysiphonia, Porphyra, Rhodymenia**



# Division Dianoflagellata

- Also called Pyrrophyta
  - Unicellular flagellates
  - Most are heterotrophic
  - Produces toxins
  - Some symbiotic
  - Some bioluminescent
- Ex. Noctiluca, Peridinium**



*Noctiluca*



*Ptychodiscus*



*Ceratium*

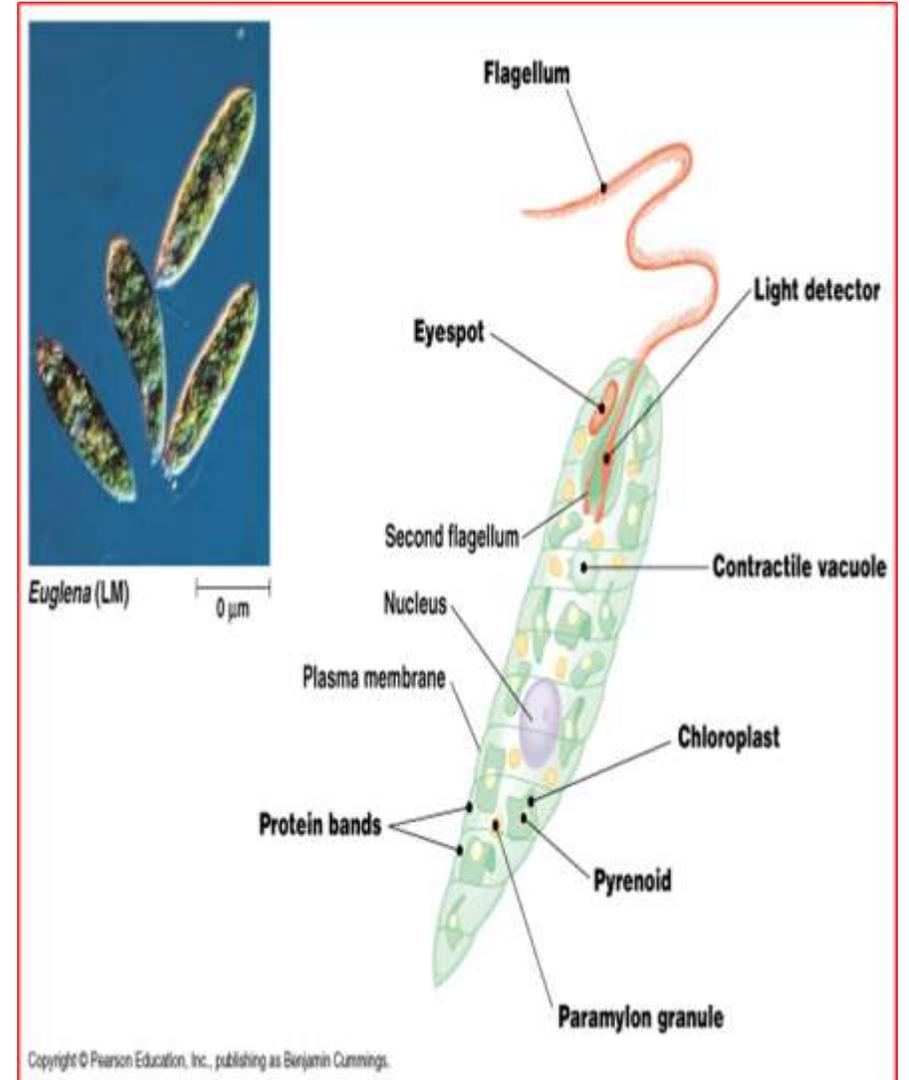


*Gonyaulax*



# Phylum Euglenophyta

- **1000 species of Euglenoids**
- **Have both plantlike and animal-like characteristics**
- **Fresh water**
- **Chlorophyll a, b**
- **Paramylon stored outside chloroplast**
- **Mitochondria with paddle shaped cristae**



Cyanophyta (Cyanobacteria / Blue-Green Algae)	Characteristic	Chlorophyta (Green Algae)
Typically 0.2 - 2.0 mm diameter	Cell Size	Typically 10-100 mm diameter
Many Toxic Species	Toxins	None
Many produce Geosmin & MIB	Taste & Odor	Some produce Geosmin & MIB
Binary fission (no meiosis)	Reproduction	Mitosis (meiosis involved)
Surface Blooms with many species	Blooms (Buoyancy)	Absent
Many Are	Nitrogen Fixers	No