

**Lecture No. B1MICP1U5.1.2**

**General Characteristics and Classification of Algae and Protozoa**

**Volume -2**  
**Classification of Algae**

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## CLASSIFICATION OF ALGAE

Algae consists of a large number of diverse forms which vary in shape and size.

According to the first view, the algae is equivalent to a division, and therefore it can only be further divided into classes(-phyceae) and not into divisions(-phyta).

This view was supported by **Fritsch** and his followers. It is based on the following characters.

(i) Chlorophyll - a is common to all algae and so there is definitely a common origin from a common source, therefore, they all belong to the same group.

(ii) Internal structure of flagella is similar in all.

(iii) Product of assimilation (reserve food) may be different but the process of assimilation is same in all.

(iv) Methods of reproduction are almost common to all.

According to the second view, the algae is above the rank of a division. So it should be divided into some divisions (=phyta) and then each division into one or more classes.

This view was supported by workers like **Smith ,Papenfuss, Prescott.**

Supporters of this view, considered the following criteria to their classification.

- (i) Pigments are different in different phytas(division)
- (ii)Product of photosynthesis is different in different divisions.

**Papenfuss** proposed that the word “phyco” must be incorporated before “phyta” especially because of their link with algae.

### **Criteria for classification:**

Generally a combination of a few or more of the following characters, are considered by the algal taxonomists

while classifying algae.

They include

- (i) Pigments: Their complement, relative amount, kinds, chemical composition.
- (ii) External forms: Size, shape, appendages and other structures.
- (iii) Chromatophore shape: Cup shaped , stellate, reticulate, discoid, spiral ,girdle shaped.
- (iv) Reserve food products: Strach , oil globules etc.
- (v) Flagella: Structure, type, number ,position , anatomy and inversion on the body.
- (vi) Cell wall: Chemical composition
- (vii) Nucleus: Presence or absence of a definite nucleus.
- (viii) Chromosome: Number, arrangement, shape.
- (ix) Life history & Reproduction: Type of life history, method of reproduction, shape of reproductive

## **F.E.Fritsch System of classification:**

Fritsch's classification: F.E.Fritsch (1935, 1945) proposed a most comprehensive and authoritative classification in his book "structure and reproduction of algae" .

- (1) Chlorophyceae
- (2) Xanthophyceae
- (3) Chrysophyceae
- (4) Bacillariophyceae
- (5) Cryptophyceae
- (6) Dinophyceae
- (7) Chloromonadinae
- (8) Euglineae
- (9) Phaeophyceae
- (10) Rhodophyceae
- (11) Myxophyceae

## **G.M.Smith's Classification (1955):**

Smith proposed the classification of algae taking into consideration the evolutionary principles proposed by Fascher (1914).

(1) Division: Chlorophyta

Class 1: Chlorophyceae(Grass green algae)

Class 2: Charophyceae(stoneworts)

(2) Division: Euglenophyta

Class 1: Euglenophyceae(Euglenoids)

(3) Division: Pyrrophyta

Class 1: Desinophyceae(Dinophysids)

Class 2: Dinophyceae(Dinoflagellates)

(4) Division: Chrysophyta

Class 1: Chrysophyceae (Golden brown algae)

Class 2: Xanthophyceae(Yellow green algae)

Class 3: Bacillariophyceae(Diatoms)

(5) Division: Phaeophyta (Brown algae)

Class 1: Isogenerateae

Class 2: Heterogenerateae

Class 3: Cyclosporeae

(6) Division: Cyanophyta

Class 1: Myxophyceae

(7) Division: Rhodophyta (Red algae)

Class 1: Rhodophyceae

(8) Division: Algae of uncertain systemic position

Chloromonadales

Cryptophyceae.

## **Classification by Robert Edward Lee (1989):**

Robert Edward Lee (1989) classified the algae **into 4 evolutionary groups, 15 divisions and classes**

**Group 1. Prokaryotic algae:** The prokaryotic algae have an outer plasma membrane enclosing protoplasm containing photosynthetic thylakoids, 70S ribosomes and DNA fibrils not enclosed within a separate membrane. Chlorophyll a is the main photosynthetic pigment.

1. **Division. Cyanophyta (blue green algae):** Chlorophyll a; phycobiliproteins.
2. **Division. Prochlorophyta (prochloro-phytes):** Chlorophyll a and b; no phycobiliproteins.

### **Group 2. Eukaryotic algae:**

Eukaryotic algae with chloroplast surrounded only by the two membranes of the chloroplast envelope.

1. **Division. Glaucophyta:** algae that represent an intermediate position in the evolution of chloroplast; photosynthesis is carried out by modified endosymbiotic blue-green algae.
2. **Division. Rhodophyta (red algae):** Chlorophyll a and d; phycobiliproteins; no flagellated cells; storage product is floridean starch.
3. **Division. Chlorophyta (green algae):** Chlorophyll a and b; storage product starch is found inside the chloroplast

### Group 3. Eukaryotic algae:

Eukaryotic algae with chloroplast surrounded only by one membrane of chloroplast endoplasmic reticulum.

1. **Division. Euglenophyta (euglenoid):** chlorophylls a and b, one flagellum with a spiralled row of fibrillar hairs; proteinaceous pellicle in strips under the plasma membrane; storage product is paramylon; characteristic type of cell division.
2. **Division. Dinophyta (dinoflagellates):** mesokaryotic nucleus; chlorophyll a and  $c_1$ ; cell commonly divides into an epicone and a hypocone by a girdle; helical transverse flagellum; thecal plates in vesicles under the plasma membrane.

### Group 4. Eukaryotic algae:

Eukaryotic algae with chloroplast surrounded by two membranes of chloroplast endoplasmic reticulum.

1. **Division. Cryptophyta (cryptophytes):** nucleomorph present between inner and outer membrane of chloroplast endoplasmic reticulum; starch is formed in grains between inner membrane of chloroplast endoplasmic reticulum and chloroplast envelop; chlorophyll a and c; phycobiliproteins; periplast is found inside plasma membrane.

**2. Division. Cryophyta (golden-brown algae):** chlorophyll a and  $c_1$  and sometimes  $c_2$ ; fucoxanthin; anterior tinsel and posterior whiplash flagella; storage product chrysolaminarin is found in vesicles in cytoplasm.

**3. Division. Prymnesiophyta (haptophytes):** haptonema, chlorophyll a,  $c_1$  and  $c_2$ , fuco-xanthin; two whiplash flagella; scales common outside cell; storage product chrysolaminarin is found in vesicles in cytoplasm.

**4. Division. Bacillariophyta (diatom):** silica in cell walls; chlorophyll a,  $c_1$  and  $c_2$ ; fuco-xanthin; one posterior tinsel flagellum on sperm; storage product chrysolaminarin is found in vesicles in cytoplasm.

**5. Division. Xanthophyta (yellow green algae):** eye-spot in chloroplast; chlorophyll a and c; anterior tinsel flagellum and posterior whiplash flagellum.

**6. Division. Eustigmatophyta:** eye-spot large and outside chloroplast; chlorophyll a; posterior whiplash flagellum (commonly reduced) and anterior tinsel flagellum.

**7. Division. Raphidophyta (chloromonads):** chlorophyll a and c; anterior tinsel flagellum and posterior whiplash flagellum.

**8. Division. Phaeophyta (brown algae):** unilocular and plurilocular sporangia, chlorophyll a,  $c_1$  and  $c_2$ ; fucoxanthin; storage product chrysolaminarin is found in vesicles in cytoplasm; anterior tinsel flagellum and posterior whiplash flagellum.

Later on **Robert Edward Lee (1999)** revised the classification of algae (“Phycology”, R.E. Lee, 1999, 3rd Edn.) with some modification of his earlier classification proposed in 1989 in his book “Phycology”.

**Robert Edward Lee (1999) classified the algae into four evolutionary groups, nine phyla and different classes.**

The 1st group consists of prokaryotic algae only, the others are eukaryotic.

**The standard botanical classification system used (suffix) in the systematics of the algae**

**Phylum-Phyta**

**Class-Phyceae**

**Order-ales**

**Family-aceae**

**Genus**

**Species**

## Group 1. Prokaryotic algae:

### 1. Phylum. Cyanophyta (cyanobacteria):

Chlorophyll a; phycobiliproteins

**Class. Cyanophyceae** -The principal pigments are chlorophylls a (green), c-phycoerythrin (red) and c-phyocyanin (blue).

## Group 2. Eukaryotic algae:

Eukaryotic algae with chloroplast surrounded only by the two membranes of the chloroplast envelope.

### 1. Phylum. Glaucophyta:

Algae that represent an intermediate position in the evolution of chloroplast; photosynthesis is carried out by modified endosymbiotic blue-green algae.

### 2. Phylum. Rhodophyta (red algae):

Chlorophylls a and d; phycobiliproteins; no flagellated cells; storage product is floridean starch.

**Class. Rhodophyceae:**- Presence of chlorophylls a and d, phycobiliproteins include r-phycoerythrin, allophycoerythrin, and three forms of phycoerythrins (b, r and c).

1. Porphyridiales. e.g., Porphyridium, Rhodosorus etc.
2. Rhodochaetales. e.g., Rhodochaete.
3. Acrochaetales. e.g., Audouinella, Rhodochorton etc.
4. Bangiales. e.g., Bangia, Porphyra etc.
5. Batrachospermales. e.g., Batrachospermum.
6. Nematiales. e.g., Nematium etc.
7. Corallinales. e.g., Corallina, Melobesia etc.
8. Gelidiales. e.g., Gelidium.
9. Gracilariales. e.g., Gracilaria.
10. Ceramiales. e.g., Polysiphonia

### 3. Phylum. Chlorophyta (green algae):

Chlorophyll a and b; storage products starch is found inside the chloroplast

**Group 3. Eukaryotic algae** with chloroplast surrounded by one membrane of chloroplast endoplasmic reticulum.

### **1. Phylum. Euglenophyta (euglenoid):**

Chlorophylls a and b, one flagellum with a spiral row of fibrillar hairs; proteinaceous pellicle in strips under the plasma membrane; storage product paramylon; characteristic type of cell division.

**Class Euglenaceae:**

**3 orders:**

1. Heteronematales. e.g., Peranema, etc.
2. Eutreptiales. e.g., Eutreptia, Eutreptiella etc.
3. Euglenales. e.g., Euglena, Trachelomonas, Phacus etc.

### **2. Phylum. Dinophyta (dinoflagellates):**

Mesokaryotic nucleus; chlorophylls a and  $c_1$ ; cell commonly divided into an epicone and a hypocone by a girdle; helical transverse flagellum; thecal plates in vesicles under the plasma membrane.

**one Class:**

Dinophyceae.

**4 orders:**

1. Prorocentrales. e.g., Prorocentrum.
2. Dinophysales. e.g., Ornithocercus.
3. Peridinales. e.g., Ceratium.
4. Gymnodiales. e.g., Gymnodinium.

## Group 4. Eukaryotic algae:

Eukaryotic algae with chloroplast surrounded by two membranes of chloroplast endoplasmic reticulum.

### 1. Phylum. Cryptophyta (cryptophytes):

Nucleomorph is present between inner and outer membranes of chloroplast endoplasmic reticulum; Starch is formed in grains between inner membrane of chloroplast endoplasmic reticulum and chloroplast envelop; chlorophylls a and c; phycobiliproteins; periplast is found inside plasma membrane.

#### one Class:

Cryptophyceae.-The plant body is dorsiventral in shape, with the cells flattened in one plane.

### 2. Phylum. Heterokontophyta (heterokonts):

Anterior tinsel and posterior whiplash flagella, chlorophylls a and  $c_1$ , fucoxanthin, storage product usually chrysolaminarin occurs in vesicles in cytoplasm.

#### nine (9)classes.

#### 1.Class. Crysophyceae (golden-brown algae)

#### 2.Class. Synurophyceae:

#### divided into 3 orders:

1. Goniomonadales. e.g., Goniomonas.
2. Cryptomonadales. e.g., Cryptomonas.
3. Chroomonadales. e.g., Chroomonas.

#### 3.Class. Dictyochophyceae (silicoflagellates):

#### divided into 3 orders:

1. Rhizochromulinales. e.g., Rhizochromulina, Phaeaster, Chrysoamoeba etc.
2. Pedinellales. e.g., Pedinella, Apedinella, Pseudopedinella, etc.
3. Dictyocales. e.g., Dictyocha etc.

**4. Class. Pelagophyceae**

**5. Class. Bacillariophyceae (diatoms)**

**divided into 2 orders:**

1. Biddulphiales. e.g., Melosira, Chaetoceros etc.
2. Bacillariales. e.g., Amphora, Navicula, Pinnularia

**6. Class Raphidophyceae (chloromonads):**

**7. Class. Xanthophyceae (yellow-green algae):**

**divided into 3 orders:**

1. Tribonematales. e.g., Tribonema.
2. Botrydiales. e.g., Botrydium.
3. Vaucheriales. e.g., Vaucheria.

**8. Class. Eustigmatophyceae:**

**9. Class. Phaeophyceae:**

**into 7 orders:**

1. Ectocarpales. e.g., Ectocarpus, Raftsia etc.
2. Desmarestiales. e.g., Desmarestia.
3. Cutleriales. e.g., Cutleria, Aglaozonia, etc.
4. Laminariales. e.g., Laminaria, Chorda etc.
5. Sphacelariales. e.g., Sphacelaria.
6. Dictyotales. e.g., Dictyota.

### **3. Phylum. Prymnesiophyta (haptophytes)**

**one Class:  
Prymnesiophyceae.**

**Devided into two orders:**

1. Prymnesiales. e.g., Prymnesium, Emiliania, Hymenomonas etc.
2. Pavlovales. e.g., Pavlova etc. Life cycle patterns.

## References

1. [www.biologydiscussion.com>algae-biotechnology>classification of algae by various Botanists by Neelesh T](http://www.biologydiscussion.com/algae-biotechnology/classification-of-algae-by-various-Botanists-by-Neelesh-T)
2. wikipedia