

Lecture 17: Morphology of algae – economic importance

Algae are any of numerous groups of chlorophyll-containing, mainly aquatic eukaryotic organisms ranging from microscopic single-celled forms to multicellular forms 100 feet (30 meters) or more long, distinguished from plants by the absence of true roots, stems, and leaves and by a lack of nonreproductive cells in the reproductive structures: classified into the six phyla Euglenophyta, Crysophyta, Pyrrophyta, Chlorophyta, Phaeophyta, and Rhodophyta.

Algae can be grown using water resources such as brackish-, sea-, and wastewater unsuitable for cultivating agricultural crops. When using wastewater, such as municipal, animal and even some industrial runoff, they can help in its treatment and purification, while benefiting from using the nutrients present.

The taxonomy of algae is mainly based on the following features: the pigments (or colors), photosynthetic products, composition of the cell wall, number of flagella, position of the flagella, cell structures, growth patterns, branching, holdfasts, types of sporangia, carpogonial branches and cystocarps.

Phylum	Pigment	Photosynthetic product(s)	Cell wall	Flagellum	Cell nucleus	Form	Note
Green algae (Chlorophyta)	chlorophyll a and b, α , β -carotene, lutein	starch	cellulose	biflagellate; equal in length; apical	Yes	unicellular, colonies or multicellular	Widely distributed; both terrestrial and marine, ca. 1,200 species worldwide.
Brown algae (Phaeophyta)	chlorophyll a and c, fucoxanthin, β -carotene, lutein	laminaran, mannitol	cellulose, alginate	biflagellate; not equal in length; lateral or not flagellum	Yes	multicellular	99.7% marine, ca. 2,000 species worldwide.
Red algae (Rhodophyta)	chlorophyll a,d; a, phycoerythrin, phycocyanin, α , β -carotene	floridean starch	Cellulose, carrageenan or agarose	No	Yes	Uni- or multicellular	98% marine, ca. 6,000 species worldwide.
Blue-green algae (Cyanophyta)	Chlorophylla; phycocyanin, phycoerythrin, β -carotene, lutein	glycogen, cyanophycean starch	glycoprotein cellulose	No	No	unicellular; colonies	Mostly freshwater (75%), some marine.

In the past, there were only three biological kingdoms i.e. Animalia (animal), Plantae (plant) and Protozoa. As algae have cell walls and chlorophyll a for photosynthesis, they were classified under Plantae. However there are five kingdoms in biology: Protista, Monera, Fungi, Plantae and Animalia. Since algae do not have vascular tissue, they no longer belong to the Planta kingdom. Instead, they are now placed in two kingdoms: Protista and Monera.

Blue-green algae belong to Monera. Green algae, red algae and brown algae belong to Protista.

Modes of reproduction: Sexual and asexual

- Have single celled gametangia (reproductive organs)
- no multicellular reproductive organs
- Life history has 1, 2, or 3 stages (in contrast, plants have 2 stages, gametophyte and sporophyte)

MORPHOLOGY OF ALGAE

The term "morphology" describes the shape, form or growth habit of an organism and its parts. Algae exhibit extremely diverse morphology. Some, like Chlorella, are unicellular organisms similar to bacteria, whereas others such as kelp are complex, multicellular organisms with cells similar to plants. Other algae run the gamut of morphological diversity, but can be categorized into several major groups.

Unicellular

- **Unicellular algae consist of a single cell.** The single cell of the body contains a chloroplast, which conducts photosynthesis to create energy from sunlight, and often contains a structure called a pyrenoid that can store energy and contractile vacuoles that help to regulate the amount of water and salts within the cell (i.e., osmoregulation). Some unicellular algae such as Chlamydomonas are motile, or able to move, using flagella.

Colonial

- Colonial algae include different numbers of cells. Some, such as Gonium, consist of a **small group of cells**, whereas others, such as Volvox, consist of hundreds of cells. Specialized colonies called coenobium contain a specific number of cells, each with their own tasks, that cannot survive alone. Like unicellular algae, many colonial algae are motile.

Filamentous

- **Filamentous algae undergo cell division but remain connected, forming long filaments of attached cells.** Each cell within the filamentous alga has its own internal structures, such as a chloroplast, and is capable of photosynthesis. Spirogyra is one commonly-studied alga. At low tide, this stringy, green algae is exposed on rocks. Under the microscope, Spirogyra reveals a unique, spiral arrangement of chloroplasts.

Siphonous

- Siphonous algae have a morphology that superficially resembles that of filamentous algae. However, siphonous algae **consist of only one single cell with branching sections**. Enteromorpha is a siphonous algae that appears similar to Spirogyra to the naked eye.

Parenchymatous

- Certain red algae contain boxy, **plant-like cells and have a complex, multicellular structure that is termed "parenchymatous."** Although the cells of algae do not truly differentiate to form various structures, these parenchymatous algae often have parts that resemble leaves, stems and roots. Kelp grows to immense lengths, and is perhaps one of the best-known parenchymatous algae.

ECONOMIC IMPORTANCE OF ALGAE

Since from olden days Algae species are intimately connected with human beings as a source food, medicine and other uses. Algae are taking an active role in human beings.

1. Primary Producers:

Algae are the main Oxygen producers in aquatic areas. They are also useful in decreasing water pollution by realizing Oxygen. 10% of photosynthesis is occurred by the algae in total photosynthesis quantity. With these activity algae forms 1.6-15.5 x 10 to the power of 11 tons of carbonic material like food.

2. Algae as food:

Algae species are used as food in several countries in several forms. Algae species have proteins, vitamins (A, B, C and E), lipids, and minerals. Laminaria species is the important edible seaweed in Japan and the food item 'Kombu' is prepared from it. 'Aonori' from Monostroma; 'Asakusa Nori' from Porphyra are prepared in different countries. Porphyra has 35% protein, 45% carbohydrates, Vitamins B and C and Niacin. Nostoc is used as food material in South America.

3. Algae as fodder for cattle:

Rhodymenia palmate is used as food for sheeps in Narvey. Laminaria saccharina, Pelvitia, Ascophyllum, etc. species are used as food for cattles.

4. Algae as fertilizers:

Blue-green algae are treated as bio-fertilizers from olden days. Nostoc, Oscillatoria, Scytonema, Spirulina, etc. are used as fertilizers to rice fields. All these algae are fixed the atmosphere Nitrogen in to ground. Cultivation of Spirulina is gaining importance as feed for fish, poultry and cattle.

5. Algae in Pisi culture:

Sea algae are used as food for fishes. So they play an important role in Pisi culture. Some green-algae, Diatoms, some blue-green algae are used as food material to fishes. These are also making the water clean, by realizing Oxygen.

6. Algae in reclamation of alkaline or Usar soils:

Our country has more number of alkaline soils or sterile soils. Blue-green algae like Nostoc, Oscillatoria, Scytonema, Spirulina are modified the soils in to fertile soils. Because they fixed Nitrogen in to soil. Nearly they fixed 400 K.g. of Nitrogen per year. Soil erosion is also reduced by these algae.

7. Algae in industry:

Iodine industry is mainly depended upon algae. Algae belonging to Phaeophyceae, like Laminaria, Ecklonia, Eisenia, etc. are used in the industry to prepare Iodine in industries. Phyllophora is used to prepare Iodine in Russia.

8. Alginates:

Alginates are the salts of **alginic acid found in the cell wall of phaeophyceae**. Alginates

are extracted from Fucus, Laminaria, Macrocystis and Ecklonia. Alginates are used in the preparation of flame-proof fabrics, plastics, paints, gauze material in surgical dressing, soups, ice creams etc.

9. Agar-Agar:

Agar-agar is a jelly like substance of great economic value. It is obtained from certain red algae like Gelidium, Gracilariaria, and Gigartina. Agar is used as a culture medium for growing callus in tissue culture.

10. Carrageen or Carrageenin:

It is extracted from cell walls of red algae like Chondrus and Gigartina. It is a **polysaccharide esterified with sulphate**. It is used as emulsifier in pharmaceutical industry and also in textile, leather, cosmetics and brewing industries.

11. Diatomite:

Diatoms deposits at marine and fresh water areas. **They are rich with silica**. It is called as diatomite. It is used in the preparation of Dynamite in olden days. But now it is used in different industries like glass, metal polishing, paints, tooth pasts, soups, etc.

12. Funori:

It is a type of glue obtained from a red alga Gloiopeltis furcata. It is used as an adhesive as well as sizing agent for paper and cloth. Chemically it is similar to agar-agar except that there is no sulphate ester group.

13. Minerals:

The brown sea weeds popularly called as kelps yield potash, soda, and iodine. Some sea weeds are rich source of iron, zinc, copper, manganese and boron. Bromine is extracted from red algae such as Polysiphonia and Rhodymenia.

14. Antibiotics and Medicines:

Antibiotic Chlorellin, obtained from Chlorella is effective against a number of pathogenic bacteria. Extracts from Cladophora, Lyngbya can kill pathogenic Pseudomonas and Mycobacterium. Laminaria is used as one of the modern tools for abortion. Seaweeds have beneficial effect on gall bladders, pancreas, kidneys, uterus and thyroid glands.

15. Role of Algae in Sewage Disposal:

Some species like Chlamydomonas, Scenedesmus, Chlorella, Pongorhina, Euridina, etc are living in sewage water. They are mainly useful to clean the water by realizing Oxygen. They also modified the carbonate material in the water into N, P, K fertilizers.

16. Algae as research material:

In biological research algae are useful because of their rapid growth, brief life span and easy mode of cultivation. Chlorella, Scenedesmus and Anacystis are used in investigations in photosynthesis. Blue-green algae are used in studies on nitrogen fixation. Researches in Genetics and Cytology are carried out on Acetabularia.

17. Algae in Space:

Chlorella and Synechococcus are finding application in space ships and nuclear submarines as oxygen regenerating and food and water recycling organisms.

Harmful aspects of Algae

Some algae species like **Microcystis, Lyngbya** are develop **water blooms** in water areas. They secrete toxic materials into water. That they polluted the water. The algae, *Cephaleuros virescens* causes for **red rust tea** in tea plant. Some algae species are caused for some **skin diseases**. Dinoflagellate is caused for the death of fishes in water.