B.Sc. (Botany Hons.) Part-1, Paper-1

Algae- General Characteristics and Economic Importance

The term **Algae (L. alga- seaweed)** is collectively used for all the **Chlorophyll bearing non-vascular thalloid organisms**. **Linnaeus (1754)** first coined the term algae, which he placed along with Liverworts & lichen under class Cryptogamia of Conventional Plant-Kingdom. But, in Whittaker's classification, all members of algae are redistributed in three kingdoms i.e. Monera (Blue Green Algae), Protista (Diatoms, Dinoflagellates, Euglenoids) & Plantae (Green algae, Brown algae & Red algae).

The study of algae is called Phycology or Algology. F.E. Fritsch is known as 'Father of algology' and, his student M.O.P. Iyenger from Madras University is known as the 'father of Modern Algology of India'. His important contribution is discovery of heterotrichous terrestrial alga (Fritschiellatuberosa).

General characteristics:

1. Algae include a group of about of 30,000 species which are generally aquatic (both freshwater & marine).

2. Their size varies from microscopic forms to the filamentous forms.

3. All the members of algae are Chlorophyllous, non-vascular thallophytes.

4. They contain chlorophyll a, carotenes and xanthophylls. Additional pigments occur in specific groups.

5. Mucilage protects algal thallus from desiccation and from epiphytic growth. G. Vascular & mechanical tissues absent.

7. Vegetative and asexual modes of reproduction are very common. Asexual spores are of two types: mitospores and meiospores. They are easily dispersed in aquatic habitat, actively, if motile and passively by water currents, if non-motile.

8. Sex organs are non jacketed.

9. Sexual reproduction usually occurs towards the end of growing season.

10. Embryonic stage absent which is a characteristic feature of thallophyta.

11. Sexual reproduction involves isogamy, anisogamy and oogamy in different groups.

12. Different types of life cycle occur, viz., Haplontic (haploid phase dominant), Diplontic (diploid phase dominant) and Haplodiplontic (both haploid and diploid phase equally dominant).

Economic Importance of ALGAE

There are many economic uses of Algae which may be summarised as follows:

1. Algae Constitute the Link of Food Chain: Both fresh and saltwater contain an enormous variety of algae which constitute the fundamental or primary link of many diverse food chains. Algae synthesize organic food stuffs, just as do the plants of the land. As the flesh of the land is dependent upon the activities of the green leaf, so the fish and other aquatic forms of animal life are dependent, directly or indirectly, upon algae, and fish in turn are important item in the daily diet of larger sea animals and man.

The reserve food materials in these algae, e.g., fats and volutin in the diatoms; starch, often accompanied by oil in the green algae; sugars and glycogen in the blue-green algae; and polysaccharides in Euglena are utilized by fish.

2. Algae is Useful in Fish Culture:

That algae are fruitfully utilized in fish culture can very well be indicated from the successful culture of the Siamese fish, _Tilapia mossambica_ which is voracious feeder of filamentous algae. This particular fish has been successfully introduced in different parts of India. A culture of _Scenedesmus_ is often exclusively used as a daily dose of fish meal for the culture T. mossambica.

3. Algae is Used for Recreational Purposes:

Certain selected algae are grown in recreational areas like—lakes and streams along with fish.

4. Algae is Useful in Sewage Treatment Plants:

Species of Chlamydomonas, Scenedesmus, Chlorella and Euglena are used in sewage treatment plants for providing through photosynthesis the oxygen necessary for rapid decomposition of the sewage by bacteria.

5. Algae and Water Supplies:

In the summer months the phytoplankton in ponds, lakes and reservoirs may become so abundant as to be extremely conspicuous. The water becomes cloudy and may assume a yellowish or greenish tinge. A floating mat of scum may develop.

These manifestations of algal growth are popularly termed **'water bloom'**. Such concentrations of algae are extremely objectionable, not only in public water supplies but also in waters used for bathing, fishing and other recreational purposes.

The blue-green algae are most frequently involved in the con-tamination of water supplies, but the greens, the flagellated golden-brown, and the diatoms are also troublesome at times. Mention may be made of *Prymnesium parvum, Gymnodinium veneficum* and *Microcystis spp*. which cause mortality of fish and domestic animals that drink water infested with these algae.

The living and the dead and decaying algae impart disagreeable oily or fishy odours to the water.

Toxic protein decomposition products may be formed by blue-green algae and these are known to have caused death of cattle, sheep, and other animals which have drunk heavily infested water.

6. Algae as the Origin of Petroleum and Gas:

The origin of oil and gas has been a matter of controversy, but it is now generally believed that, like coal, these fuels owe their energy to photosynthesis in ancient plants.

The plankton of the seas was probably of the greatest importance as a source of this organic matter. Minute marine algae captured the energy of sunlight, which was in turn transferred to the animals that fed upon them.

Natural gas is largely methane (CH4), which can be produced by certain kinds of anaerobic bacteria. Gas is generally associated with oil and can result from the action of methane-producing bacteria upon organic compounds.

7. Algae and Limestone Formation:

Many species of algae withdraw calcium from water, both fresh and salt, and deposit it, in the form of calcium carbonate, in their cell walls or gelatinous sheaths. The most significant forms in this category are the blue-greens and reds, but certain green algae and flagellates are also concerned.

The blue-greens are chiefly important in fresh-waters; they are responsible, for example, for the formation of extensive limestone deposits around hot springs and glaciers. The red algae are the most important calcareous algae of the seas; in particular, they play a significant role in the construction of coral reefs and islands.

8. Algae is Used in Space Research and Other Fundamental Studies.

In recent years Chlorella is being used in space research. Chlorella has been found very suitable for keeping the air in space vehicles pure on long interplanetary flights. The stale air in which the carbon dioxide has been concentrated is fed into a flood-lit con-tainer containing a mixture of water and nutrient chemicals and Chlorella.

The alga restores oxygen into the space vehicle by its photosynthesis. Again species of Chlorella, Chlamydomonas, and Acetabularia are used as tools for solving fundamental biochemical and genetical problems.

9. Algae is Used as Food:

Large number of algae have entered into the diets of human beings from ancient times. The earliest records are those of the Chinese, who mentioned such food plants as *Laminaria* and *Gracilaria* in their *‘materia medica’* several thousand years ago.

The ancient inhabitants of Japan ate *Porphyra* as a healthful supplement to their rice diet. Its use became widespread, not only in Japan, but in China in course of time. *Kombu* , a Japanese food is prepared from stipes of species of Laminaria.

Perhaps the best known and most widely used food alga in Western Europe in recent centuries was *Irish moss,* or *carragheen* (_Chondrus chrispus_), which was cooked with milk, seasoned with vanilla or fruit, and made into a highly palatable dish known, as blancmanges. The jellying qualities of Irish moss gave the alga an early food use.

Man, thus obtains carbohydrates, vitamins (algae are especially rich in vitamins A and E, and they contain some C and D), and inorganic substances, e.g., iodine (goiter is unknown among the people who eat seaweeds), not to mention the benefits of the mild laxative action of the ingested algae.

10. Algae is Used as Fodder:

Europeans profited by extensive use of these plants for stock feed. In Ice-land and Scandinavia, in the British Isles, and along the coast of France, stock has long been driven or allowed to wander to the seashore at low tide to feed on seaweeds.

Some kinds of algae, such as Rhodymenia palmata and Alaria esculenta, are favourable food of goats, cows, and sheep, and in Scotland and Ireland the stock actively hunt the shores at low tide for particular algae, especially the former.

The milk does not have any taste of algae, nor is the meat inferior because of the seaweed diet.

The high mineral and vitamin G content of kelp meal has made possible its use in various poultry and other animal rations.

11. Algae is Used as Fertilizers:

The value of seaweeds in fertilizing the soil was dis-covered early in the history of agriculture in coastal Asia, and by the ancient colonizers of the coasts and islands of North-Western Europe. In some areas of Britain, and along the coast of North-West France.

Furthermore, the bulky organic substances decay slowly in the soil and form humus. Again yield of paddy is increased substancially when paddy field is inoculated with nitrogen fixing blue-green algae. Some of them are: Tolypothrix tenius, Aulosira fertilissima, Anabaena oryzae, Anabaenopsis arnoldii, Calothrix confervicola, Nostoc commune, and Cylindrospermum bengalense.

12. Algae is Used as Medicine:

Medicinal applications of plants are almost as old as their food uses. From earliest times the Chinese used Sargassum and various Lamina-riales for treatment of goiter and other glandular troubles. Gelidium very early became employed for stomach disorders arid for heat-induced illness.

The gentle swelling of dried Laminaria stipes upon exposure to moisture make them surgical tool in the opening of wounds. Similarly, the orientals have employed the same technique in child-birth for expansion of the cervix.

Perhaps the algae used most widely and for the longest time for medicinal pur-poses and from which agar is extracted are the agarphytes, including Gelidium, Pterocladia, Gracilaria, and Ahnfeltia. The name **'agar-agar'** is of Malay origin and. means 'jelly'. This jelly was obtained by boiling up seaweeds and cooling the resulting liquid.

Agar early became useful for stomach disorders and as a laxative, and was once em-ployed as a dietetic. It was originally produced and marketed in China, bat the Japanese took over production in about 1662 and maintained a world monopoly till 1940.

Chlorella is used for the preparation of antibiotic **Chlorellin.**

13. Industrial Utilization of Algae:

The industrial utilization of algae may be outlined in the following manner:

(i) Kelp Industry:

Industrial utilization of seaweeds in Europe had its principal early development in the production of **'kelp'**, a name that originally referred to the ash, rich in soda and potash, derived from burning marine plants. Kelp production was begun sometimes in the seventeenth century by French peasants and spread to other parts of North-West Europe.

Drift-weeds were first used, but cutting was later resorted to Laminaria and Saccorhiza in North Britain as of major importance.

Kelp extract contains a number of chemical elements, notably potassium and iodine. About 25 per cent, of the dry weight of kelp is potassium chloride. Many species of kelp are used as food for man, especially in the Orient. In Northern Europe they also serve as food for domestic animals, such as sheep and cattle.

(ii) Algin Industry:

Algin is the general term designating the hydrophilic, or water-loving derivatives of alginic acid. The most commonly known algin is sodium alginate, but other commercially important compounds are the potassium, ammonium, calcium, and propylene glycol alginates, as well as alginic acid itself.

With the excep-tion of alginic acid and calcium, alginate, the algin products offered commercially arc soluble in water to form vis-Sous solutions.

Algin occurs generally throughout the brown algae (Laminaria, Macrocystis, Sargassum and Fucus) as a cell wall constituent. It has remarkable water-absorbing qualities that make it useful in numerous industries in which a thickening, suspending, stabilizing, emulsifying, gel-forming, or film-form-ing colloid is required.

Thus, algin provides ice cream with a smooth texture by pre-venting the formation of ice crystals. In automobile polishes it suspends the abrasive; in paints, the pigments; also in pharmaceuticals, the drugs and antibiotics. As a stabi-lizing agent it serves in the processing of rubber latex .and in the printing of textiles. As an emulsifier it is widely used in such products as water-based paints, French dressings, and cosmetics.

(iii) Agar Industry:

The outstanding use of the red algae, however, is in the production of *agar* . This is a dried and bleached gelatinous extract obtained from red algae— _*Gelidium nudifrons*_ , *G. pusillum*, G. robustum, and *Gracilaria verrucosa*. Agar is used extensively in medicine, chiefly as laxative, since it is not digested and in-creases greatly in bulk with the absorption of water.

More important than this medicinal utilization is its use as an essential ingredient in the preparation of medium for the growth of bacteria and fungi. As such it is indispensable in bacteriological laboratories, because no adequate substitute for agar is known.

Agar serves widely as a substitute for gelatin, as an anti-drying agent in breads and pastry, in improving the slicing quality of cheese, in the preparation of rapid-setting jellies and desserts, and in the manu-facture of frozen dairy products. The use of agar in meat and fish canning has greatly expanded, and hundreds of tons are utilized annually.

Early industrial uses of agar in the Orient included sizing fabric, water-proofing paper and cloth, and making rice paper more durable. Modern industry has refined and expanded these uses to meet new needs in the manufacturing of such items as photographic film, shoe polish, dental impression molds, shaving soaps, and hand lotions.

In the tanning industry agar imparts a gloss and stiffness to finished leather. In the manufacture of electric lamps, a lubricant of graphite and agar is used in draw-ing the hot tungsten wire.

(iv) Diatomaceous Earth Industry:

The Diatoms are equally important in comparison with other algae that have industrial utilization. Most species of Diatoms are marine, and when these minute plants die, they fall to the sea bottom and, because of their siliceous nature, the cell walls are preserved indefinitely. Great deposits of this material, known as diatomaceous earth, are found in many parts of the world.

Because diatomaceous earth is inert chemically and has unusual physical pro-perties, it has become an important and valuable material in industry. It makes an excellent filtering agent, which is widely used to remove colouring matters from pro-ducts as diverse as petrol and sugar.

As a poor conductor of heat it is used in sound-proofing. It is used in the manufacture of paints and varnishes, of phonograph records, and as a filler for battery boxes. Because of its hardness, it is used as an abrasive in scouring and polishing powders.

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