B.Sc. Semester I

Botany

Unit III - Phycology

Pigments and Reserve food in Algae

Dr. Sugandha Tiwari
Associate Professor
Department of Botany
D.G. College, Kanpur
Email: sugandhatiwari7@gmail.com

PIGMENTS IN ALGAE

Pigments in Algae

Algae show great diversity in pigmentation. Colour of the algal thallus (plant body) may be green,blue- green, red, brown or golden brown depending on the dominant pigment present .

Type of pigment present in the algal thallus is an important criteria for their classification.

Pigments in Algae

Volvox- Green algae (Class Chlorophyceae)
https://commons.wikimedia.org/wiki/File:Mikrofoto.de-volvox-8.jpg

Polysiphonia- Red algae (Class Rhodophyceae)
https://commons.wikimedia.org/wiki/File:Polysiphonia_spermatangia_WM.jpg

Sargassum- Brown algae (Class Phaeophyceae)
https://commons.wikimedia.org/wiki/File:Sargassum_natans_%28brown_algae%29_%28San_Salvador_Island,_Bahamas%29_2_%2816055332975%29.jpg

Chlorophylls

Chlorophyll is found in all photosynthetic organisms, including green plants, cyanobacteria, and algae

Chlorophyll is composed of a porphyrin-ring system that is very similar to that of hemoglobin but has a magnesium atom instead of an iron atom.

The algae have four types of chlorophyll, a, b, c and d.

Chlorophyll a is the primary photosynthetic pigment in all photosynthetic algae.

Chl a has two main **absorption bands** in vitro, one band in the red light region at 663 nm and the other in violet region at 430 nm .

Chlorophylls

chlorophyll a - found in all photosynthetic algae

Chlorophyll b - Euglenophyta and Chlorophyta.

Chlorophyll c- Dinophyta, Cryptophyta, Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae).

Chlorophyll d -occurs in some cyanobacteria, Rhodophyceae.

Chlorophyll e- rare and found in some golden algae (chrysophyceae)

Carotenoids

Carotenoids are yellow, orange, or red pigments that usually occur inside the plastid but may occur outside in certain cases.

carotenoids can be divided into two classes:

(1) oxygen-free hydrocarbons, the carotenes; and

(2) their oxygenated derivatives,the xanthophylls.

The most widespread carotene in the algae is β-carotene.

Fucoxanthin

Fucoxanthin is the principal xanthophyll in the golden- brown algae and found in (Chrysophyceae, Bacillariophyceae, Prymnesiophyceae, and Phaeophyceae), giving these algae their characteristic brown color.

Phycobilins/ Phycobiliproteins

The cyanobacteria and chloroplasts of the Rhodophyta contain phycobiliproteins

Phycobiliproteins are water-soluble

blue (phycocyanin) or

red (phycoerythrin) pigments

Phycobilins/ Phycobiliproteins

There are 3 types of phycoerythrin:

1. R-phycoerythrin - Rhodophyta
2. B-phycoerythrin - Rhodophyta
3. C-phycoerythrin - Cyanophyta

There are also 3 types of phycocyanin:

1. R-phycocyanin - Rhodophyta
2. C-phycocyanin - Cyanophyta
3. Allophycocyanin - Cyanophyta

RESERVE FOOD IN ALGAE

Reserve Food in Algae

(1) α-1,4 Linked glucans (polysaccharide derived from D glucose, linked by **α-1,4** glycosidic bonds)

(2) β-1,3 Linked glucans(polysaccharide derived from D glucose, linked by **β-1,3** glycosidic bonds)

(3) Fructosans: Polymer of fructose units terminated by a glucose group.

(4) Low-molecular-weight compounds:

- Sugars
- Polyols
- Glycosides

Reserve Food in Algae

(1) α-1,4 Linked glucans (polysaccharide derived from D glucose, linked by glycosidic bonds)

(a) Floridean starch : occurs in Rhodophyta and is similar to the amylopectin of higher plants. Floridean starch is stored in the form of grains outside the chloroplast. This differs from the Chlorophyta where starch is produced in the chloroplast.

(b) Myxophycean starch: Found in the Cyanophyta, myxophycean starch has a similar structure to glycogen.

(c) True Starch: In the Chlorophyta, starch is composed of amylose and amylopectin. It occurs inside the chloroplast in the form of starch grains . True starch is also found in Cryptophyta and in Dinophyta.

Reserve Food in Algae

(2) β-1,3 Linked glucans(polysaccharide derived from D glucose, linked by glycosidic bonds)

(a) Laminarin : In the Phaeophyceae, laminarin occurs as an oil-like liquid outside of the chloroplasts, commonly in a vesicle surrounding the pyrenoid.

(b)Chrysolaminarin (leucosin): In the Chrysophyceae, Prymnesiophyta, and Bacillariophyceae, chrysolaminarin occurs in vesicles outside of the chloroplast and has more glucose residues per molecule than laminarin.

(c) Paramylon: In the Euglenophyta and Xanthophyceae, , paramylon occurs outside of the chloroplast.

Reserve Food in Algae

(3) Fructosans: Acetabularia (Chlorophyta) has an inulin-like storage product.

Fructosans are polymer of fructose units terminated by a glucose group.

Reserve Food in Algae

(4)Low-molecular-weight compounds

(a) Sugars:

Sucrose is found in Chlorophyta and Euglenophyta

Trehalose is found in the Cyanophyta and at low levels in the Rhodophyta.

(b) Glycosides: The glycerol glycosides, floridoside and iso floridoside, are widely distributed in the Rhodophyta.

(c) Polyols: Mannitol occurs in Rhodophyta and Phaeophyceae.

Free glycerol occurs widely in the algae and is an important photosynthetic product in several zooxanthellae (endosymbiotic algae in animals) and in some marine Volvocales, especially Dunaliella.

S. No.	Algal Class	Major pigments Chlorophyll a and beta carotene are present in all the algal classes	Reserve food (Storage products)
1.	**Cyanophyceae** (Blue- green algae)	c- phycocyanin (blue), allophycocyanin, c-phycoerythrin (red), myxoxanthin , myxoxanthophyll, zeaxanthin	cyanophycean starch and cyanophycean granules (proteins)
2.	**Rhodophyceae** (Red algae)	chlorophyll d, r- phycocyanin (blue), r- phycoerythrin (red), zeaxanthin	floridean starch
3.	**Chlorophyceae** (Green algae)	chlorophyll b, carotenes and xanthophylls	starch
4.	**Xanthophyceae** (Yellow- green algae)	chlorophyll c & e, carotenes and xanthophylls	oil, fats, leucosin
5.	**Bacillariophyceae** (Golden- brown algae, Diatoms)	chlorophyll c, diatoxanthin, diadinoxanthin, fucoxanthin	Fats , leucosin
6.	**Phaeophyceae** (Brown algae)	chlorophyll c, carotenes, fucoxanthin, violaxanthin	Laminarin, mannitol

Let’s revise

Q.1 Give the pigment composition and reserve food of the following classes of algae-

Cyanophyceae, Chlorophyceae, Phaeophyceae and Rhodophyceae

Q.2 What are phycobiliproteins.

Q.3 Compare the pigment composition of class cyanophyceae and rhodophyceae.

Q.4 What are the different types of chlorophylls. Give their distribution in algal classes.

References:

Recommended Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East- West Press Pvt. Ltd. Delhi 2nd edition.
2. Annie Ragland, 2012, Algae and Bryophytes, Saras publication, Kanyakumari, india.
3. Chopra, G.L., 1984. A textbook of Algae, rastogi Publications, Meerut, India.
4. Desicachari, T.V., 1959. Cyanophyta, ICAR, New delhi.
5. Fritsch, F.E., 1977. structure and Reproduction of Algae, Cambridge University Press, London.
6. Pandey, B.P., 2001. College Botany, Vol I, S. Chand & Company Pvt. Ltd., New Delhi.
7. Sunder Rajan, S.,2010. College Botany, Vol I, Himalaya Publications, Mumbai.
8. Vashishtha, B.R., Sinha, A.K. and Singh, V.P., 1991. Algae, S. Chand & Company Pvt. Ltd., New Delhi.
9. O.P. Sharma (2011)Algae, Tata McGraw Hill Publication.