United States Environmental Protection Agency

Learn about Cyanobacteria and Cyanotoxins

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Overview of Cyanobacteria

Blue-green algae, more correctly known as cyanobacteria, are frequently found in freshwater systems. They can also be found in estuarine and marine waters in the U.S. Cyanobacteria are often confused with green algae, because both can produce dense mats that can impede activities like swimming and fishing, and may cause odor problems and oxygen depletion; however, unlike cyanobacteria, green algae are not generally thought to produce toxins. Some freshwater cyanobacterial blooms or cyanoHABs are able to produce highly potent toxins, known as cyanotoxins.

Overview of Cyanotoxins

Cyanotoxins are produced and contained within the cyanobacterial cells (intracellular). The release of these toxins in an algal bloom into the surrounding water occurs mostly during cell death and lysis (i.e., cell rupture) as opposed to continuous excretion from the cyanobacterial cells. However, some cyanobacteria species are capable of releasing toxins (extracellular) into the water without cell rupture or death.

Species of Cyanobacteria that Produces Toxins

Cyanotoxins can be produced by a wide variety of planktonic cyanobacteria. Some of the most commonly occurring genera are Microcystis, *Dolichospermum (previously Anabaena),* and *Planktothrix*.

Microcystis is the most common bloom-forming genus, and is almost always toxic. Microcystis blooms resemble a greenish, thick, paint-like (sometimes granular) material that accumulates along shores. Scums that dry on the shores of lakes may contain high concentrations of microcystin for several months, allowing toxins to dissolve in the water even when the cells are no longer alive or after a recently collapsed bloom.

Species of the filamentous genus *Dolichospermum* form slimy summer blooms on the surface of eutrophic lakes and reservoirs. *Dolichospermum* blooms may develop quickly and resemble green paint. In less eutrophic waters, some species also form colonies, which are large dark dots in water samples and on filters after filtration.

Planktothrix agardhii forms long, slender, straight filaments that usually remain separate but form dense surface scums. Its presence may be revealed by a strong earthy odor and the filaments are easily detected visually in a water sample.

The Most Commonly Found Cyanotoxins in the U.S.

The most commonly found cyanotoxins in the U.S. are microcystins, cylindrospermopsin, anatoxins and saxitoxins.

Microcystins

Microcystins are produced by *Dolichospermum (previously Anabaena)*, *Fischerella*, *Gloeotrichia, Nodularia*, *Nostoc, Oscillatoria*, members of *Microcystis*, and *Planktothrix*. Microcystins are the most widespread cyanobacterial toxins and can bioaccumulate in common aquatic vertebrates and invertebrates such as fish, mussels, and zooplankton. Microcystins primarily affect the liver (hepatotoxin), but can also affect the kidney and reproductive system. While there is evidence of an association between liver and colorectal cancers in humans and microcystins exposure and some evidence that microcystin-LR is a tumor promoter in mechanistic studies, EPA determined that there is inadequate information to assess carcinogenic potential of microcystins in humans due to the limitations in the few available human studies (i.e., potential co-exposure to other contaminants) and lack of long-term animal studies evaluating cancer following oral exposure.

Cylindrospermopsin

Cylindrospermopsin is usually produced by *Raphidiopsis (previously Cylindrospermopsis), raciborskii (C. raciborskii), Aphanizomenon flos-aquae, Aphanizomenon gracile, Aphanizomenon ovalisporum, Umezakia natans, Dolichospermum (previously Anabaena) bergii, Dolichospermum lapponica, Dolichospermum planctonica, Lyngbya wollei, Rhaphidiopsis curvata,* and

Rhaphidiopsis mediterranea. The primary toxic effects of this toxin are damage to the liver and kidney. Following EPA Guidelines for Carcinogen Risk Assessment, there is inadequate information to assess carcinogenic potential of cylindrospermopsin.

Anatoxins

Anatoxins bind to neuronal nicotinic acetylcholine receptors affecting the central nervous system (neurotoxins). There are multiple variants, including anatoxin-a, homoanatoxin-a, and anatoxin-a(s). These toxins are mainly associated with the cyanobacterial genera *Chrysosporum (Aphanizomenon) ovalisporum, Cuspidothrix, Raphidiopsis (previously Cylindrospermopsis), Cylindrospermum, Dolichospermum, Microcystis, Oscillatoria, Planktothrix, Phormidium, Dolichospermum (previously Anabaena) flos-aquae, A. lemmermannii Raphidiopsis mediterranea (*strain of *Raphidiopsis raciborskii), Tychonema* and *Woronichinia.* There is no information available on the carcinogenicity of anatoxin-a in humans or animals or on potential carcinogenic precursor effects.

Saxitoxins

Saxitoxins are representative of a large toxin family referred to as the Paralytic Shellfish Poisoning (PSP) toxins. When toxigenic marine dinoflagellates are consumed by shellfish, toxins concentrate and are delivered to consumers of the shellfish. These toxins have been reported also in freshwater cyanobacteria including *Aphanizomenon flos–aquae, Dolichospermum (previously Anabaena) circinalis, Lyngbya wollei, Planktothrix spp. and a Brazilian isolate of Raphidiopsis raciborskii.*

More information on on cyanobacteria and cyanotoxins:

- Shedding Light on Cyanobacteria Webinar

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