Overview
Cyanobacteria are microscopic organisms commonly found in freshwater sources. Cyanobacterial blooms—caused by eutrophication—are becoming more frequent, perhaps due to increased nutrient loading, rising temperatures, and climate change. Due to the increase of cyanobacterial blooms, the occurrence of cyanotoxins—also known as algal toxins—in water supplies has also increased.

Health Effects
There is growing concern about the potential for negative health effects in humans and animals due to cyanotoxins. Most poisoning by cyanotoxins involves three types of toxins:

1. Hepatotoxins: taken up by the liver; cause weakness and anorexia
2. Neurotoxins: affect the nervous system
3. Dermatoxins: cause skin and mucous irritations upon contact (Svrcek and Smith 2004)

Regulatory Activities
There are no federal regulations for cyanotoxins in drinking water in the United States, but the U.S. Environmental Protection Agency (EPA) has issued health advisories for two cyanotoxins, microcystins and cylindrospermopsin. These non-regulatory levels are conservative levels below which no health impacts are expected, intended to serve as informal technical guidance to assist federal, state, and local officials, and managers of water systems protect public health. The health advisory levels, based on 10 days of exposure, are 0.3 µg/L for microcystin and 0.7 µg/L for...
Cyanotoxins can cause human health impacts if ingested by drinking water or by skin contact in recreational waters.

cylindrospermopsin for children less than six years old, and 1.6 µg/L for microcystin and 3.0 µg/L for cylindrospermopsin for children six and up and adults (EPA 2015). These two cyanotoxins, along with anatoxin-a, are included on the EPA’s final contaminant candidate list (CCL3). EPA has published health effects support documents for all three of these cyanobacterial toxins, but concluded that there was not adequate information to support a health advisory for anatoxin-a. The lower levels for young children are because they consume more water relative to their body weight and are therefore considered more susceptible. The World Health Organization issued a provisional guideline value of 1 µg/L for microcystin-LR, and many countries have developed their own guidelines, depending on the types of toxins found in their source waters.

Although no federal drinking water standards have been established in the United States, several states have developed proactive approaches and monitoring programs to deal with potential cyanotoxin events in recreational waters.

Detecting Cyanotoxins

Methods for the detection of cyanotoxins can be divided into those that detect the toxins and those that measure toxicity. Methods for toxin detection include high performance liquid chromatography, liquid chromatography coupled with mass spectrometry or tandem mass spectrometry, and enzyme linked immunoadsorbent assays. The methods can also be divided into those suitable for quantitative determinations and those that are more qualitative and therefore better suited as screening assays. The toxicity assays include the neuroblastoma assay and the protein phosphatase inhibition assay (Newcombe 2009). More recently, molecular methods have been developed that detect the genes controlling toxin production.

Treatment

Because cyanotoxins can be released into the water upon cell lysis, removing intact cells is the most effective means to minimize the risk of releasing intracellular metabolites (Yoo et al. 1995). Conventional treatment (coagulation, flocculation, sedimentation, and filtration) has repeatedly been proven to almost completely remove intact bacterial cells. Treatment selection is directly related to the specific toxin of concern, because different toxins are removed or inactivated to varying degrees by different treatment technologies (Table 1). Maintaining intact cells during these processes is vital.

<table>
<thead>
<tr>
<th>Oxidation Process</th>
<th>Anatoxin-a</th>
<th>Cylindrospermopsin</th>
<th>Microcystin</th>
<th>Saxitoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Chloramine</td>
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<td>no</td>
<td>no</td>
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<tr>
<td>Ozone</td>
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<td>yes</td>
<td>yes</td>
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<tr>
<td>Chlorine dioxide</td>
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<td>no</td>
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<td>n/a</td>
</tr>
<tr>
<td>Potassium permanganate</td>
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<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Advanced oxidation (OH radical)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Source: Westrick et al. 2010
The removal of extracellular toxins can be achieved by the use of several treatment techniques, including activated carbon, membrane filtration, biologically active filtration, UV disinfection, oxidation processes, and advanced oxidation processes (Wert et al. 2014, Westrick et al. 2010).

### Source Water Control

Using traditional source water quality parameters related to phosphorous, temperature, and sometimes nitrogen can provide utilities with early indication of likely cyanobacterial bloom activity. With early warning, utilities can take action to control these blooms and minimize the chance that cyanotoxins will enter the water supply.

### References


