Cyanobacteria: The Basics

- Naturally occurring microorganisms (bacteria) formerly known as blue-green algae
- Present in all waterbodies in low numbers
- Cyanobacterial species number in the thousands
- Single cells, thread-like filaments or colonies and groups
- Grow as benthic or planktonic populations
- Four most common cyanobacteria in Massachusetts
  - Anabaena
  - Aphanizomenon
  - Microcystis
  - Planktothrix
Cyanobacteria: Blooms

- Dramatic cyanobacteria increases can lead to cyanobacterial Harmful Algal Blooms (CyanoHABs)
  - May cause dissolved oxygen, taste and odor, public health issues
  - Discoloration
Cyanobacteria: Misidentifications

- Pollen
- Paint or dye spills
- Duckweed
- Green algae
## CyanoHABs: Risk Factors

### Predominant Indicators

Potential for cyanobacterial blooms in waterbodies based upon environmental factors.

<table>
<thead>
<tr>
<th>Bloom Risk Level</th>
<th>History of Blooms</th>
<th>Water Temp °C</th>
<th>Total Phosphorous micrograms per liter (µg/L)</th>
<th>Thermal Stratification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>No</td>
<td>&lt;15</td>
<td>&lt;10</td>
<td>Rare or never</td>
</tr>
<tr>
<td>Low</td>
<td>Yes</td>
<td>&lt;15-20</td>
<td>&lt;10</td>
<td>Infrequent</td>
</tr>
<tr>
<td>Moderate</td>
<td>Yes</td>
<td>20-25</td>
<td>10-25</td>
<td>Occasional</td>
</tr>
<tr>
<td>High</td>
<td>Yes</td>
<td>&gt;25</td>
<td>25-100</td>
<td>Frequent and persistent</td>
</tr>
<tr>
<td>Very high</td>
<td>Yes</td>
<td>&gt;25</td>
<td>&gt;100</td>
<td>Frequent and persistent/strong</td>
</tr>
</tbody>
</table>

Based on Newcombe et.al., 2010

- Reduced flow/high residence time
- Wind
Cyanotoxins

Cyanotoxins Produced

- Anabaena – Anatoxins, Microcystins, Saxitoxins
- Aphanizomenon – Saxitoxins, Cylindrospermopsins
- Microcystis – Microcystins
- Planktothrix – Anatoxins, Aplysiatoxins, Microcystins, Saxitoxins

- Intracellular and Extracellular
- Number of species that produce toxins is unknown
- Cyanotoxin identification requires laboratory analysis
Cyanotoxins: Exposure & Health Effects

Exposure Routes
- Dermal, oral and inhalation

Health Effects
- Dermatological Effects & Illness
- Hepatotoxins
- Neurotoxins

Possible Reactions
- Rashes, abdominal pain, fever, vomiting, diarrhea, respiratory irritation, liver and kidney damage; and, and effects to the nervous system
**USEPA Human Health Risks to Cyanotoxins Exposure:**

[https://www.epa.gov/nutrient-policy-data/health-and-ecological-effects#what1](https://www.epa.gov/nutrient-policy-data/health-and-ecological-effects#what1)

<table>
<thead>
<tr>
<th>CYANOTOXINS</th>
<th>ACUTE HEALTH EFFECTS IN HUMANS</th>
<th>MOST COMMON CYANOBACTERIA PRODUCING TOXIN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microcystin-LR</strong></td>
<td>Abdominal pain, Headache, Sore throat, Vomiting and nausea, Dry cough, Diarrhea, Blisterring around the mouth, and Pneumonia</td>
<td>Microcystis, Anabaena, Nodularia, Planktothrix, Fisherella, Nostoc, Oscillatoria, and Gloeotrichia</td>
</tr>
<tr>
<td><strong>Cylindrospermopsin</strong></td>
<td>Fever, Headache, Vomiting, Bloody diarrhea</td>
<td>Cylindrospermopsis raciborskii, Aphanizomenon flos-aquae, Aphanizomenon gracile, Aphanizomenon ovalispororum, Umezakia natans, Anabaena bergii, Anabaena lapponica, Anabaena planctonica, Lyngbya wollei, Rhaphidiopsis curvata, and Rhaphidiopsis mediterranea</td>
</tr>
<tr>
<td><strong>Anatoxin-a group</strong></td>
<td>Tingling, Burning, Numbness, Drowsiness, Incoherent speech, Salivation, Respiratory paralysis leading to death*</td>
<td>Chrysosporum (Aphanizomenon) ovalisporum, Cuspidothrix, Cylindrospermopsis, Cylindrospermum, Dolichospermum, Microcystis, Oscillatoria, Planktothrix, Phormidium, Anabaena flos-aquae, A. lemmermannii Raphidiopsis mediterranea (strain of Cylindrospermopsis raciborskii), Tychonema and Woronichinia</td>
</tr>
</tbody>
</table>

*Symptoms observed in animals.
EMERGING ISSUE: NO current federal or Massachusetts regulations for cyanobacteria or cyanotoxins

- US EPA Health Advisories (HAs)
- US EPA Required UCMR4 Monitoring
- Massachusetts Department of Public Health (MDPH) Guidance (public beaches)
- MassDEP Guidance for Public Water Systems (PWSs)
US EPA DW Health Advisories

- Two (2) HAs - microcystins and cylindrospermopsin
- Non-regulatory concentrations at or below which adverse health effects are not anticipated to occur by oral ingestion of DW over specific exposure durations.

<table>
<thead>
<tr>
<th>US EPA DW Health Advisories</th>
<th>US EPA 10-day HA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cyanotoxin</strong></td>
<td></td>
</tr>
<tr>
<td>Microcystins</td>
<td>0.3 µg/L</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>0.7 µg/L</td>
</tr>
</tbody>
</table>

Bottle-fed infants & pre-school children | School-age children and adults
Cyanotoxins Monitoring: UCMR4

• Cyanotoxins Sampling between 2018-2020

• Ten (10) Cyanotoxins: total microcystins, microcystin-LA, microcystin-LF, microcystin-LR, microcystin-LY, microcystin-RR, microcystin-YR, nodularin, anatoxin-a, and cylindrospermopsin

• Data from the UCMR serves as a primary source of research information, which US EPA utilizes to develop regulatory decisions.

• Three (3) US EPA approved methods for drinking water
  - EPA 544 (LC/MS/MS – MC/NOD)
  - EPA 545 (LC/MS/MS – CYN/Ana)
  - EPA 546 (ELISA – MC/NOD)

For further information on UCMR4 and cyanotoxins assessment monitoring, please see: https://www.epa.gov/dwucmr/fourth-unregulated-contaminant-monitoring-rule.
Cyanobacteria: MDPH Guidance

- MDPH has developed health-based guidance levels for recreational exposure to cyanobacteria.

- MDPH recommends that beaches be posted and individuals limit all contact with a waterbody if the waterbody has cyanobacteria cell counts exceeding 70,000 cells/milliliter (mL) or microcystin concentrations that meet or exceed 14 micrograms per liter (µg/L).
Coming Soon: MassDEP Guidance

• Collaborative Development
  • MDPH, Office of Research and Standards (ORS)
  • Regional DW Programs, Watershed Planning Program (WPP)
  • Safe Drinking Water Act Advisory Committee (SDWAAC)

• Watershed Management & Source Water Protection Focus
  • Cyanobacteria/Cyanotoxin Information
  • Critical factors for assessing source vulnerability
  • Fact Sheet & PWS Bloom Tracking Form
  • Treatment options
    • In-reservoir & within treatment facility
  • Additional resource materials and MassDEP contacts

• Website Update & Internal/Interagency Protocols
Helpful Resources

US EPA Website: https://www.epa.gov/nutrient-policy-data/cyanohabs

MA EOEEA Website: https://www.mass.gov/guides/cyanobacterial-harmful-algal-blooms-cyanohabs-water

MDPH Website: https://www.mass.gov/lists/algae-information

University of New Hampshire Online Guide: http://cfb.unh.edu/CyanoKey/indexCyanoQuickGuide.htm
SAFETY FIRST!
CyanoHAB
QUESTIONS/COMMENTS?

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