Great Lakes HABs Collaboratory

HABs State of the Science webinar series:
HABs & Safe Drinking Water

Speakers:

Jason Huntley – University of Toledo

Allison MacKay – Ohio State University

Dragan Isailovic – University of Toledo

Glenn Lipscomb – University of Toledo

Jen Mou – Kent State University

Teresa Cutright – University of Akron

In partnership with:

NOAA — NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION — U.S. DEPARTMENT OF COMMERCE

Sea Grant — Ohio Sea Grant College Program

THE OHIO STATE UNIVERSITY

LimnoTech — Water Environment | Scientists Engineers

Linking Science and Management to Reduce Harmful Algal Blooms

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GoToWebinar Housekeeping Items

- Submit your text questions and comments using the Questions Panel

- Note: This webinar is being recorded and will be posted on the HABs Collaboratory website

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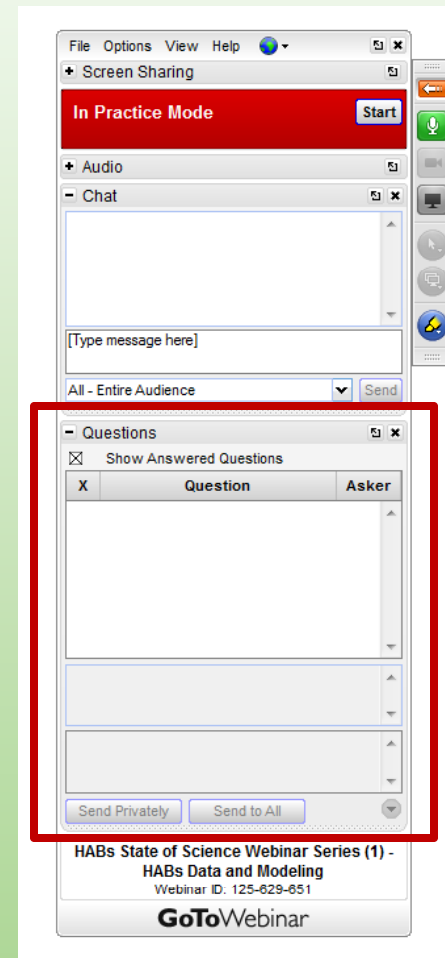
Great Lakes HABs Collaboratory

"A virtual laboratory for information sharing and collective actions to address HABs"
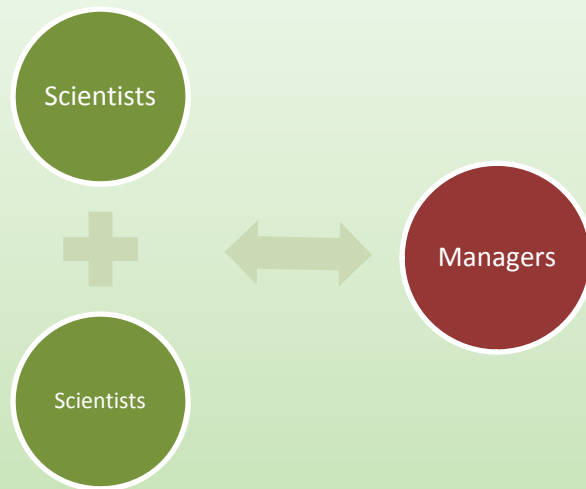
- Multidisciplinary group, 100+ members from different Agencies, Ministries, Colleges, Universities and Organizations across the Great Lakes

Linking Science and Management to Reduce Harmful Algal Blooms

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HABs State of the Science webinar series

- Result of the inaugural meeting of the HABs Collaboratory
  - Identified need for communication between researchers, and between researchers and managers
- Present on-going research projects related to HABs in the Great Lakes region
- Goals:
  - Improve communication
  - Knowledge transfer
  - Opportunities for collaboration

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Ohio Sea Grant / OSU Stone Lab

- Managing 55 HABS related projects (~$7,000,000)
  - 18 funded by Ohio Sea Grant
  - 5 funded by OSU's Field 2 Faucet initiative
  - 32 funded under the Ohio Department of Higher Education (OSU/UT; 18 vs. 14)
- Stone Lab Guest and Research Lecture Series
  - *June 16th, 23rd, 30th,* **July 7th, 14th, 28th, and August 4th**
  - 7pm -9pm
  - https://ohioseagrant.osu.edu/news/calendar
- Webinar: Forecast for HABs in Lake Erie in 2016
  - July 7th, 2:00 p.m. : https://ohioseagrant.osu.edu/news/calendar/2016/07/07/ken40/go-url
- 9/15/16 "State of Science" meeting in Toledo
  - Stranahan Theater
  - Modeling, BMPs, and Public Health-Water treatment
  - https://ohioseagrant.osu.edu/news/calendar/2016/09/15/o47km/understanding-algal-blooms

July 7, 2016

Linking Science and Management to Reduce Harmful Algal Blooms

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ISOLATION AND CHARACTERIZATION OF LAKE ERIE BACTERIA THAT DEGRADE THE MICROCYSTIN TOXIN MC-LR

Jason F. Huntley, Ph.D.
University of Toledo College of Medicine and Life Sciences

UT
HEALTH SCIENCE CAMPUS
THE UNIVERSITY OF TOLEDO

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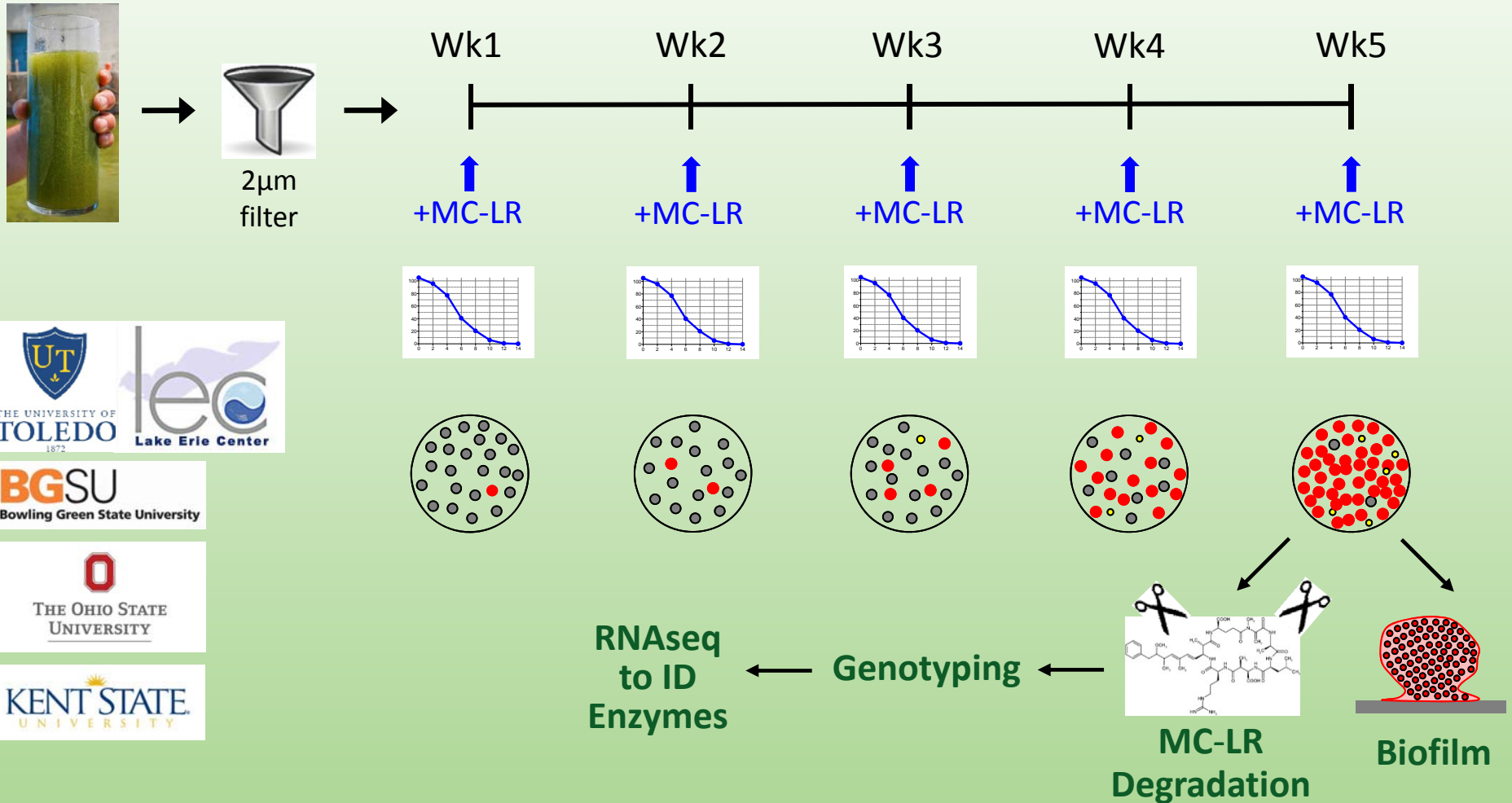**Great Lakes HABs Collaboratory**

Project Overview

- *Development of Microcystin Detoxifying Water Biofilters* (Award R/HHT-5-BOR); *Discovery of Enzymes and Pathways Responsible for Microcystin Degradation* (Award R/PPH-4-ODHE)

- Jason F. Huntley, University of Toledo College of Medicine and Life Sciences

- Funding: Ohio Department of Higher Education

- Dates funded: 3/2015 – 6/2017; 4/2016 – 6/2018

- Hypothesis: (1) Naturally-occurring Lake Erie bacteria can degrade MC-LR, therefore biofilter development efforts will lead to efficient and cost-effective MC-LR removal methods; (2) Identification and characterization of MC-LR degradation pathways will lead to new technologies [*i.e.* enzyme drops or tablets] to remove MC-LR from drinking water
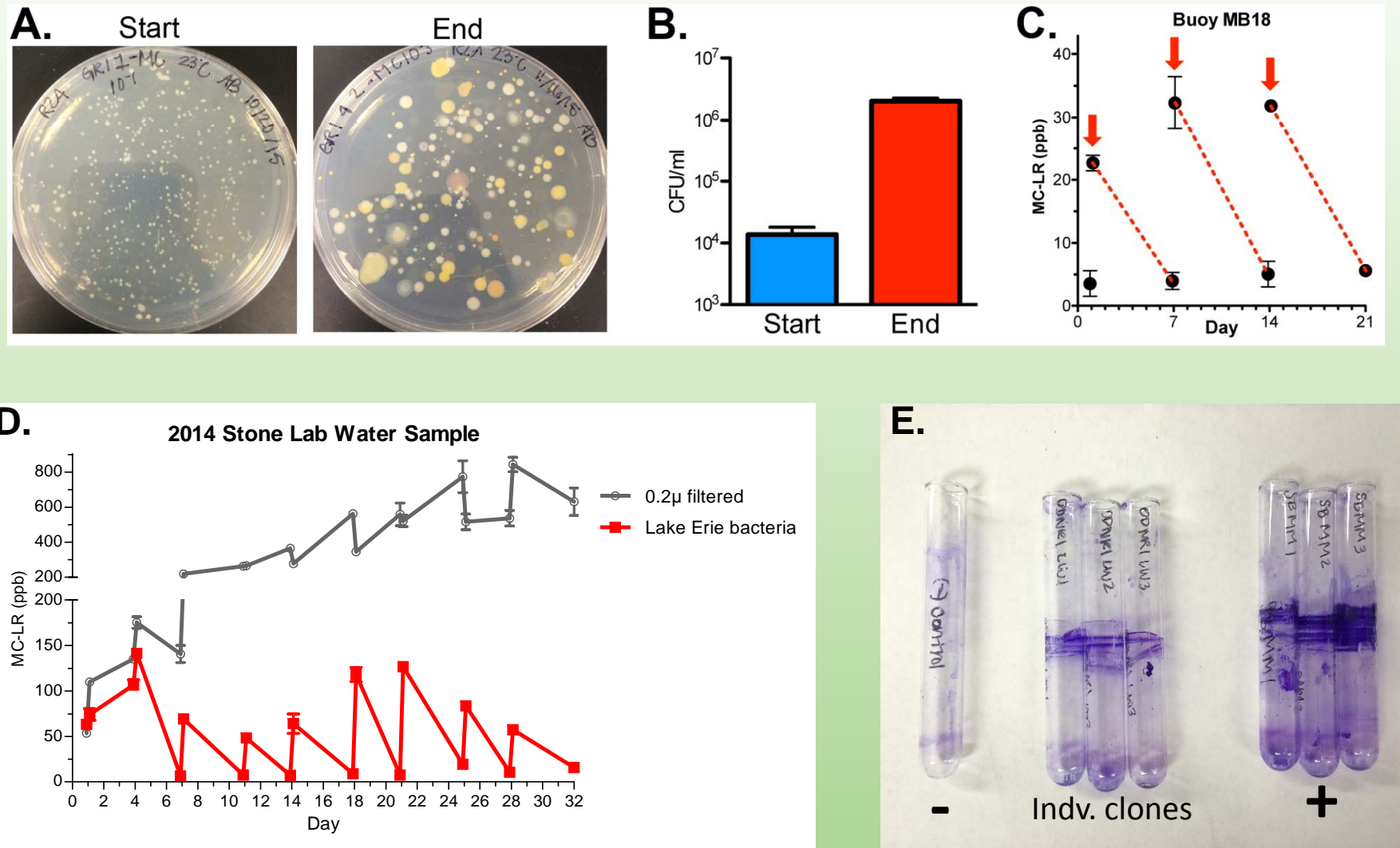
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Approach

2µm filter

Wk1	Wk2	Wk3	Wk4	Wk5

+MC-LR   +MC-LR   +MC-LR   +MC-LR   +MC-LR

RNAseq to ID Enzymes ← Genotyping ← MC-LR Degradation

Biofilm

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Summary of Findings

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In Progress and Future Directions:

- Which individual clones are the best MC-LR degraders? Groups of 2 or 3?

- What enzymes/pathways do Lake Erie bacteria use to degrade MC-LR?

- Partner with Ohio biotech companies to develop biofilters and/or produce enzyme drops/tablets.

- Collaborations with other groups.

- Consultation with government agencies.

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KINETIC MODELS FOR OXIDATIVE DEGRADATION OF CYANOTOXINS IN RAW DRINKING WATER

Allison A. MacKay – The Ohio State University

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Project Overview

- Kinetic Models for Oxidative Degradation of Cyanotoxins in Raw Drinking Water

- Allison MacKay & Yu-Ping Chin (Ohio State); Dionysios Dionysiou & Soryong Chae (U. Cincinnati)

- ODHE – Annex IV Nutrient/HAB Focus

- Utilities: Claremont County, Cincinnati, Oregon, Port Clinton, Toledo

- Objective: Produce tools to optimize oxidant dosages to achieve targeted cyanotoxin removals accouting for varied water quality parameters

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Project background

- Pathogen removal: "Ct" = fixed log reduction

- Can "Ct" model work for cyanotoxins?

- Focus: permanganate; chlorine with UV

- Challenge: possible loss of oxidants to reaction with organic matter if oxidation of cyanotoxins (microcystin-LR, saxitoxin) slow

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Approach

- Test waters: **synthetic** to control water quality parameters; **HAB-afflicted** raw drinking water sources

- Measure reaction of **permanganate, chlorine, chlorine/UV** with **microcystin or saxitoxin** with varied pH, temperature, alkalinity, organic matter

- Measure and relate organic matter reaction rates with oxidants to optical properties

- Build practitioner tool for estimating oxidant dosing to achieve target reductions of microcystin or saxitoxin with intake water quality parameters

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- Questions/Needs: Rapid detection to couple with effective treatment

- Collaboration: Current state-of-science regarding water quality parameters and alternative treatment approaches

DEVELOPING AN LC-MS METHOD FOR QUANTIFICATION OF MICROCYSTINS

Dragan Isailovic

University of Toledo

Department of Chemistry and Biochemistry

Toledo, Ohio 43606

Dragan.Isailovic@utoledo.edu

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Project Overview

- Title: Developing an LC-MS method for quantification of microcystins

- Author & Affiliations: Dilrukshika Palagama, Raymond West, and Dragan Isailovic

- Funding Source: ODHE, 2015-2017

- Project Location & Study years: University of Toledo, Dept. of Chemistry and Biochemistry

- Research hypothesis: Quantification of microcystins can be done accurately and reproducibly using an LC-Orbitrap-MS system.

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Approach

- How will you meet your project objectives to answer your hypothesis?

- An HPLC was coupled to Orbitrap MS

- A sample preparation protocol for purification and preconcentration of MC-LR was developed

- HPLC conditions from EPA Method 544 used

- MC-LR was accurately quantified by LC-MS

- MCs in environmental samples will be analyzed

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Summary of Findings

- What did you learn from your work?
- MC-LR was reproducibly quantified after spiking in tap water and in a mixture with MC-LA and MC-RR
- What happened that you didn't expect?
- Sample preparation procedures are important
- Relevant conclusions for water quality managers?
- Our LC-MS methods can quantify < 0.3 ppb of MC-LR reproducibly with and without preconcentration, and they can be useful for water quality analysis.

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- What questions still need to be answered about HABs?
- Further validation of LC-MS methods on more MC standards are needed
- How can collaboration help your research?
- It will help validating our sample preparation procedures and LC-MS methods, and improve our contribution to study of water quality.

EVALUATING HOME POINT-OF-USE REVERSE OSMOSIS MEMBRANE SYSTEMS FOR CYANOTOXIN REMOVAL

Glenn Lipscomb – Chemical & Environmental Eng., University of Toledo

Youngwoo Seo – Civil Eng., University of Toledo
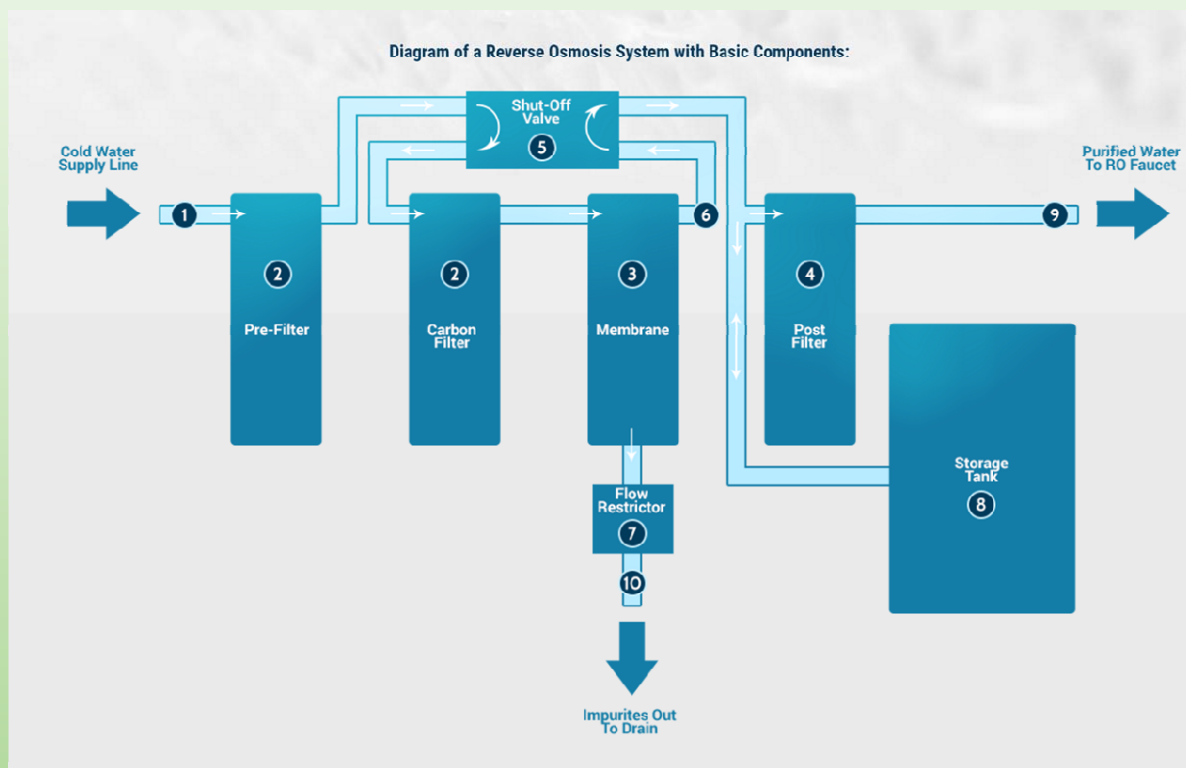
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Project Overview

- Evaluating Home Point-of-Use Reverse Osmosis Membrane Systems for Cyanotoxin Removal

- PIs: Glenn Lipscomb & Youngwoo Seo, UT

- Funding: Ohio Department of Higher Ed

- Location: Toledo, OH, June 2016 – May 2018

- Home RO systems can effectively remove cyanotoxins from contaminated water

June 23, 2016

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Home RO System

(www.lowes.com, www.espwaterproducts.com)

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Project background

- PIs have extensive academic and industrial experience in membrane separation processes and water treatment

- Past projects include: biofilms for water treatment, charge mosaic membrane design, and membrane module design

- Students are involved in projects to provide water treatment systems in developing areas

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Approach

- Establish relationships with partners
  - NSF International – develop performance evaluation protocols, assess aging effects
  - Dow Water & Process Solutions – source of membranes and test systems
  - National University of Singapore – protocol development and collaboration with Singapore Public Utilities Board
- Develop a database of home RO products and manufacturers and select test units
- Evaluate effectiveness of hepatotoxin removal
- Evaluate long term removal and accelerated testing

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- Future work:
  - Evaluate other home RO system components (other than RO cartridge) for cyanotoxin interactions
  - Optimize RO membrane for cyanotoxin rejection
  - Development of protocol for fouling control
- Collaboration critical to development, acceptance, and use of certification protocols

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TAXA AND PATHWAY INVOLVED IN MICROBIALLY MEDIATED CYANOTOXIN DEGRADATION

Jen Mou

Kent State University

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Project Overview

- Title: Isolation of microcystin degrading bacteria

- PI: Xiaozhen Mou, Kent State University

- Funding Source: Lake Erie Commission, Ohio Water Resource Center, Ohio Higher Education Board of Regents

- Project Location & Study years: Lake Erie, 2008-2017

- Research hypothesis
  - Lake Erie harbors a diverse group of bacteria that can degrade microcystins
  - Microbially mediated MC degradation in Lake Erie follow an alternative route other than *mlrA*-based pathway.

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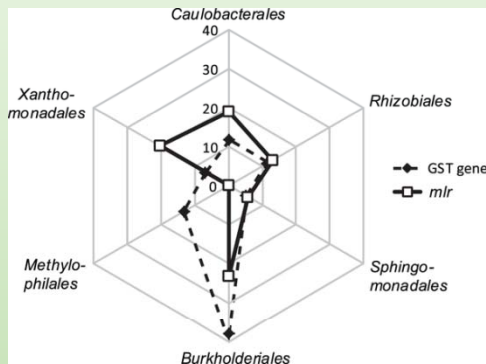
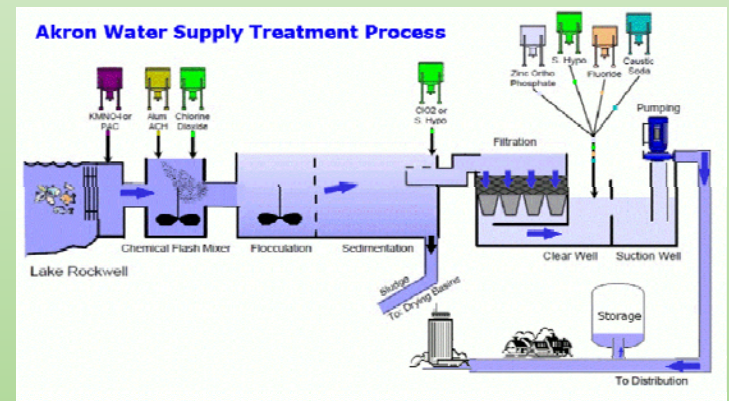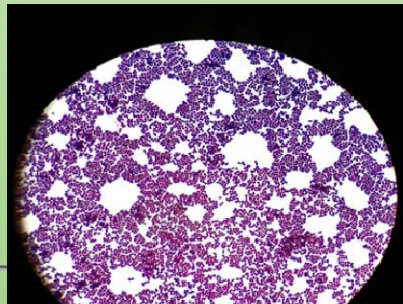Diverse MC-degrading taxa and novel MC degradation pathway
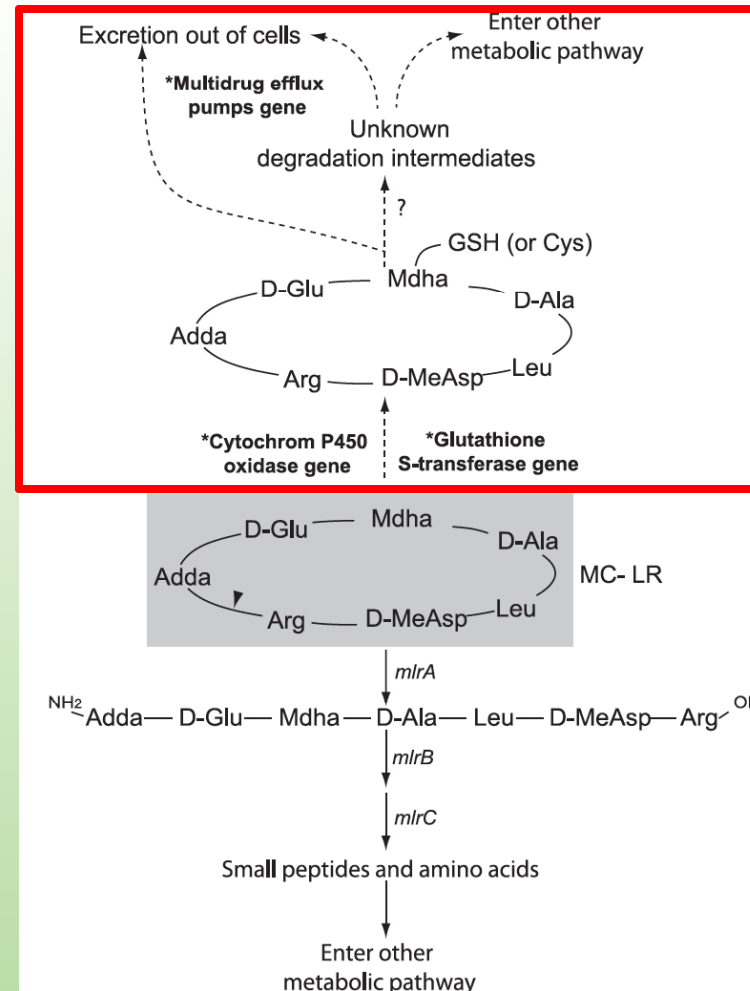
Mou et al., 2013

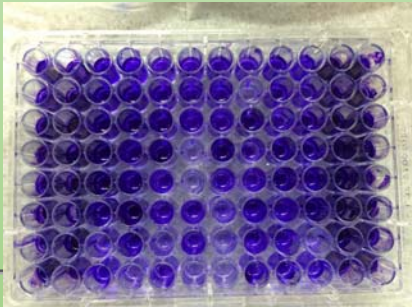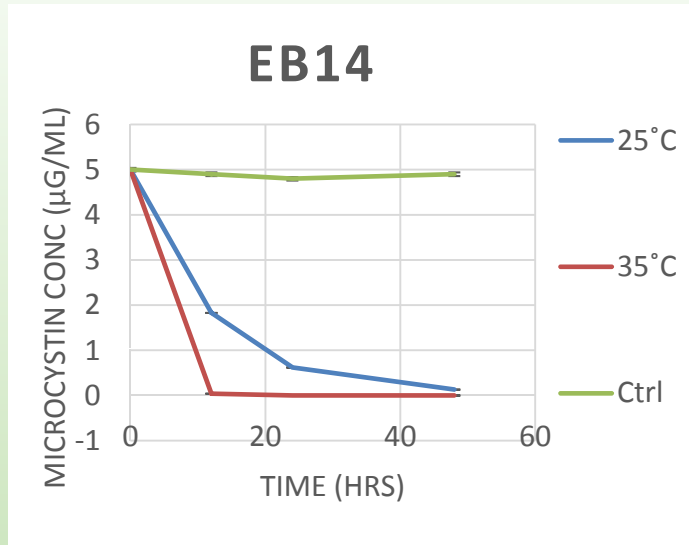# MC-degrading bacteria isolates

- Lake Erie and Grand Lake St Marys
  - Water, Sediment

- Water Treatment Plants (Akron, Alliance, Sandusky)
  - Source Water, Backwash, Sludge

Got 45 confirmed, more under screening

Effects of Environmental Factors

EB14

- Gram+ (*Bacillus, Micromonospora*) & G- (*Pseudomonas, Ralstonia*)

- MC-degraders degrade MCs faster at 35°C than 25°C.

- Most MC-degrading isolates grow between pH= 6-9

- No *mlrA*!
  - Transposon mutagenesis
  - Genome sequencing

- Biofilm formation study

Biological Filter Removal of Microcystin

- colonization of bacteria in water filtration systems

- community structure of bacteria

- Bacterial removal and degradation of MCs
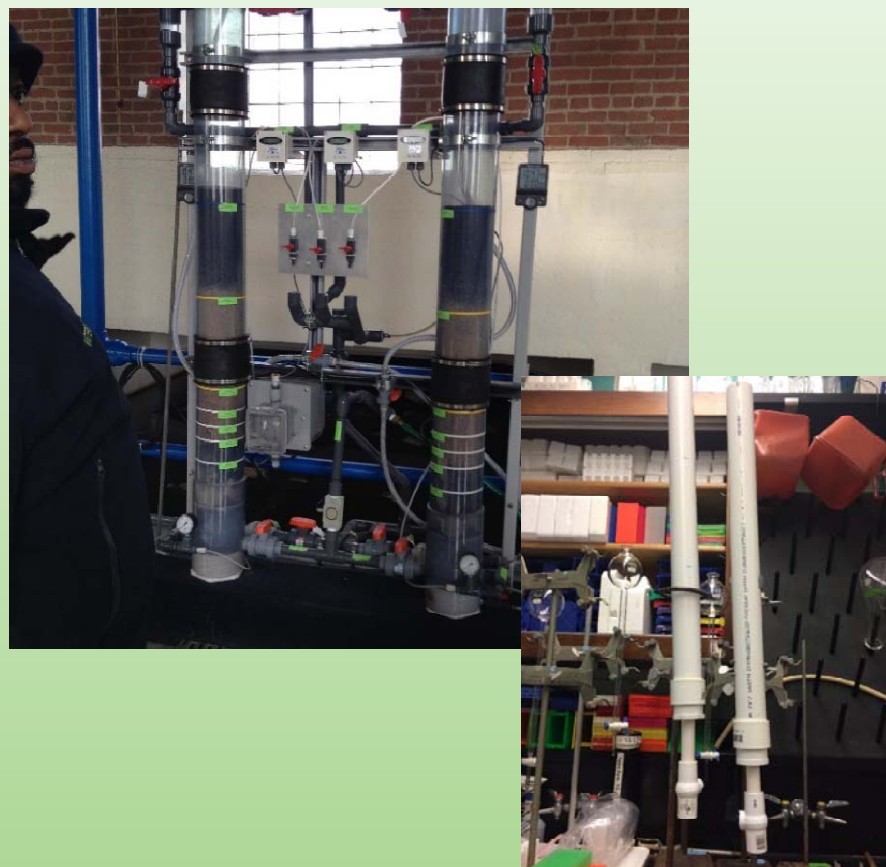
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Questions need to be answered:

- What is the role of heterotrophic bacteria played in HAB and MC dynamics?

- Whether efficiency of water treatment can be augmented by encouraging biodegradation?

How can collaboration help your research?

- Share the sampling effort, and samples

- Multidisciplinary approach
  - Chemical measurements
  - models

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EVALUATION OF OPTIMAL ALGAECIDE SOURCES AND DOSAGES FOR OHIO DRINKING WATER SOURCES

Teresa J. Cutright– The University of Akron

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Project Overview

- Evaluation of Optimal Algaecide Sources and Dosages for Ohio Drinking Water Sources

- Teresa Cutright, Don Ott, Lan Zhang, The University of Akron

- Jessica Glowczewski, Kenneth Crisp, City of Akron Watershed Division

- Ohio Sea Grant & Dept. Higher Education

- 4 watersheds in Northeast Ohio from April 2016-2018

- Each reservoir has a unique ecosystem
  - Different nutrient levels and cyanobacteria present
  - "Best" source and level of algaecide different

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Project background

- Initial informal collaboration with watershed

- Interest in

  - Effective short term bloom treatment

  - Long term 'holistic' management of watershed

- Provide specific solution to specific cyanobacteria population

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Approach

- Isolate cyanobacteria from water source
  - Enrich to 'bloom' level, add to reactor with source water, track with time
  - Repeat with 1 to 4 different algaecides
- Optimal dosage f($\downarrow$bloom count, $\downarrow$target, limited-no toxin release)
- Use optimal to determine residual concentration, application frequency & timing
- Watershed receive tailored source & level
  - Mitigate bloom potential without harm to ecosystem

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- Research questions
  - Treatment optimization: cyanotoxin kinetics, cell lysis, etc.
  - Toxicity: acute, Saxitoxin, kinetics
  - Bloom dynamics: movement, triggers toxin release
- Collaboration essential:
  - Forming best research teams
  - Sharing of up to date knowledge
  - Increasing awareness

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HABs & Safe Drinking Water

Questions?

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Coming up next:

Ohio Sea Grant & Stone Lab public webinar: NOAA's Forecast for HABs in Lake Erie in 2016
Today July 7th 2-4pm
www.ohioseagrant.osu.edu/news/calendar/2016/07/07/ken40/go-url

HABs Blooms Detection, Compositions & Effects
Tuesday, July 19 2016, 11 am-12:15 pm (EDT)

HABs & Public Health – TBD

HABs Blooms Monitoring & Forecasting – TBD

HABs Blooms Sources & Toxicity - TBD

HABs: Educate and Engage - TBD

To learn more about the HABs Collaboratory and the HABs State of the Science Webinar Series, visit us at:

http://glc.org/projects/water-quality/habs/

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