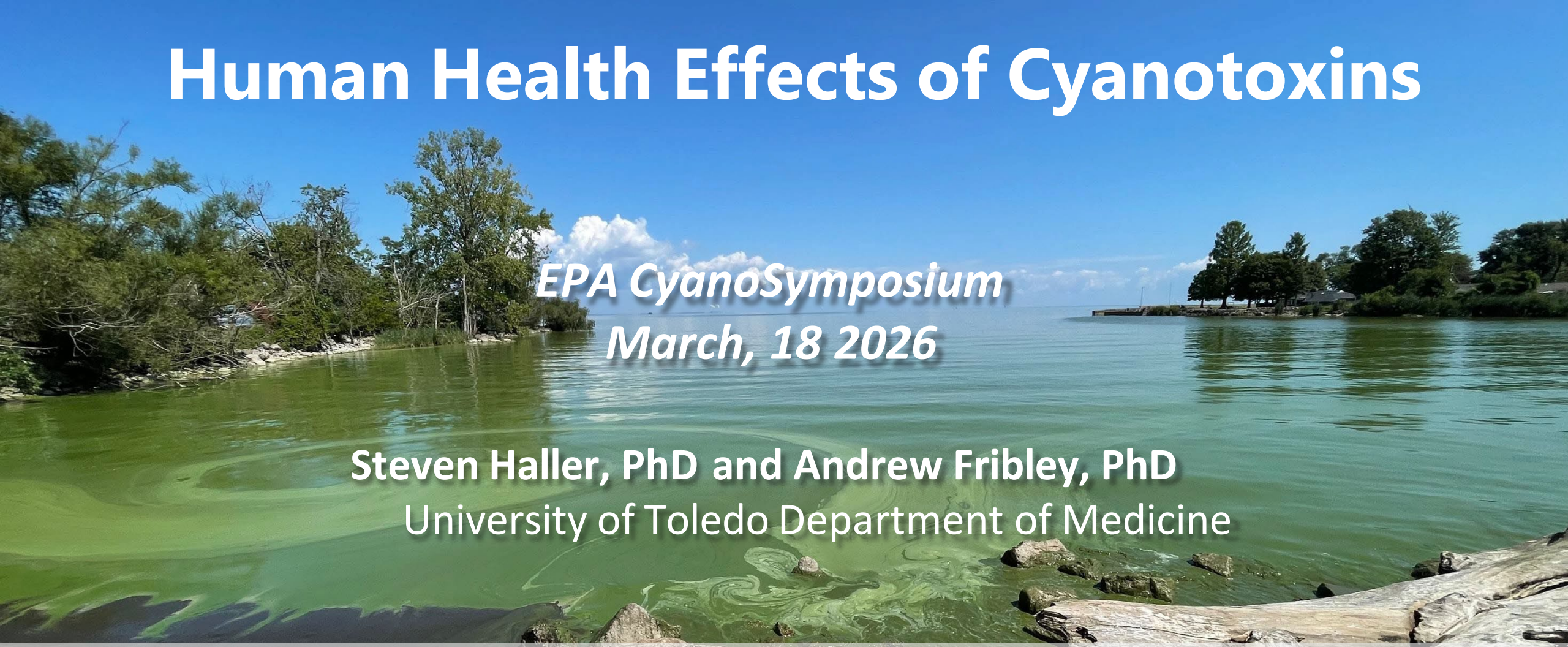
Human Health Effects of Cyanotoxins



EPA CyanoSymposium
March, 18 2026

Steven Haller, PhD and Andrew Fribley, PhD
University of Toledo Department of Medicine

COLLEGE OF MEDICINE AND LIFE SCIENCES
THE UNIVERSITY OF TOLEDO

GREAT LAKES CENTER
FOR FRESH WATERS AND HUMAN HEALTH

Disclosures (Haller)

- Research Funding from Abbott Laboratories

I ATTEST:

a) these funds are not sole clinical or educational resources or a source to learners

b) this relationship/affiliation will not bias or otherwise influence my involvement in any CME activity

c) practice recommendations given relevant to the companies with whom I have relationships/affiliations will be supported by best available evidence or, absent evidence, will be consistent with generally accepted medical and scientific practice and

d) that all reasonable clinical alternatives will be discussed when making practice recommendations.

Disclosures (Fribley)

- None

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d) that all reasonable clinical alternatives will be discussed when making practice recommendations.

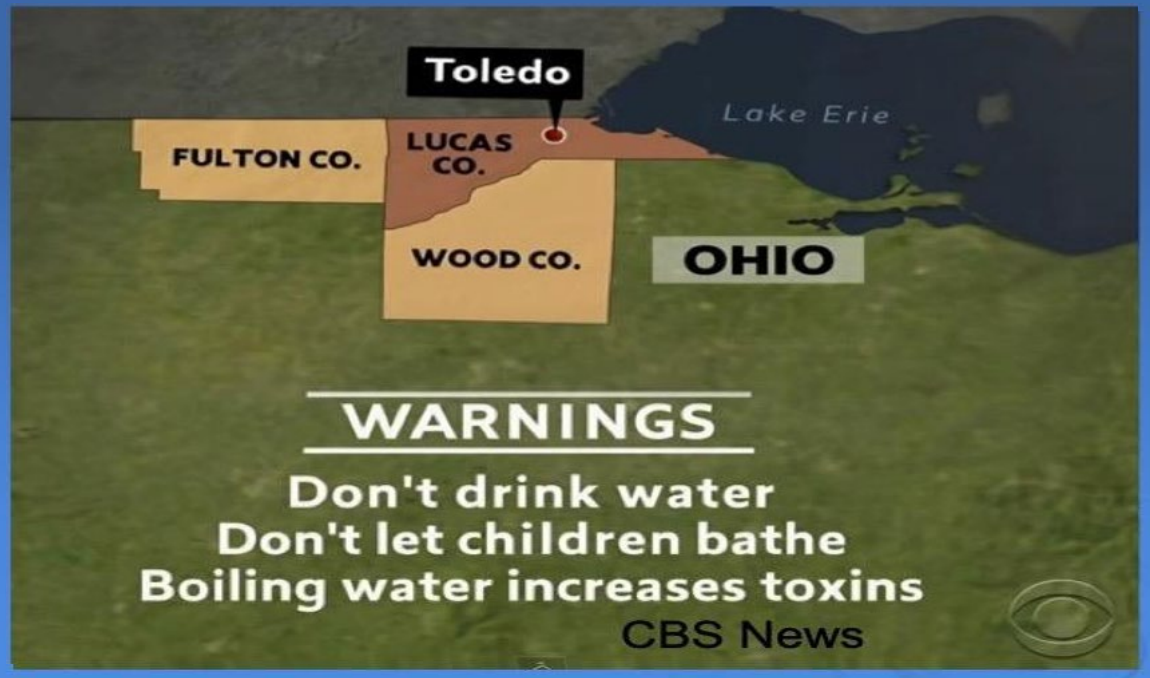
Goals for Today…

- Describe the basic characteristics of Harmful Algal Blooms and identify the primary routes of exposure to harmful algal toxins.
- Explain the mechanisms by which Harmful Algal Blooms toxins affect human health
- Discuss the symptoms and health effects associated with exposure to Harmful Algal Blooms .
- Discuss evidence-based medicine approaches to recognizing and reporting Harmful Algal Bloom Exposures
- Analyze recent research findings on the health impacts of Harmful Algal Blooms and their implications for human health.
- Discuss ongoing efforts to improve public health related to Harmful Algal Bloom exposures

Why do we care about Harmful Algal Blooms (HAB's)?

Toledo Water Crisis, August 2014

- Algal toxin in <u>treated</u> Toledo water exceeded 1.0 ug/L limit recommended by the WHO
- 'Do not drink' advisory Aug 2-4
- 500,000 residents temporarily without potable water



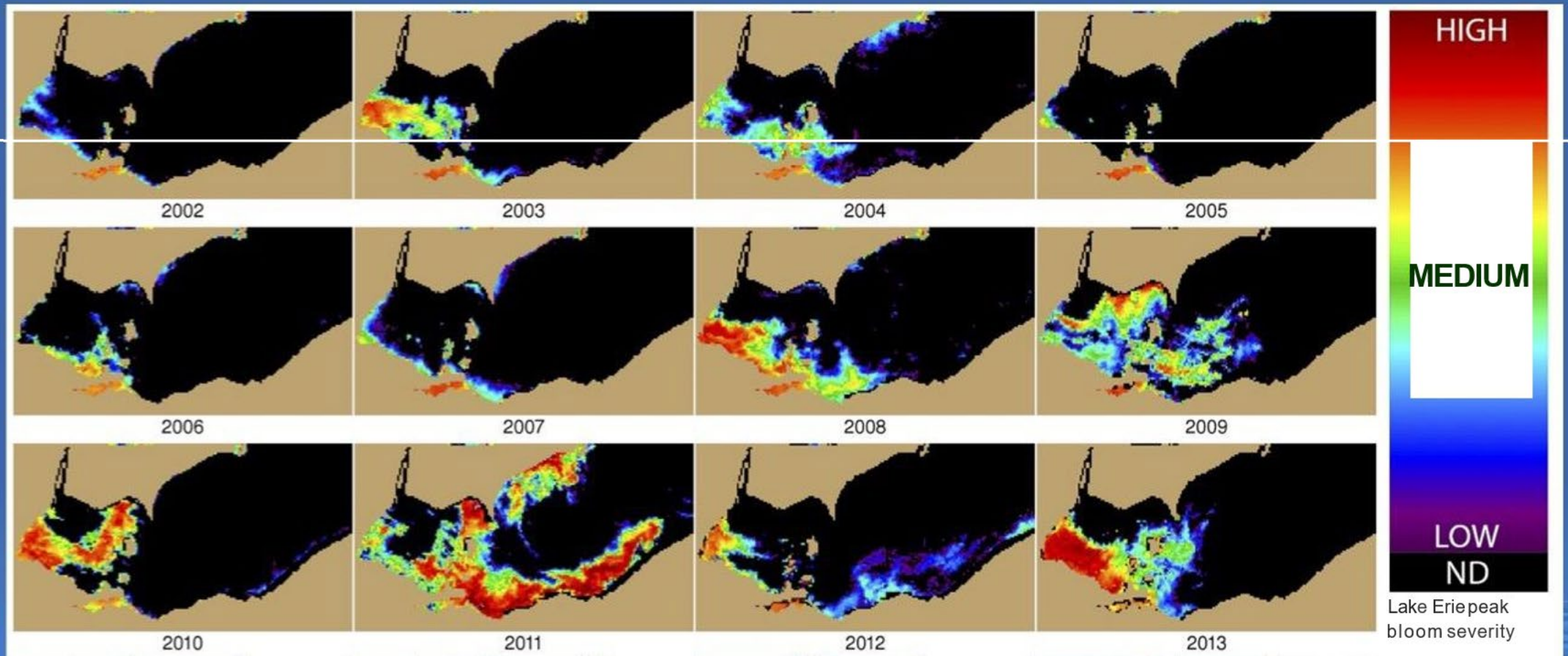
Courtesy of Dr. Tom Bridgeman, UT Lake Erie Center

Harmful Algal Blooms Are On The Rise

Photo Courtesy of https://www.greatlakesoutreach.com/

Source: Environmental Working Group. Updated on June 14, 2019.

Annual HAB Size: 2002-17



HAB Dynami… …t the Year

Michigan
…limited Digital Access - Sale Ends 9/30/24
More Local t…

PUBLIC INTEREST

Lake Erie h… worse,” say…

Updated: Jun. 30, 2024, 2:06 …

A harmful algae…

A long, strange bloom: Lake Erie algae acted very unusual this year

Published: Nov. 22, 2022, 8:01 a.m.

eBlade
THE BLADE

…KETPLACE
…Place Classifieds

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…s off algae …n Lake Erie

…Monroe in western Lake …o above-moderate season

…, said Rick Stumpf, a …rapher who leads the …s for Coastal Ocean

…he Ohio area know, …up in the Monroe

…ent plant, director

HAB Dynamics Throughout the Year

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Microcystis

Dominant Toxin:

- Microcystin

Anabaena/Dolichospermum

Dominant Toxins:

- Microcystin
- Saxitoxin
- Anatoxin
- (*Cylindrospermopsin*)

Cold resistant

HAB Dynamics Throughout the Year

Grand Lake St. Mary's
Celina, Ohio:
Year Round HAB!!!

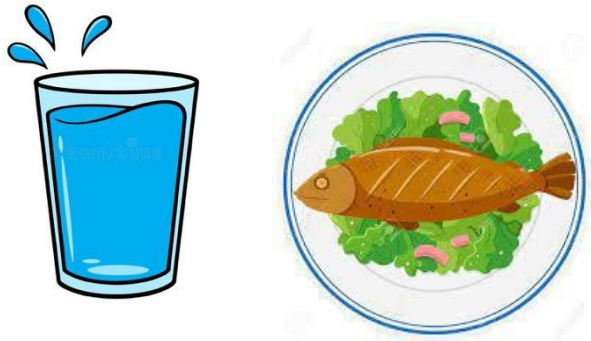
Clinical Take Home Message 1:

HAB's are becoming more complex and persistent (in some cases year-round), prolonging the window of exposure and the number of toxins to which our community may be exposed.

What are the major routes of exposure and target organs for common Harmful Algal Bloom (HAB) toxins?

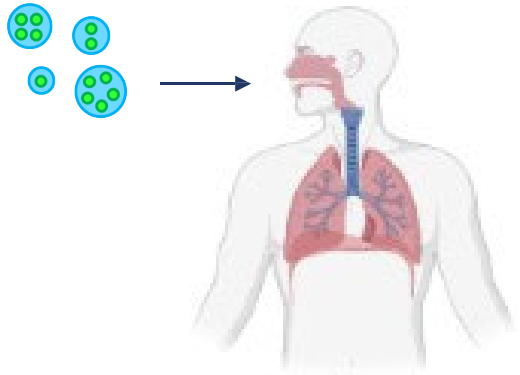
Common Routes of HAB Toxin Exposure in Humans

Ingestion



Consumption of contaminated food, water and supplements

Inhalation



Breathing in aerosols generated from water containing HAB toxins

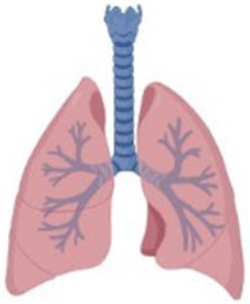
Dermal contact

Skin contact through recreational activities such as swimming

HAB Toxins and Target Organs

Inhalation may cause inflammation and weaken walls of the lungs

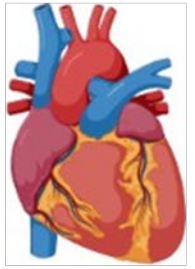
(Oliveira et al. Toxicon, 2015)



Some HAB toxins can cross the blood brain barrier and target nerve synapses or channels, can damage neurons by inducing oxidative stress and inflammation

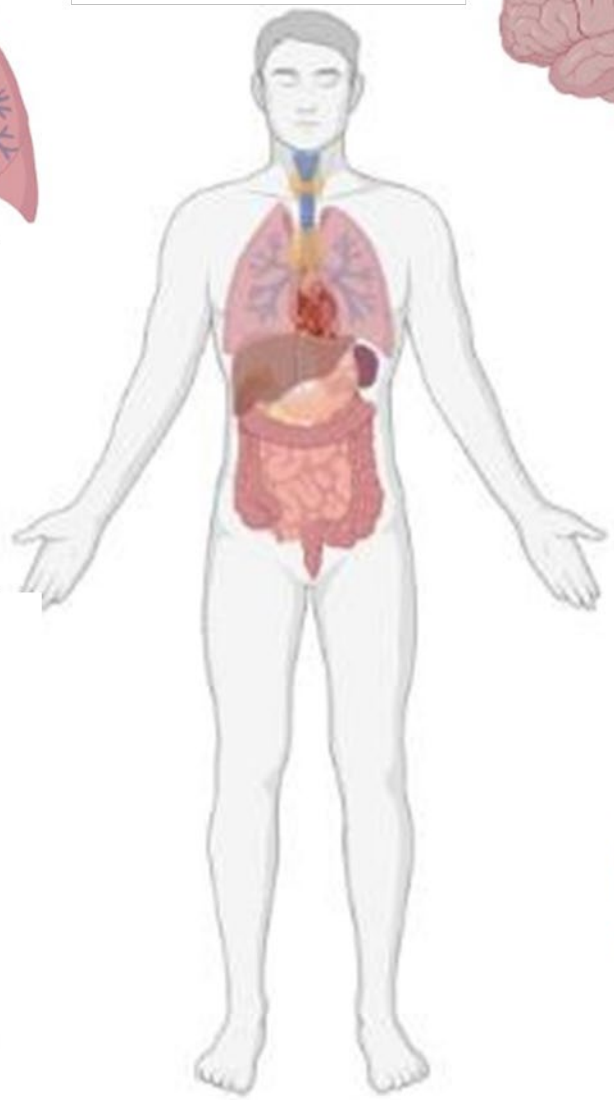
(Pablo et al. *Neurologica*, 2009)

Increase accumulation of fat in liver cells, death of liver cells and incidence of some liver cancers (Lundqvist et al. *Toxicon*, 2017; Batista et al. Aquat *Toxicol*, 2003)



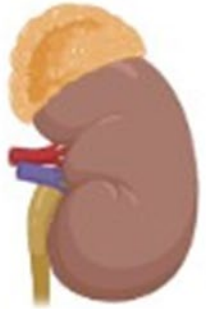
May lead to cardiac inflammation and fibrosis as well as cardiac hypertrophy

(Martins et al. *Chemosphere*, 2011; Qui et al. *Toxicology*, 2009)



Lead to inflammation and cell death in gut cells and may be associated with some colorectal cancers

(Miao et al. Mol Carcinog, 2016)



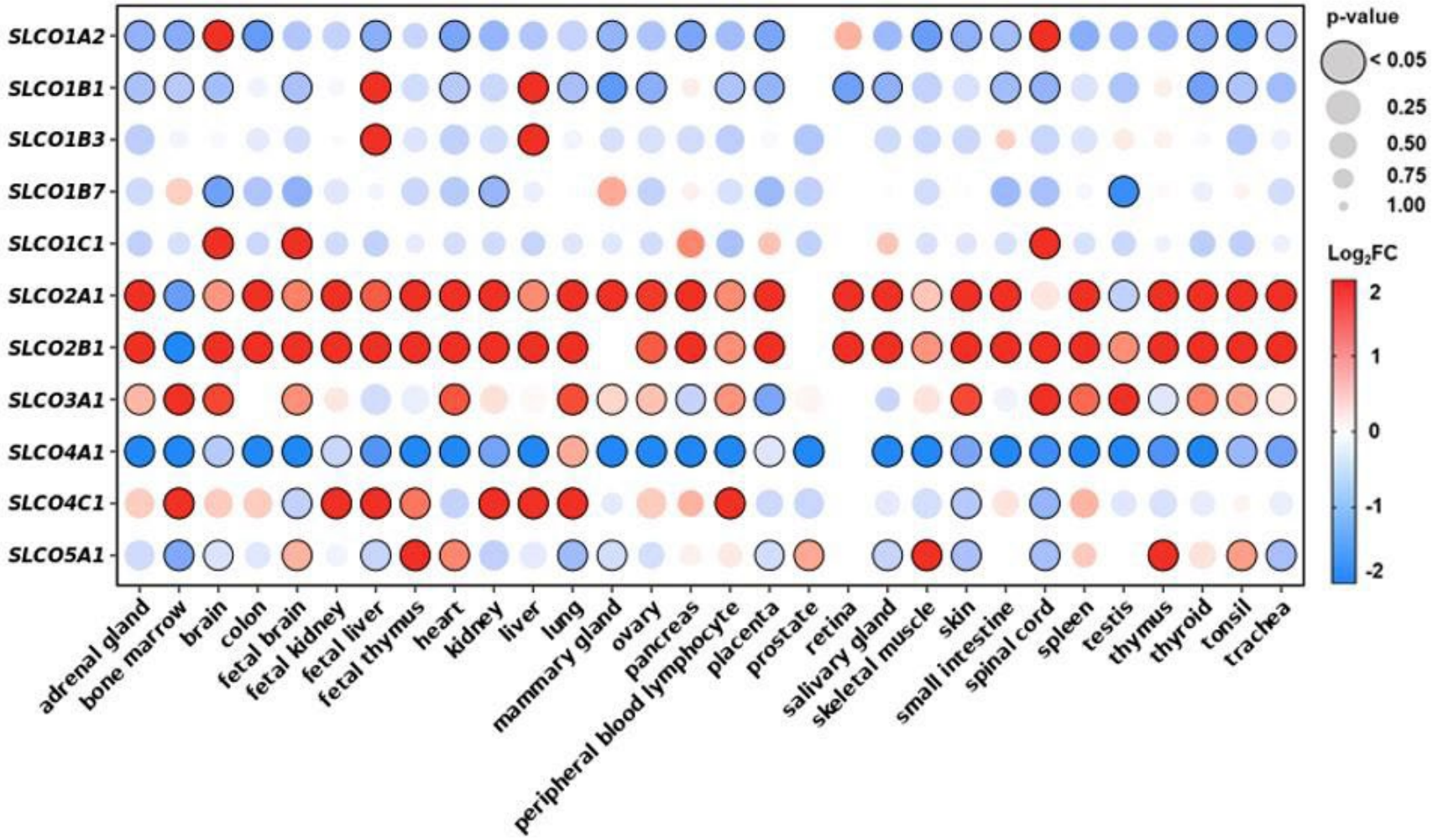
Induces oxidative stress, inflammation and cell death in renal cell types, potentially leading to decreased renal function

(Berry, *Environ Microbiol*, 2017)

Lad et al. Life 2022, 12, 418.

Why Are HAB Microcystins so Harmful and What is Their Mechanism of Action?

Microcystin transporters:
At a Major Organ System Near YOU!



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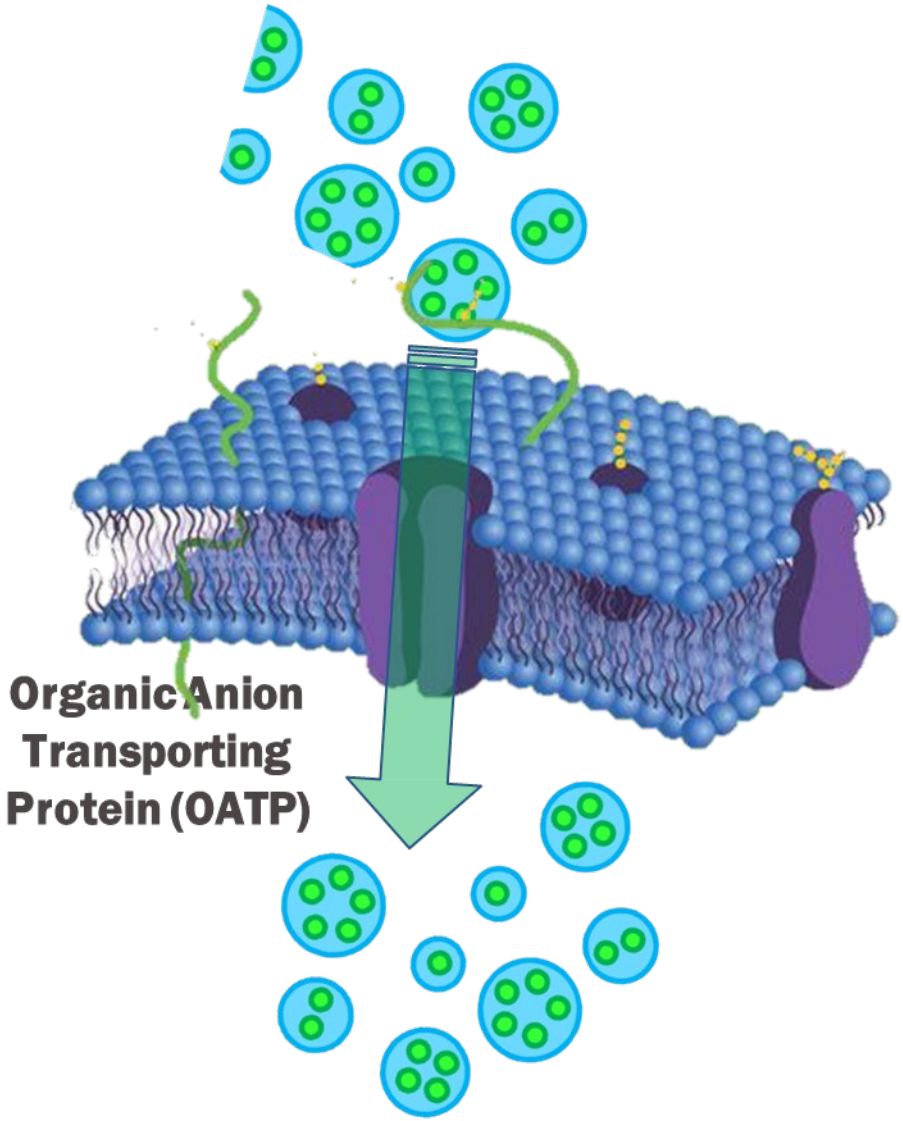
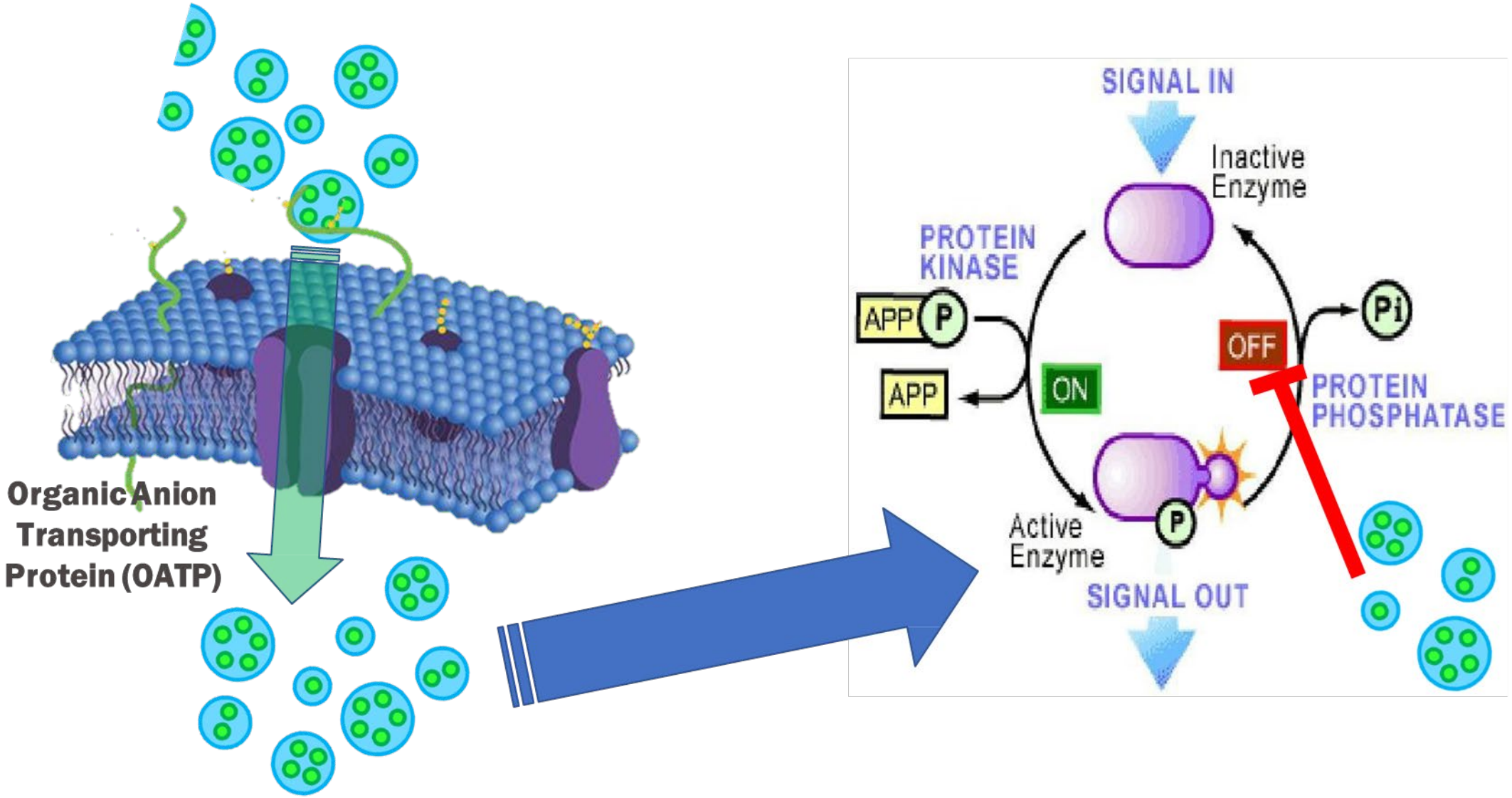
Organic Anion Transporting Proteins (OATP's) are the Main Cellular Transporter for Microcystins

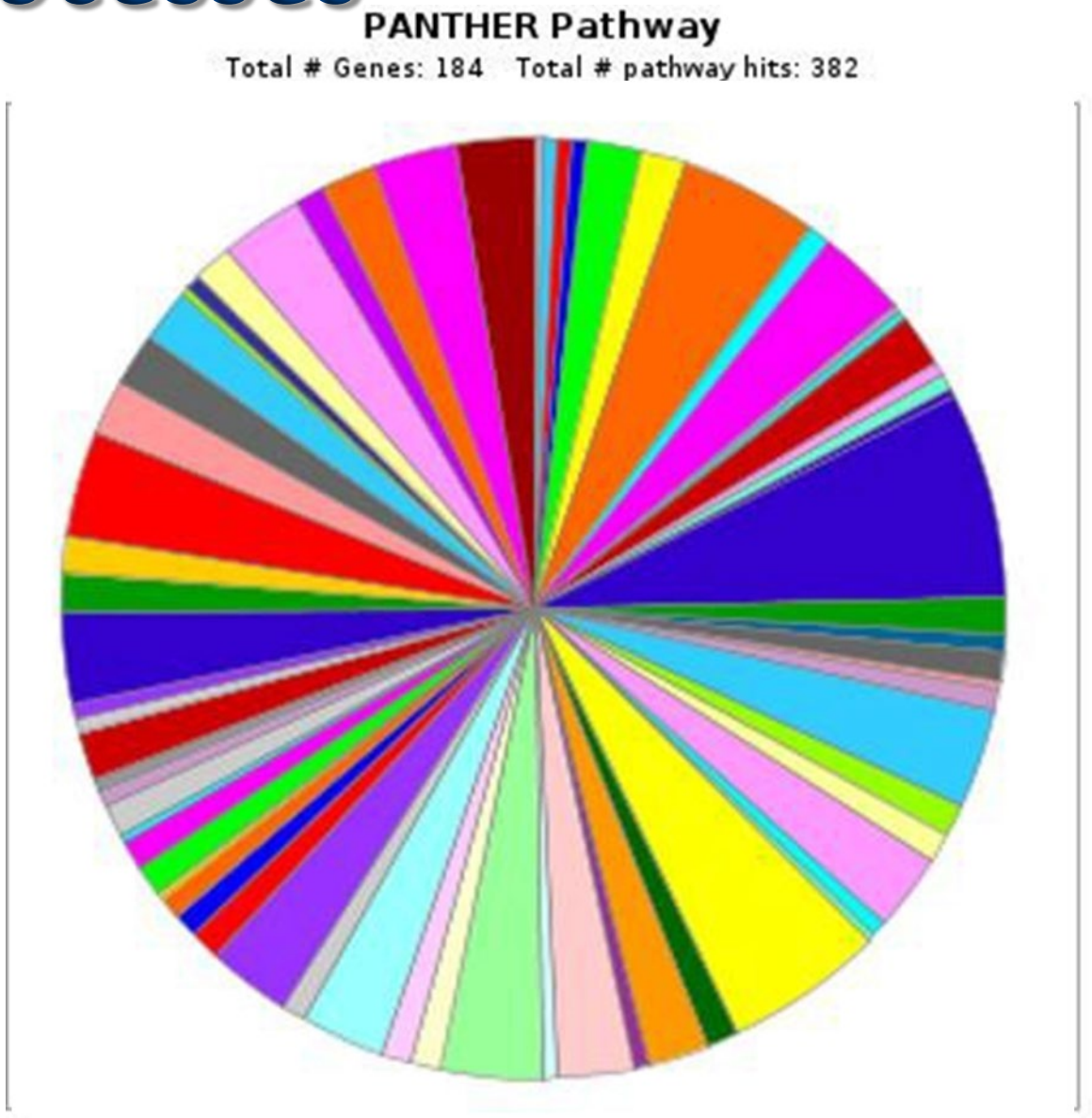


Protein Phosphatase 1 and 2A (PP1, PP2A) are the main Cellular Targets for Microcystins



Protein Phosphatases Control Thousands of Important Cellular Processes

- PP1 and 2A have hundreds of known substrates
- PP2A and PP1 account for the majority of dephosphorylation activity in eukaryotic cells
- PP2A and PP1 make up roughly 1% of the dry weight of the cell



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4905575/

What can we learn from public health data on Harmful Algal Bloom (HAB) exposures?

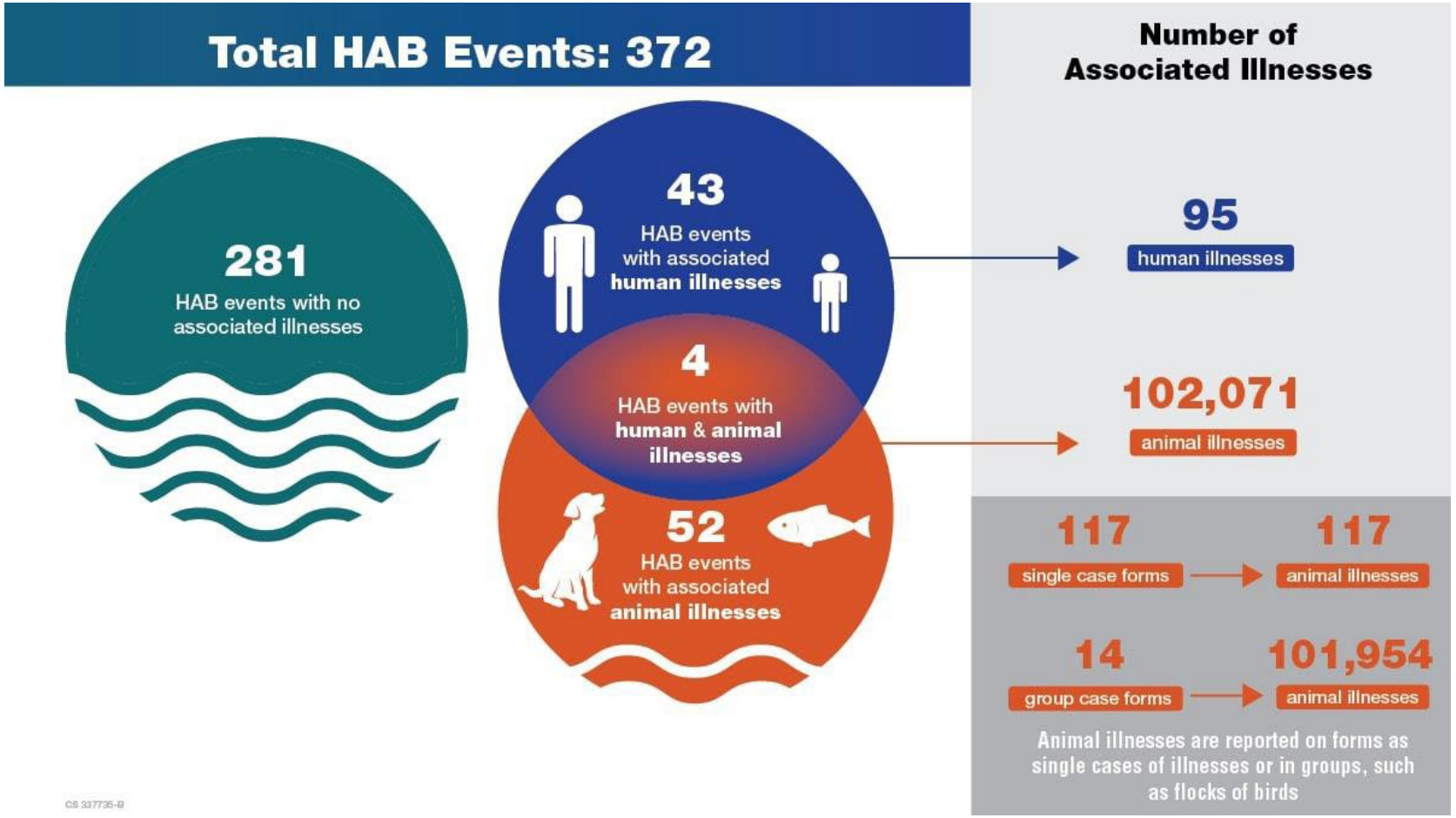
One Health Harmful Algal Bloom System (OHHABS)

EXPLORE TOPICS

- People and animals are getting sick from harmful algal blooms (HABs) across the United States.

- In 2022, Fifteen states voluntarily reported 372 HAB events, 95 human illnesses, and at least 102,071 animal illnesses.

- Nearly half (45%) of human illnesses were among children and teens younger than 18 years old.



2022 Data from CDC's One Health Harmful Algal Bloom System (OHHABS)

Physician Reference for Cyanobacterial Blooms

People can become ill from cyanobacteria or their toxins through ingestion, direct skin contact, or inhalation. There are no clinically available diagnostic tests for cyanotoxins or treatments for illnesses caused by cyanobacterial blooms, but you can help relieve patients' symptoms by providing supportive medical care.

Cyanobacterial Bloom Basics

Cyanobacteria (also called blue-green algae) can grow quickly, or bloom, when the water is warm, slow-moving, and full of nutrients. Cyanobacterial blooms are most commonly found in fresh water such as lakes, rivers, and streams. Blooms can discolor the water and look like foam, scum, mats, or paint on the surface. These blooms sometimes produce toxins (cyanotoxins) that can cause illness.

Common cyanotoxins include

- Microcystins
- Anatoxins
- Nodularins
- Cylindrospermopsin
- Saxitoxins
- Lyngbyatoxins

Exposure and Health Impacts

- People are most often exposed while swimming, boating, or doing other activities in or near water with a cyanobacterial bloom. People can also be exposed through contaminated tap water; seafood; dietary supplements; or, infrequently, dialysis.
- Symptoms and signs depend on how people were exposed, how long they were exposed, and the types of toxins they were exposed to (see the table on page two for more information on health effects).
- Pet illness may provide additional evidence that a patient could have an illness caused by a cyanobacterial bloom. Dogs and other animals might have more severe symptoms than people, including collapse and sudden death.

ICD-10-CM codes can be used in diagnosing and recording harmful algal and cyanobacterial bloom-related illnesses.

- T65.82 Toxic effect harmful algae & algae toxins
- Z77.121 Contact with and (suspected) exposure to harmful algae and algae toxins

Tests and Treatments

- Medical care is supportive. There are no known antidotes to cyanotoxins or specific treatments for illnesses caused by cyanobacteria and their toxins.
- There are currently no clinically available diagnostic tests for cyanotoxins.

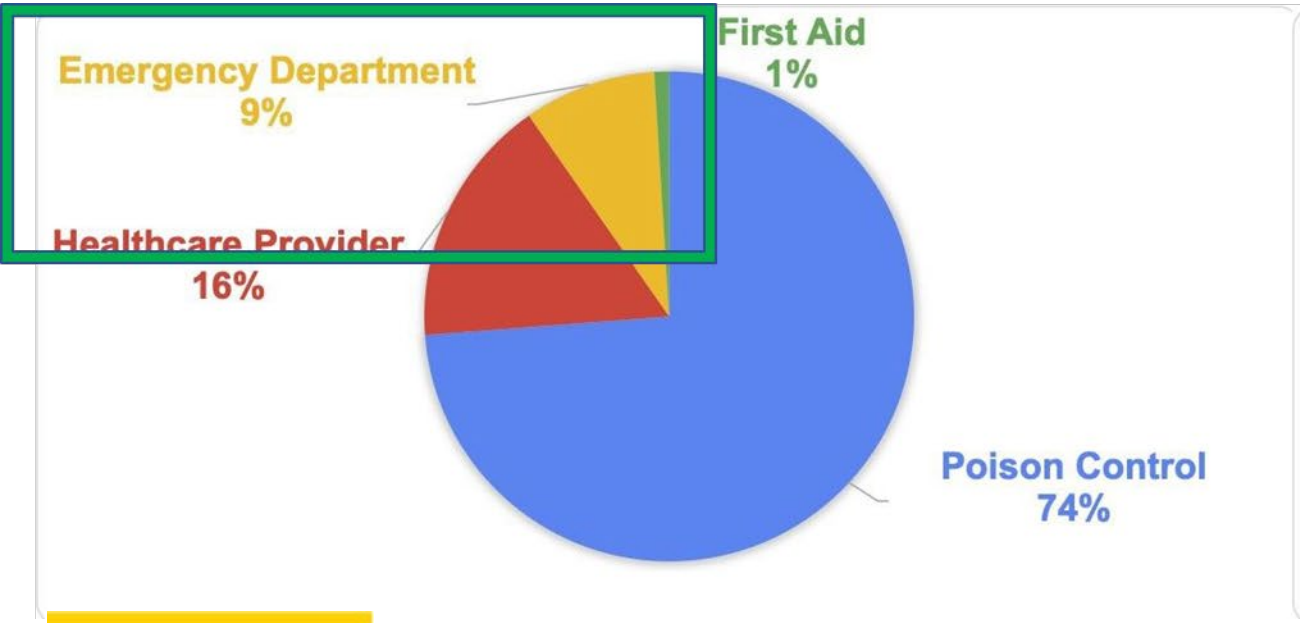
CS319451-B

https://www.cdc.gov/habs/pdf/habsphysician_card.pdf

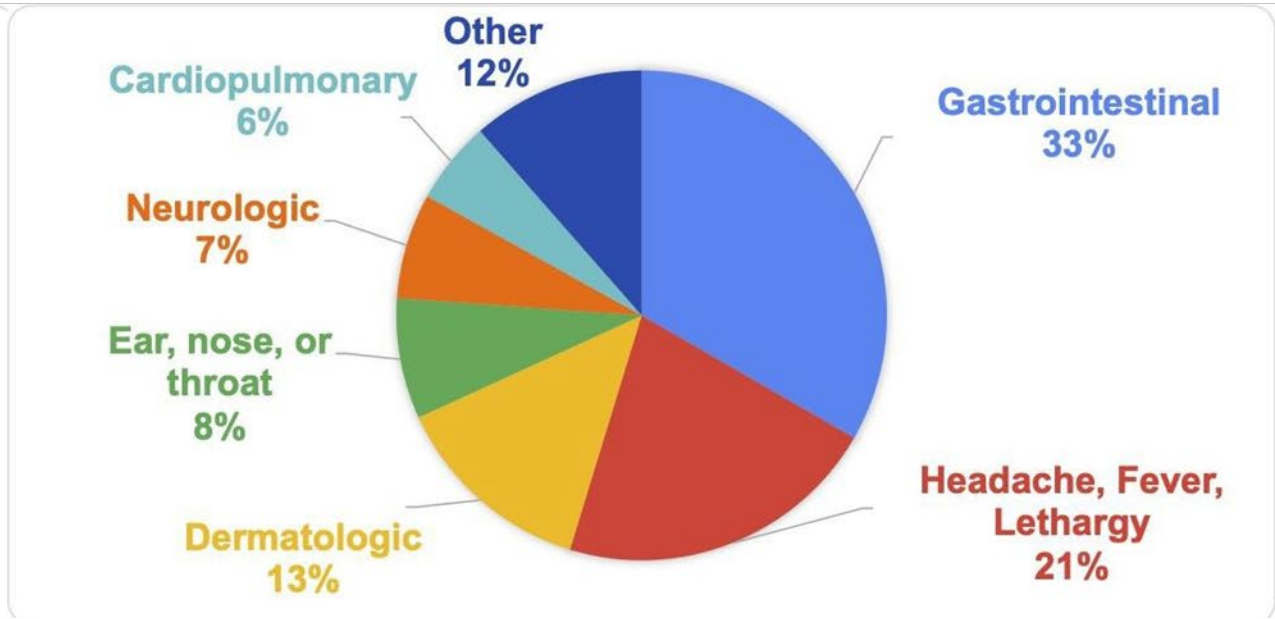
Characteristics of HAB Exposures and Illness

2016-2018 Data from CDC's One Health Harmful Algal Bloom System

Healthcare Setting



Most Common Symptoms



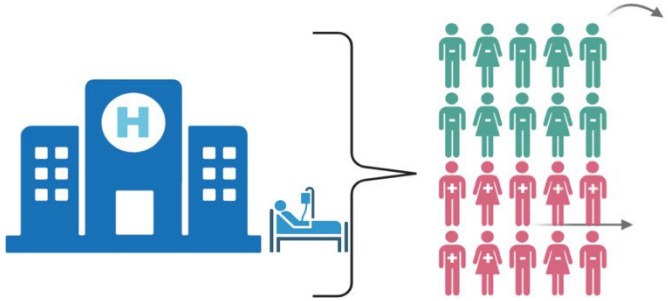
Reported cases (n = 389) associated with HAB events. (*MMWR*, 2020)

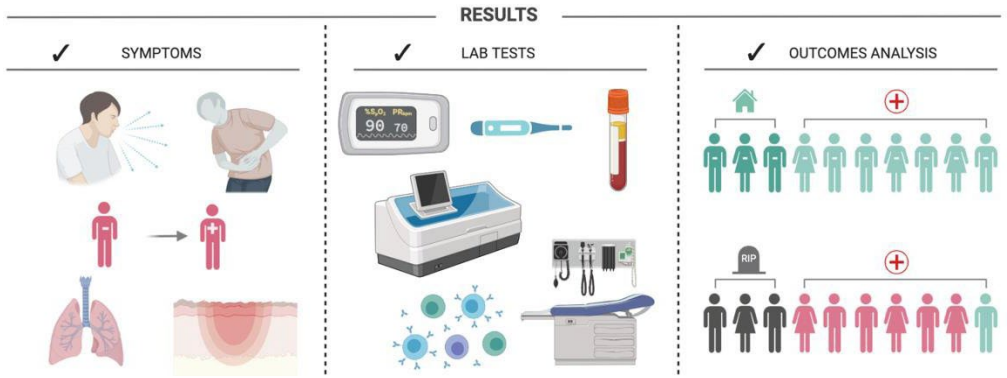
Characteristics of HAB Exposures and Illness

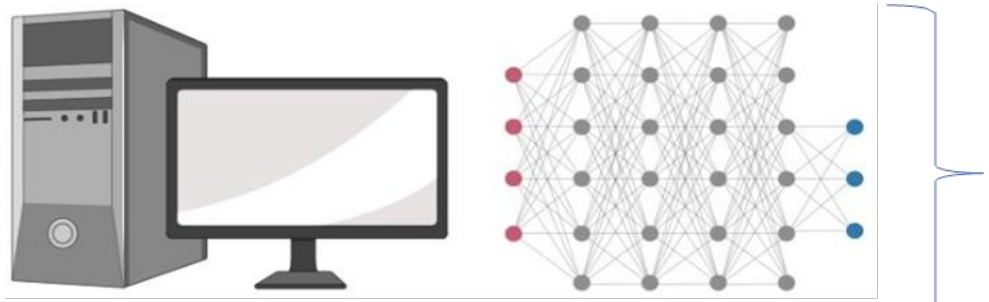
2016-2018 Data from Healthcare Cost and Utilization Projects (HCUP) Nationwide Emergency Department Sample (NEDS)

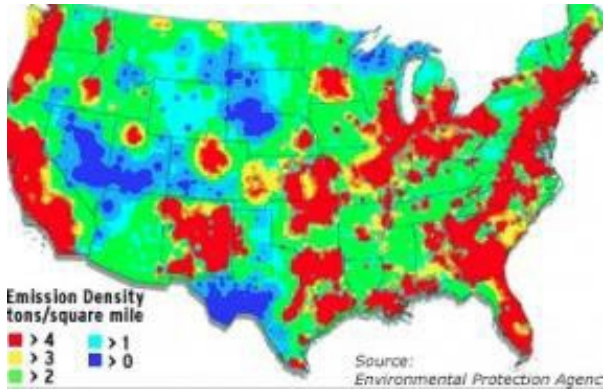
H·CUP
HEALTHCARE COST AND UTILIZATION PROJECT

AHRQ
Agency for Healthcare Research and Quality









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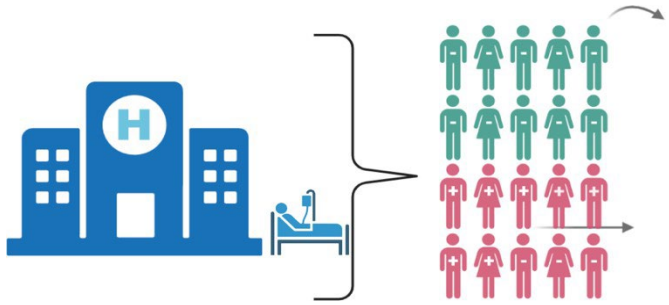
Characteristics of HAB Exposures and Illness

H·CUP HEALTHCARE COST AND UTILIZATION PROJECT

AHRQ Agency for Healthcare Research and Quality

118 Patient Visits to Emergency Department for HAB Exposure from 2016-2018



Year	2016	2017	2018	Summary
Respiratory related illness as primary code (%)	24%	10%	36%	**30%**
Any Respiratory Illness (%)	53%	15%	60%	**53%**
Smoking (%)	11%	33%	26%	**27%**
Diabetes (%)	5%	10%	11%	**10%**

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What can we learn from clinical case series from Northwest Ohio?

Public Health Data Matches our Clinical Experience

Open Access | Case Report

A Case Series of Potential Pediatric Cyanotoxin Exposures Associated with Harmful Algal Blooms in Northwest Ohio

by Benjamin W. French [1,†], Rajat Kaul [2,†], Jerrin George [1], Steven T. Haller [1,*], David J. Kennedy [1,*] and Deepa Mukundan [2,*]

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[2] Department of Pediatrics, College of Medicine and Life Science, University of Toledo, Toledo, OH 43614, USA

[*] Authors to whom correspondence should be addressed.

[†] These authors contributed equally to this work.

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(This article belongs to the Topic **Ecosystem Change, Infectious Diseases Transmission and Early Warning**)

Characteristics of HAB Exposures and Illness

https://ncceh.ca/resources/evidence-reviews/cyanobacteria-recreational-freshwaters-understanding-exposures-and

Characteristics of HAB Exposures and Illness

Year	Location	Activity	Affected population	Symptoms	Outcome	Suspected toxin
1959[66]	Saskatchewan, Canada	Swimming	Adult male	Headache, nausea, and severe gastrointestinal symptoms.	Hospitalized for 24h. Fully recovered.	Suspected *Microcystis* cells found in patient's stool.
1989[79]	Rudyard, England	Canoeing (Barrel roles, heads immersed in water)	Eight teenage male army recruits	Sore throat, headache, abdominal pain, dry cough, diarrhoea, vomiting, and blistered mouths. Two teens who swallowed water had more severe symptoms, malaise, pleuritic pain, fever. One suffered confusion and hallucinations.	Two recruits hospitalized for pneumonia. All fully recovered.	*Microcystis aeruginosa* and MC-LR detected in bloom material.
2002[25,78]	Wisconsin, USA	Playing in a golf course pond	Five teenage boys	Three of the boys had minor symptoms. Two boys who were fully immersed and accidently ingested water had more severe symptoms. One suffered severe diarrhoea and abdominal pain. The second suffered nausea, vomiting, shock, seizure, acute heart failure and death.	One fatality. Four fully recovered.	Initial stool and blood from the fatal case appeared to indicate *Anabaena flos-aquae* and ATX-a, later identified to be phenylalanine. Cause of death was inconclusive.
2007[80]	Salto Grande Dam, Argentina	Jet skiing (Immersion for >2h, ingested water)	19-year-old male	Symptoms included gastrointestinal symptoms, nausea, vomiting, weakness, Worsened to respiratory, renal, and liver problems.	Hospitalized for 20 d, including three days in ICU. Fully recovered.	Intense bloom of *Microcystis* spp.
2011[81]	Kansas, USA	Swimming	17-year-old male	Sore throat, cough, malaise, headache, and fever.	Both hospitalized for three days. Both fully recovered.	*M. aeruginosa* and microcystins were detected in the lake.
		Water skiing (Ingested water)	38-year-old male	Headache, joint pain, fatigue, sore throat, fever, chills, and diaphoresis.		
2015[82]	Montevideo, Uruguay	Repeated recreational activity at a beach	Three adults and 20-month old child.	Self-limiting gastrointestinal symptoms for the adults. Severe symptoms for the child including jaundice, elevated liver enzymes, respiratory symptoms, liver failure.	Child hospitalized with respiratory support; liver failure leading to liver transplant. All fully recovered.	*Microcystis* spp. bloom was present and MC up to 8.2 mg/L was reported.
2014-2016[64]	Maumee River and Maumee Bay, Lake Erie, USA	Swimming	Case 1 (2016): 16-year-old girl	Rash, headache, fever, vomiting, diarrhea, and severe respiratory distress. A male sibling also developed mild self limiting symptoms that resolved.	Hospitalized with worsening symptoms two weeks after exposure. Fully recovered.	Events occurred in areas where cyanobacterial blooms were present or reported shortly after the event. Tampon-use during swimming for Cases 1 and 2 may have caused contaminated water to be absorbed, prolonging exposure and subsequent symptoms experienced.
			Case 2 (2015): 14-year-old girl	Rash, fever, vomiting, diarrhea, and dehydration. No ingestion of water reported.	Hospitalized in ICU for treatment. Fully recovered.	
			Case 3 (2014): Seven-year-old girl; history of asthma	Decreased responsiveness, tachycardia, and severe respiratory distress.	Hospitalized in ICU with mechanical intubation; prolonged hospital stay. Fully recovered.	

https://ncceh.ca/resources/evidence-reviews/cyanobacteria-recreational-freshwaters-understanding-exposures-and

Characteristics of HAB Exposures and Illness

Health effects from recreational exposure:

- Most reports of human illness following recreational exposure to cyanobacteria are mild and self-limiting, but **symptoms can be wide ranging** from gastrointestinal or respiratory symptoms to irritant effects, fever, headache, and fatigue.

- Occasionally, exposure to cyanobacterial blooms can cause serious and life-threatening illness, most often following full body immersion and accidental ingestion of water, and **often involve children** (< 18 yrs).

https://ncceh.ca/resources/evidence-reviews/cyanobacteria-recreational-freshwaters-understanding-exposures-and

Knowledge Gaps of HAB Exposures and Illness

Limited research and **knowledge gaps remain on:**

- Health effects associated with **non-ingestion routes** of exposure
- Incidental water contact
- The health effects of **chronic, low-level exposures**
- **Other diseases** that may **increase vulnerability**

https://ncceh.ca/resources/evidence-reviews/cyanobacteria-recreational-freshwaters-understanding-exposures-and

Knowledge Gaps of HAB Exposures and Illness

Limited research and **knowledge gaps remain on:**

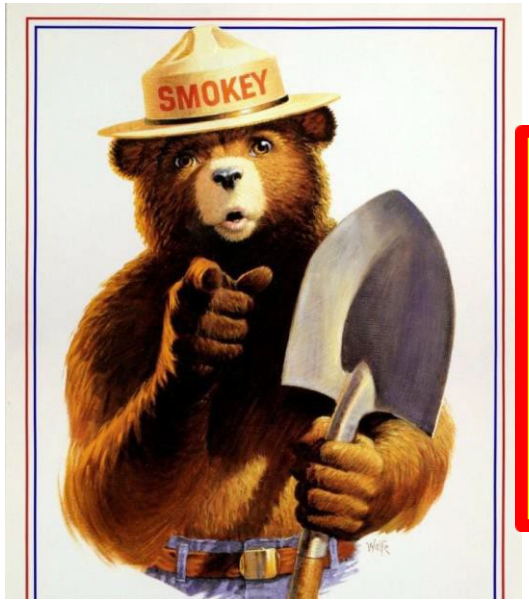
- **Disease surveillance and reporting systems** for cyanobacteria-related illnesses to improve our understanding of health effects due to recreational exposures.

- **Evidence-based guidance for the community *and* clinicians**

https://ncceh.ca/resources/evidence-reviews/cyanobacteria-recreational-freshwaters-understanding-exposures-and

Clinical Take Home Message 2:

<u>Only you</u> *can encourage use of ICD-10 codes in diagnosing and recording Harmful Algal Bloom Related Illness*



- T65.82 Toxic effect harmful algae & algae toxins
- Z77.121 Contact with and (suspected) exposure to harmful algae and algae toxins

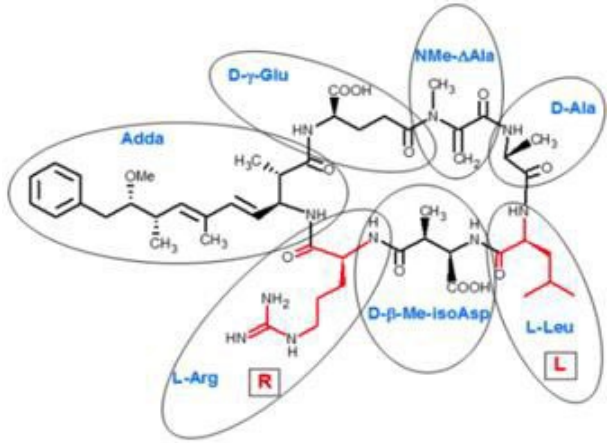
Clinical Take Home Message 3:

Reporting to Health Departments and CDC is key to recording and tracking HAB exposures and informing research efforts

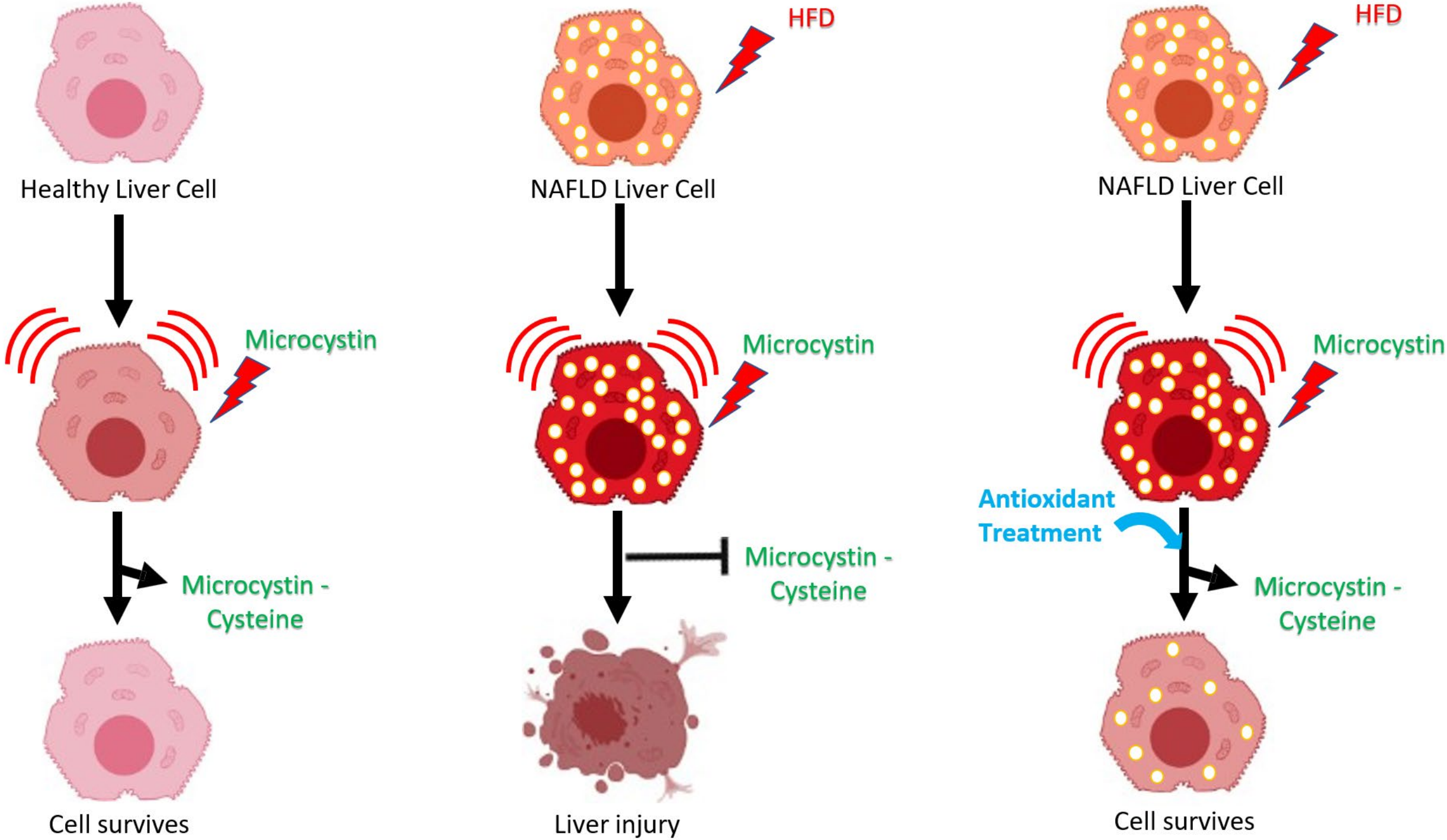
CDC
Centers for Disease Control and Prevention

https://www.cdc.gov/harmful-algal-blooms/?CDC_AAref_Val=https://www.cdc.gov/habs/pdf/habsphysician_card.pdf

What are the current experimental and pre-clinical data for microcystin toxicity especially in models of susceptibility?

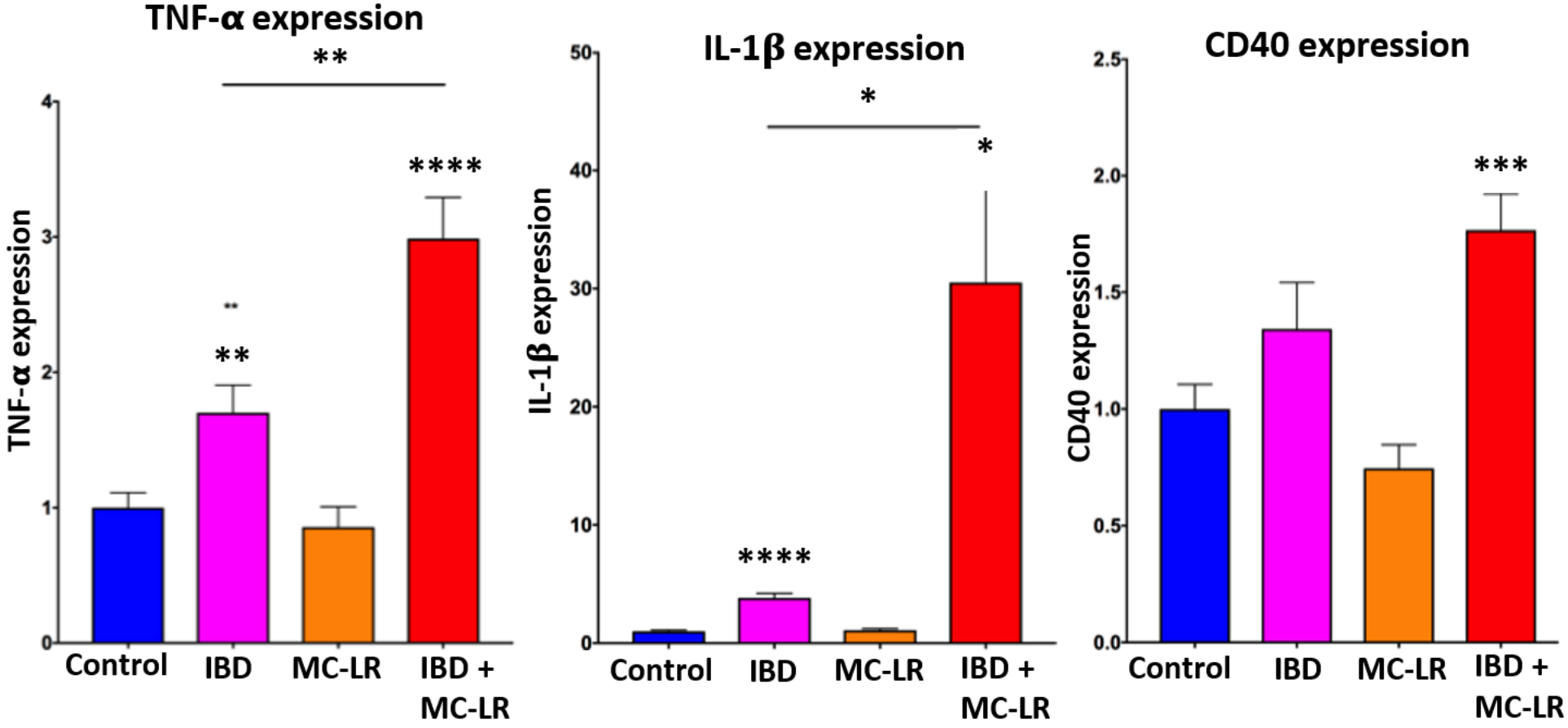


Focus on Microcystin-LR (MC-LR)


Healthy Liver Cell
Microcystin
Microcystin - Cysteine
Cell survives
HFD
NAFLD Liver Cell
Microcystin
Microcystin - Cysteine
Liver injury
HFD
NAFLD Liver Cell
Microcystin
Antioxidant Treatment
Microcystin - Cysteine
Cell survives

Microcystin Exacerbates Inflammation in a Model of Inflammatory Bowel Disease

Gene expression of pro-inflammatory markers in intestinal tissue from our inflammatory bowel disease (IBD) model

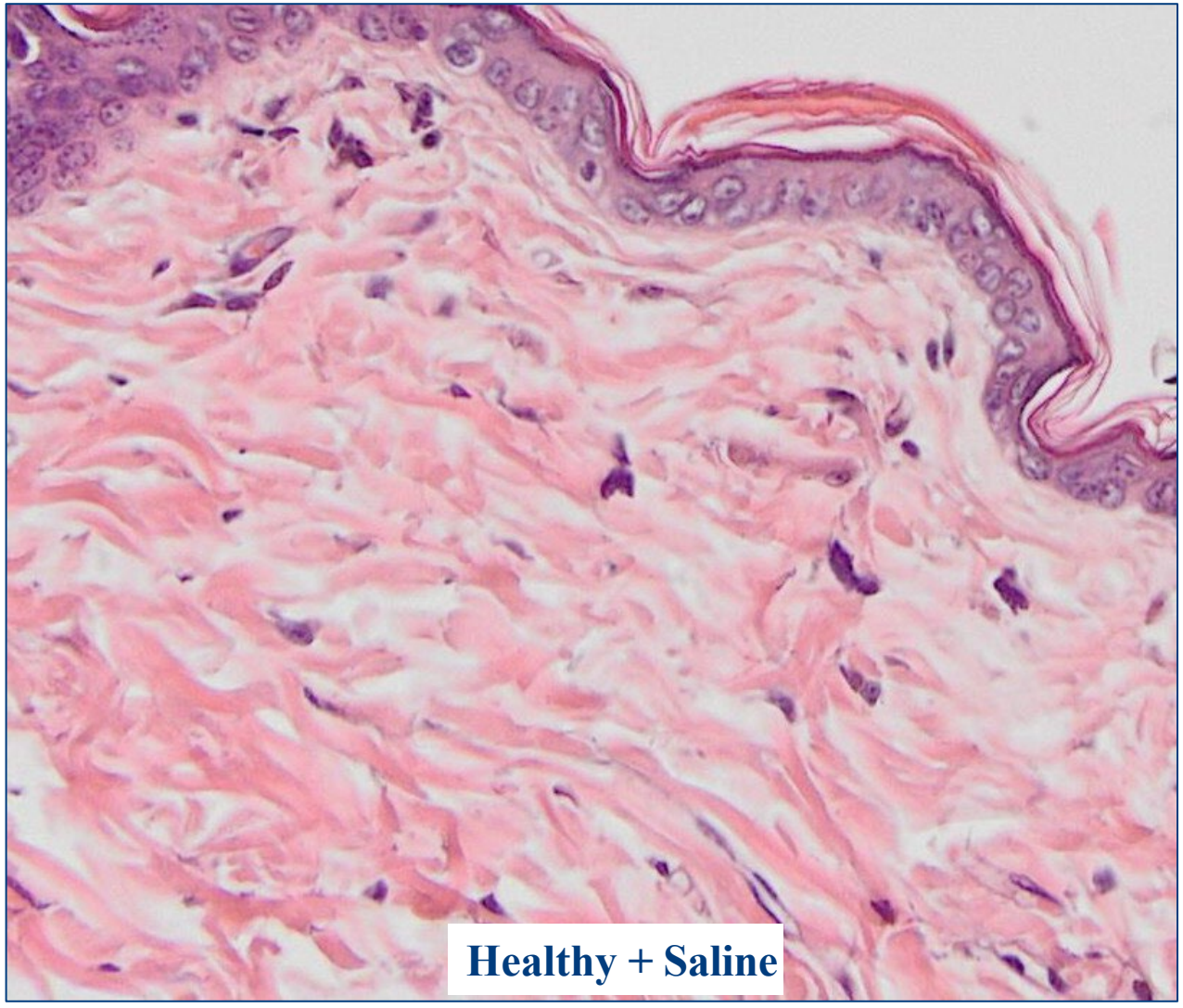


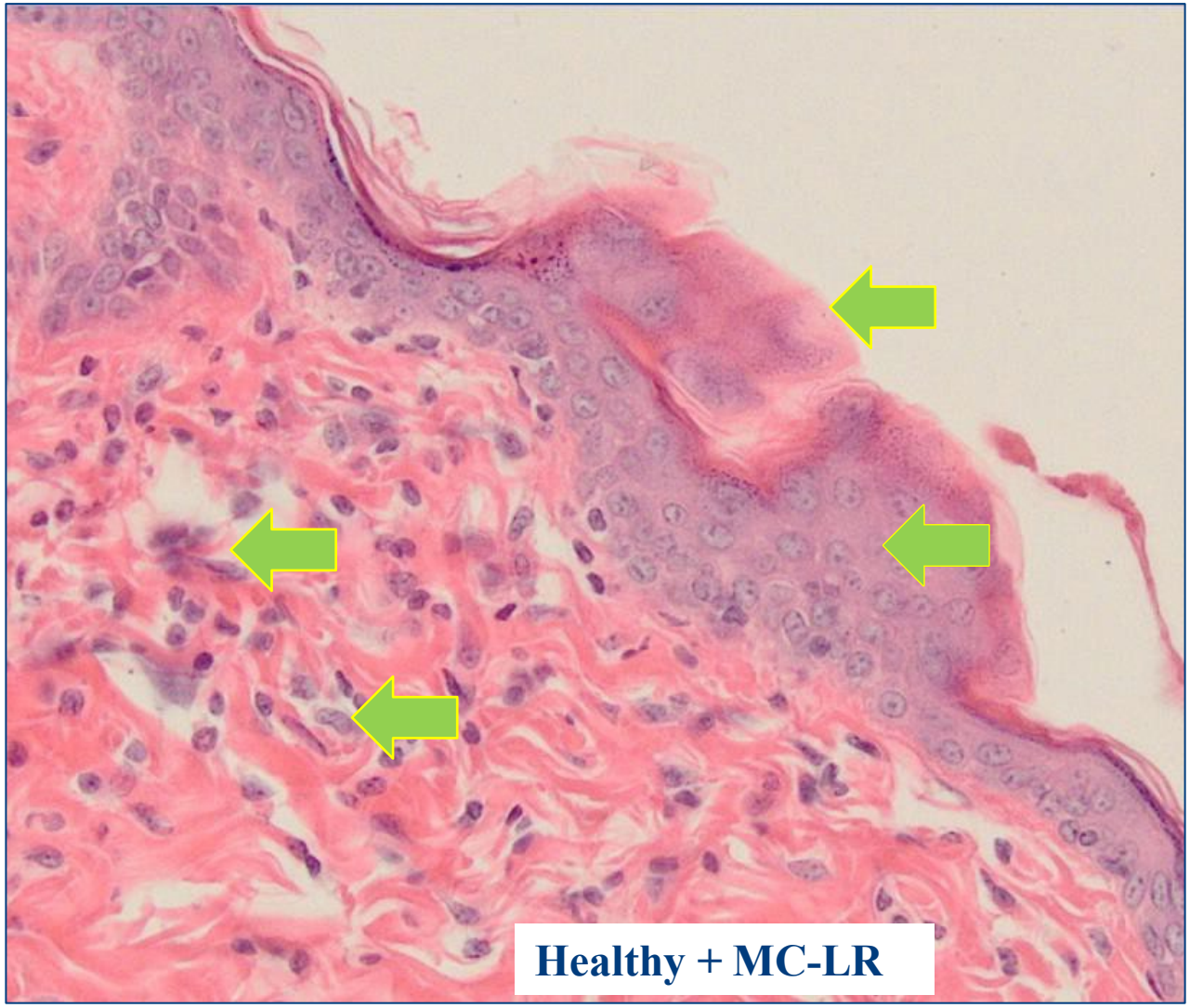
- ✓ Prolonged weight loss
- ✓ Prolonged blood detectable in stool
- ✓ Exacerbated colonic shortening

*p<0.05
**p<0.01
****p<0.0001

Su et al. *Toxins*. 2019. 11(6). PMID: 31242640

Dermal Microcystin Exposure Accelerates Atopic Dermatitis in Skin





Why might respiratory conditions be a common health impact after HAB exposure?

Toledo, OH ranked the highest in the nation for asthma medicine usage: 2024 Data

Quick-relief medicine use is highest in these cities†:

Asthma Quick-Relief Medicine Use Ranking	Metropolitan Area	Overall Asthma Capital National Ranking
1	Toledo, OH	41
2	Springfield, MA	4
3	Detroit, MI	3
4	Louisville, KY	40
5	Columbus, OH	20
6	Providence, RI	10
7	Greenville, SC	13
8	Boston, MA	74
9	Indianapolis, IN	61
10	Atlanta, GA	43

Asthma control medicine use is highest in these cities†:

Asthma Control Medicine Use Ranking	Metropolitan Area	Overall Asthma Capital National Ranking
1	Toledo, OH	41
2	Ogden, UT	79
3	Louisville, KY	40
4	Indianapolis, IN	61
5	Jackson, MS	48
6	Pittsburgh, PA	45
7	Harrisburg, PA	14
8	Greenville, SC	13
9	Detroit, MI	3
10	New Haven, CT	83

aafa Asthma and Allergy Foundation of America

2024 AsthmaCapitals

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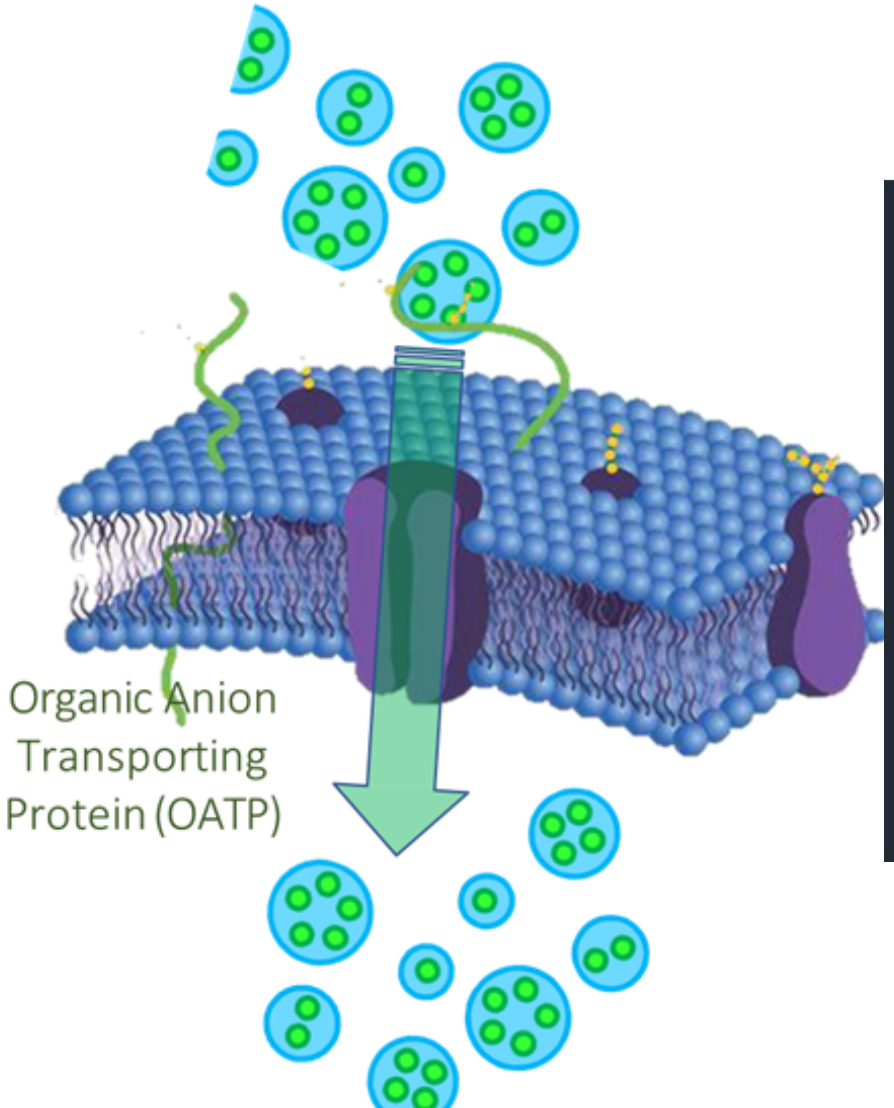
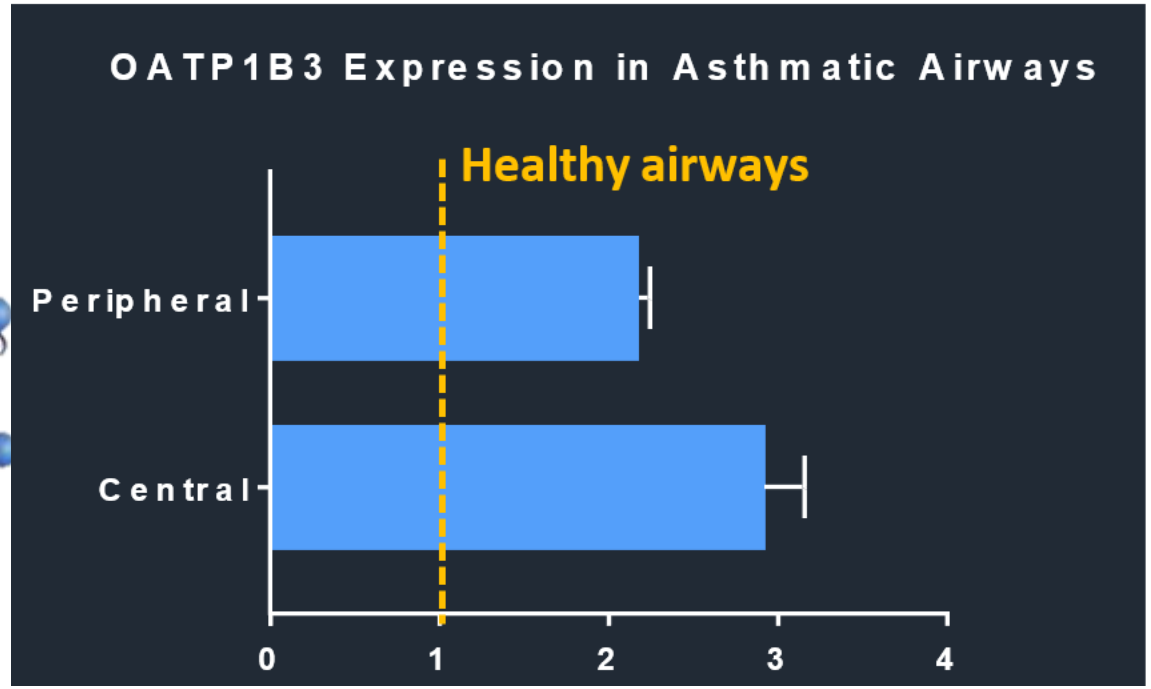
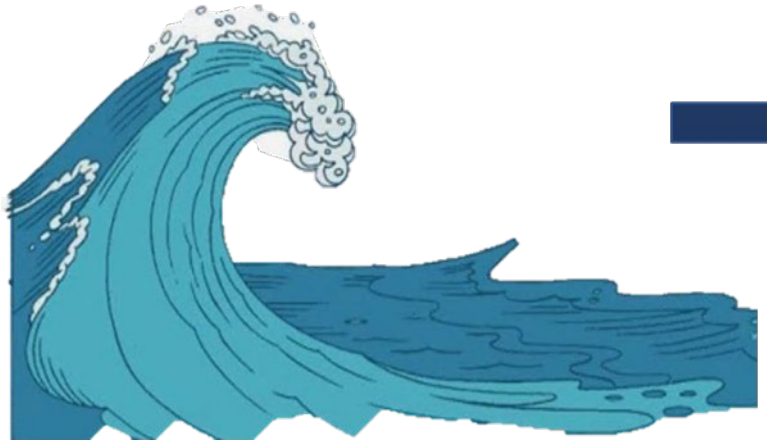
Source: Asthma and Allergy Foundation of American, 2024 Asthma Capitals Report (asthmacapitals.com)

Patients with Asthma Have More of the Transporters that Microcystin Uses to Gain Access to Lung Cells

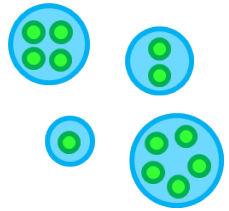




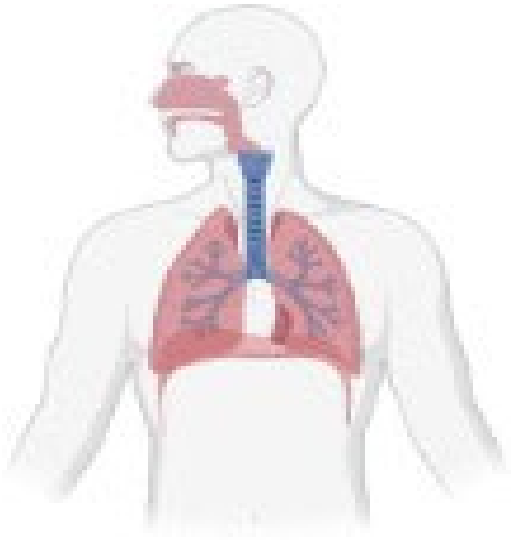
Microcystin Toxins in the AIR we Breath?



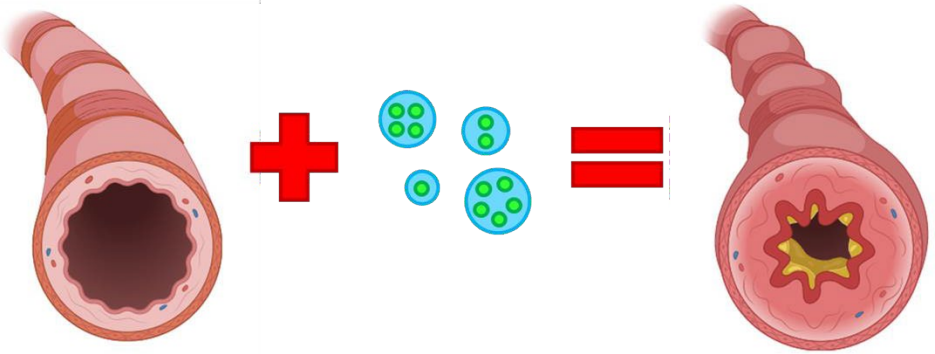
Aerosols are produced by wave breaking, bubble-bursting, and recreational activity



Aerosols can be carried 30 kilometers from the source (Olsen et al. *Environ Sci Technol*, 2020)



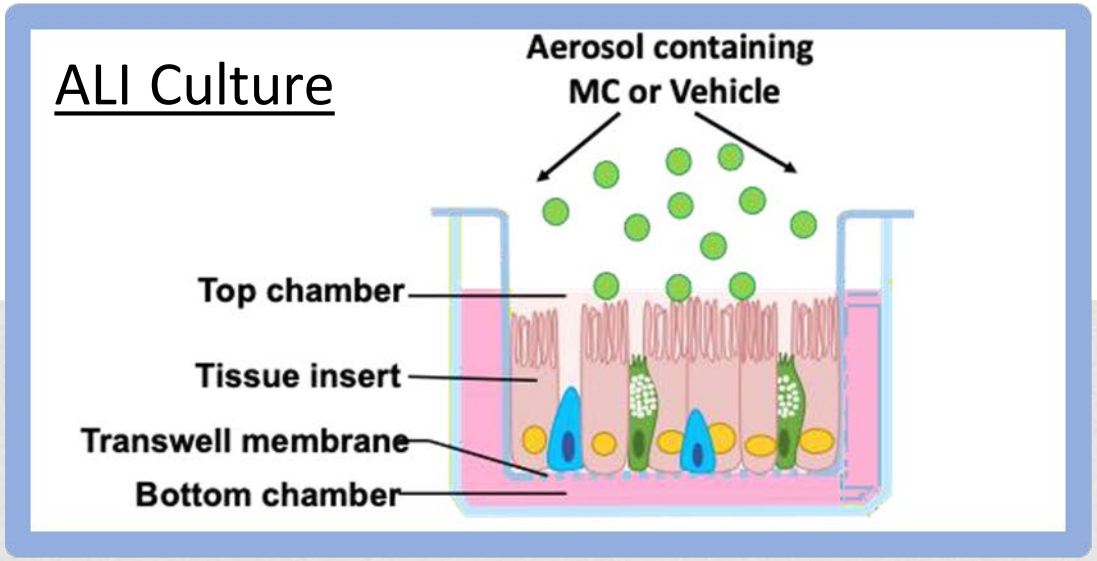
Inhalation of aerosols may occur at source or distance

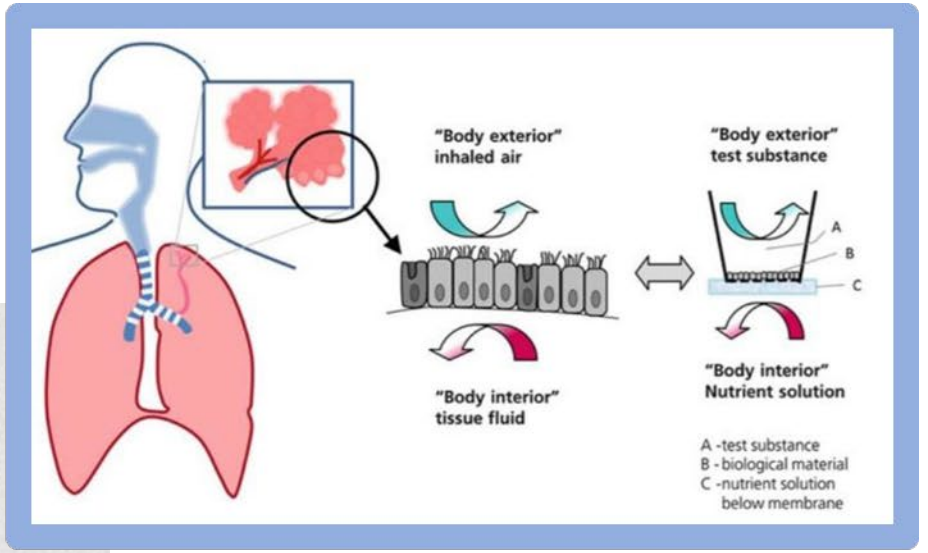


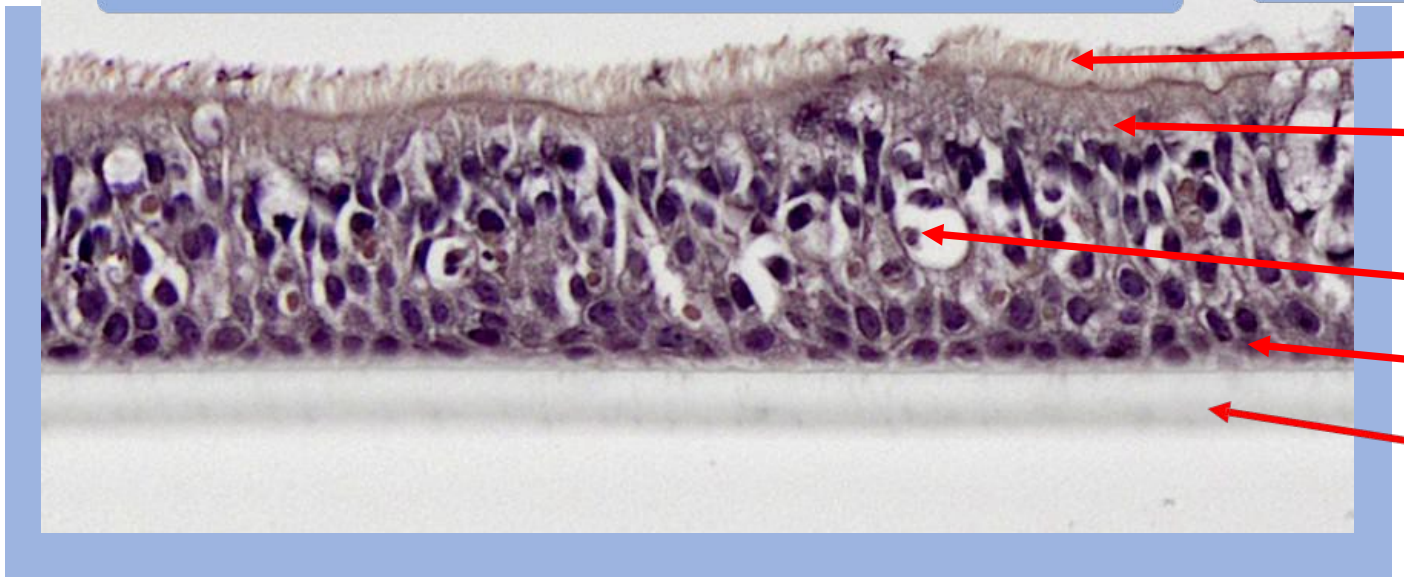
Exposure to aerosolized toxins may lead to airway inflammation (Facciponte et al. *Sci Total Environ*, 2018)

How do we model Harmful Algal Bloom (HAB) aerosols experimentally?

Modeling Human Airway Epithelium In 3D culture







Cilia

Ciliated cells (Multi-layered columnar epithelium

Goblet cells

Basal cells

Transwell membrane

0.4 µm

MC-LR exposure induces pro-inflammatory response that is heightened in the setting of asthma

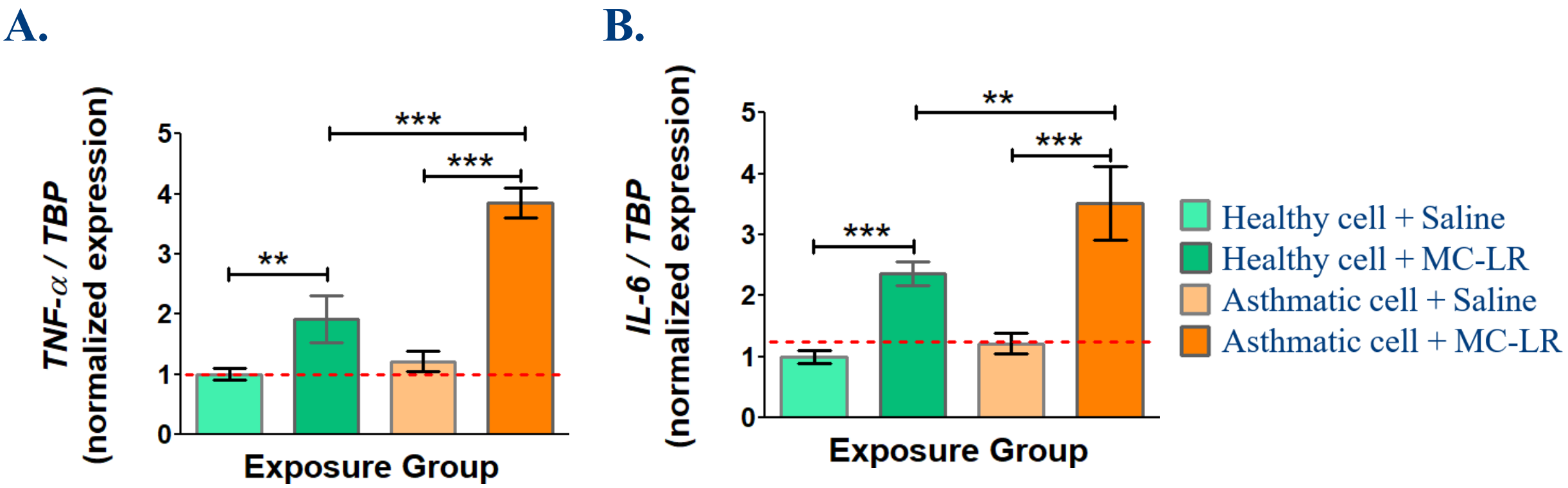


Figure 1. Aerosolized MC-LR exposure in primary airway epithelial cells: MC-LR exposure (1µM) resulted in increased expression of *TNF-α*, and *IL-6* which are further heightened in asthmatic cells. P-values: **P<0.01; *** P<0.001 (One-way ANOVA)

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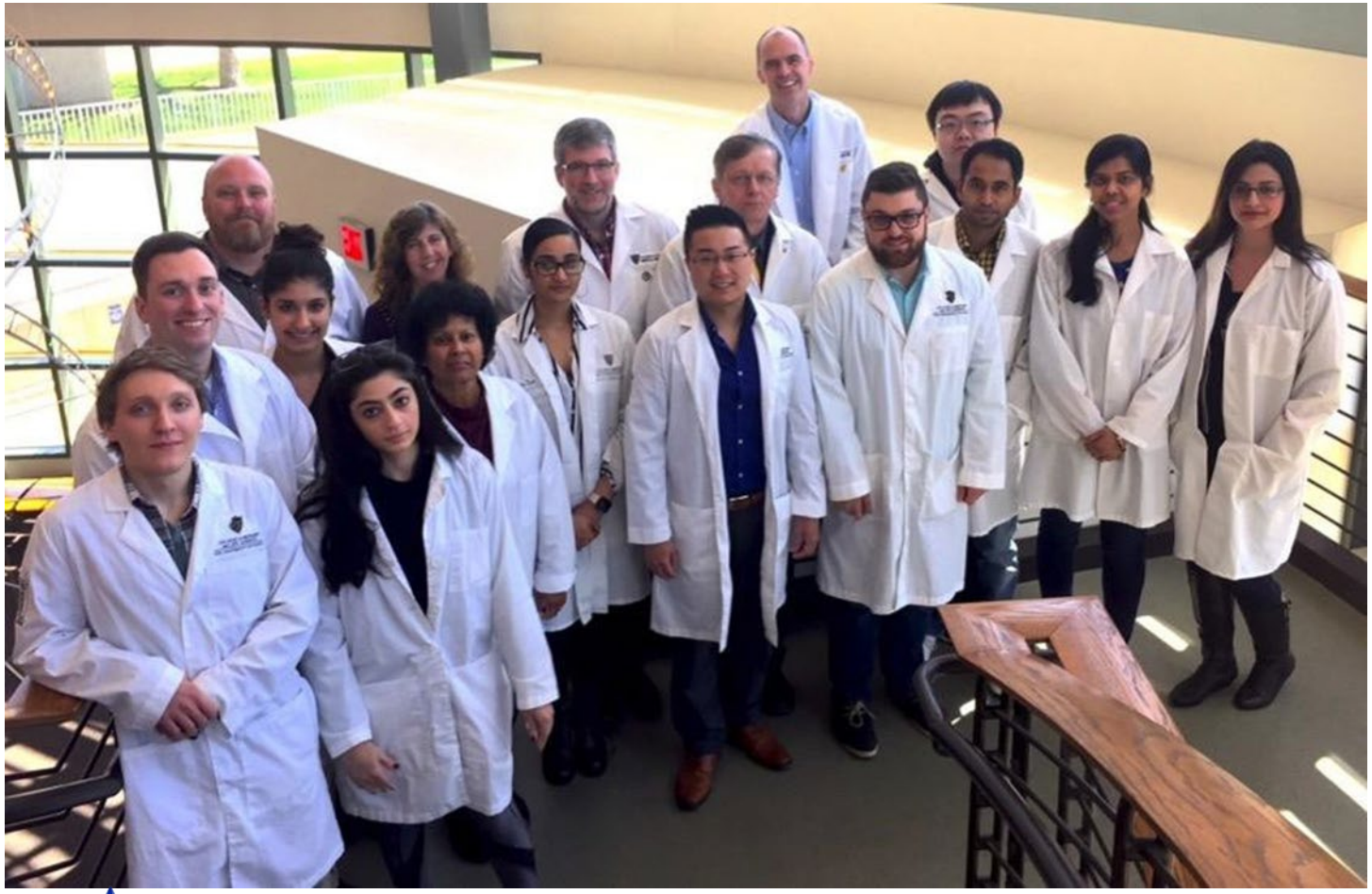
Clinical Take Home Message 4:

Asthma may exacerbate harmful health effects of HAB toxins

What are we doing to improve this?



Environmental, Occupational and
Community Medicine Program
University of Toledo Department of Medicine

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Physician Reference for Cyanobacterial Blooms

People can become ill from cyanobacteria or their toxins through ingestion, direct skin contact, or inhalation. There are no clinically available diagnostic tests for cyanotoxins or treatments for illnesses caused by cyanobacterial blooms, but you can help relieve patients' symptoms by providing supportive medical care.

Cyanobacterial Bloom Basics

Cyanobacteria (also called blue-green algae) can grow quickly, or bloom, when the water is warm, slow-moving, and full of nutrients. Cyanobacterial blooms are most commonly found in fresh water such as lakes, rivers, and streams. Blooms can discolor the water and look like foam, scum, mats, or paint on the surface. These blooms sometimes produce toxins (cyanotoxins) that can cause illness.

Common cyanotoxins include

- Microcystins
- Anatoxins
- Nodularins
- Cylindrospermopsin
- Saxitoxins
- Lyngbyatoxins

Exposure and Health Impacts

- People are most often exposed while swimming, boating, or doing other activities in or near water with a cyanobacterial bloom. People can also be exposed through contaminated tap water; seafood; dietary supplements; or, infrequently, dialysis.
- Symptoms and signs depend on how people were exposed, how long they were exposed, and the types of toxins they were exposed to (see the table on page two for more information on health effects).
- Pet illness may provide additional evidence that a patient could have an illness caused by a cyanobacterial bloom. Dogs and other animals might have more severe symptoms than people, including collapse

ICD-10-CM codes can be used in diagnosing and recording harmful algal and cyanobacterial bloom-related illnesses.

- T65.82 Toxic effect harmful algae & algae toxins
- Z77.121 Contact with and (suspected) exposure to harmful algae and algae toxins

Tests and Treatments

- Medical care is supportive. There are no known antidotes to cyanotoxins or specific treatments for illnesses caused by cyanobacteria and their toxins.
- There are currently no clinically available diagnostic tests for cyanotoxins.

https://www.cdc.gov/habs/pdf/habsphysician_card.pdf

Physician Reference for Cyanobacterial Blooms

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Tests and Treatments

- Medical care is supportive. There are no known antidotes to cyanotoxins or specific treatments for illnesses caused by cyanobacteria and their toxins.
- There are currently no clinically available diagnostic tests for cyanotoxins.

and sudden death.

Tests and Treatments

- Medical care is supportive. There are no known antidotes to cyanotoxins or specific treatments for illnesses caused by cyanobacteria and their toxins.
- There are currently no clinically available diagnostic tests for cyanotoxins.

CS319451-B

https://www.cdc.gov/habs/pdf/habsphysician_card.pdf

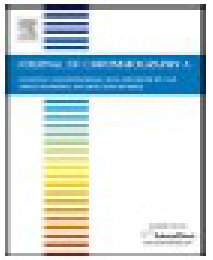
New, Sensitive Diagnostic Methods Developed for Detection of Microcystins in Urine, Plasma, and Serum

Journal of Chromatography A, 1573 (2018) 66–77

Contents lists available at ScienceDirect

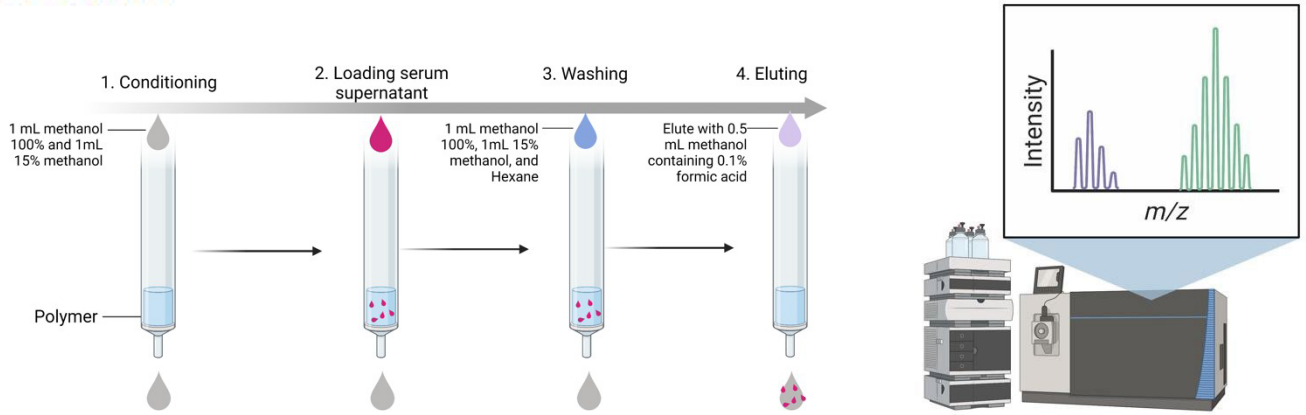
Journal of Chromatography A

journal homepage: www.elsevier.com/locate/chroma



Development and applications of solid-phase extraction and liquid chromatography-mass spectrometry methods for quantification of microcystins in urine, plasma, and serum

Dilrukshika S.W. Palagama[a], David Baliu-Rodriguez[a], Apurva Lad[b], Bruce S. Levison[c], David J. Kennedy[b], Steven T. Haller[b], Judy Westrick[d], Kenneth Hensley[e], Dragan Isailovic[a,*]



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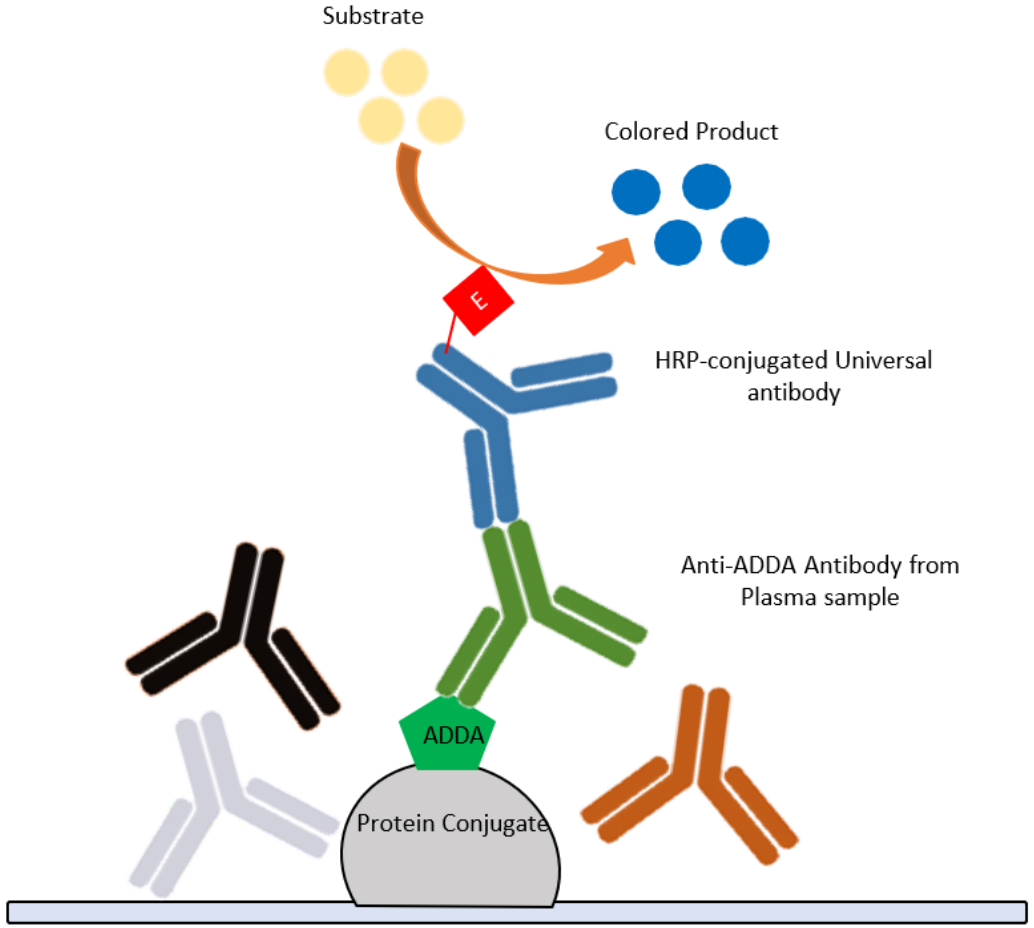
New, Sensitive Diagnostic Methods Developed for Long term Detection of Microcystins in Blood

Deepa Mukundan, M.D.
Chair, Department of Pediatrics
University of Toledo College of Medicine and Life Sciences



Apurva Lad, Ph.D.
Post-Doctoral Fellow
University of Toledo College of Medicine and Life Sciences

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Two Patent Applications for New, Sensitive Diagnostic Methods Developed for Detection of Microcystins

Patent Applications

1) Method for detecting exposure to cyanotoxins
Filed: 6/28/2018, Serial Number: 62/691,036

2) An improved protocol for preconcentration and quantification of microcystins using LC-MS
Filed: 7/12/2018, Serial Number: 16/033,496

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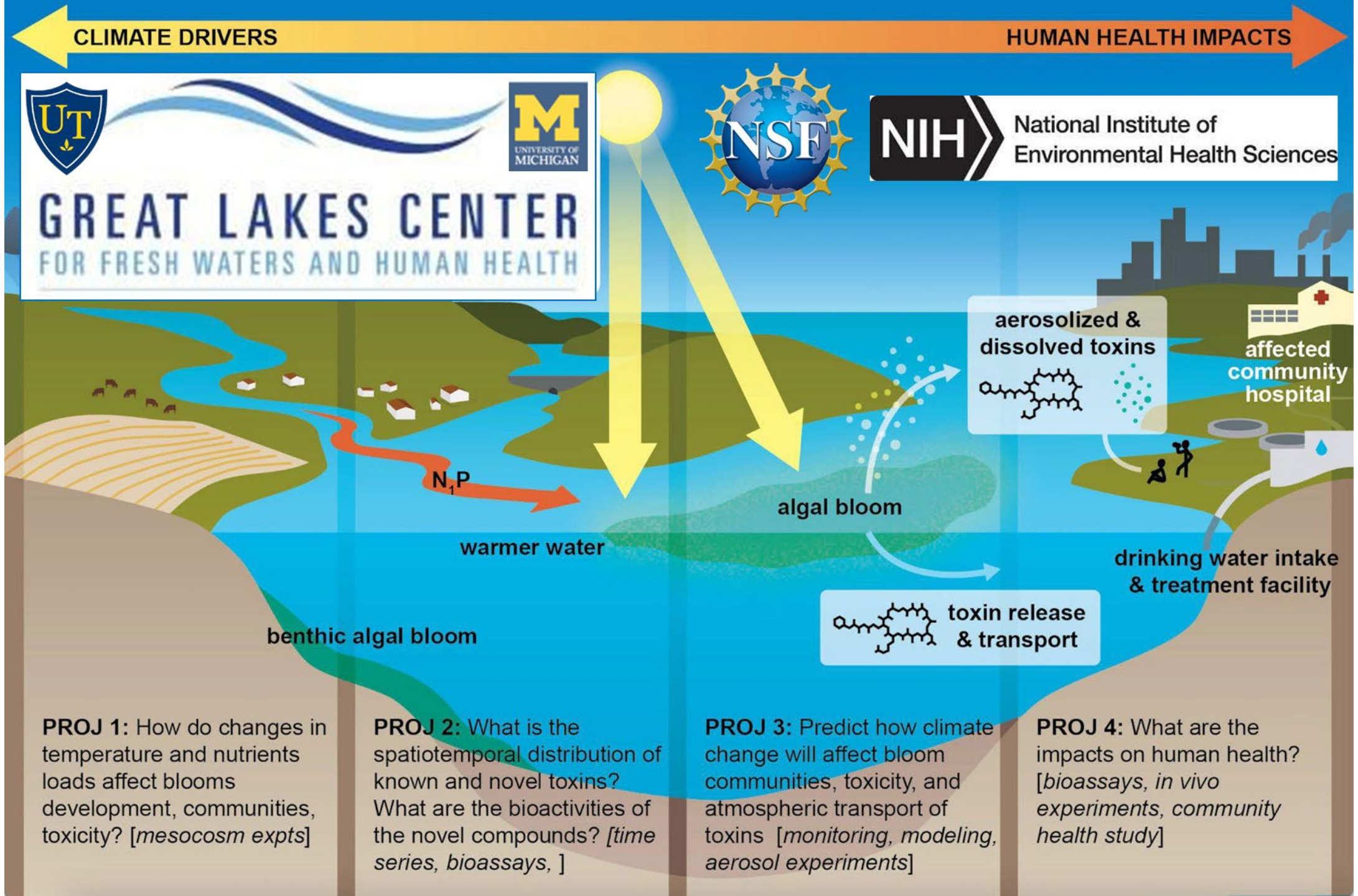

CLIMATE DRIVERS
HUMAN HEALTH IMPACTS
GREAT LAKES CENTER
FOR FRESH WATERS AND HUMAN HEALTH
NSF
NIH
National Institute of Environmental Health Sciences
aerosolized & dissolved toxins
affected community hospital
N_1P
algal bloom
warmer water
drinking water intake & treatment facility
toxin release & transport
benthic algal bloom
PROJ 1: How do changes in temperature and nutrients loads affect blooms development, communities, toxicity? [mesocosm expts]
PROJ 2: What is the spatiotemporal distribution of known and novel toxins? What are the bioactivities of the novel compounds? [time series, bioassays,]
PROJ 3: Predict how climate change will affect bloom communities, toxicity, and atmospheric transport of toxins [monitoring, modeling, aerosol experiments]
PROJ 4: What are the impacts on human health? [bioassays, in vivo experiments, community health study]

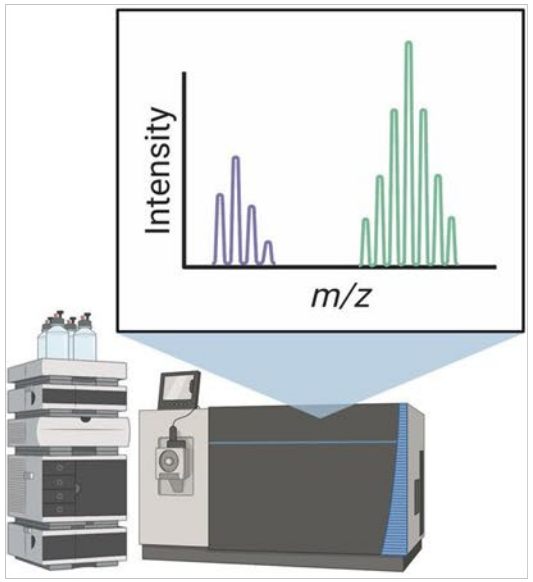
New Center Creates *First Ever* Harmful Algal Bloom Aerosol Sensor Network in Western Lake Erie Basin

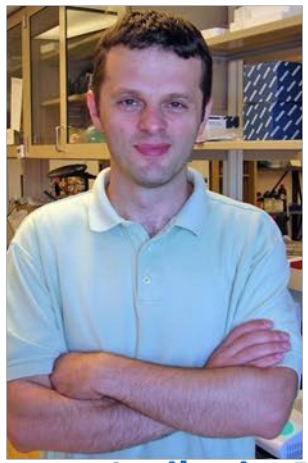
UToledo Lake Erie Center

Lake Erie Center
High Volume
Air Sampler Station

Portable
Bioaerosol
Sampling Units

HPLC-MS/MS





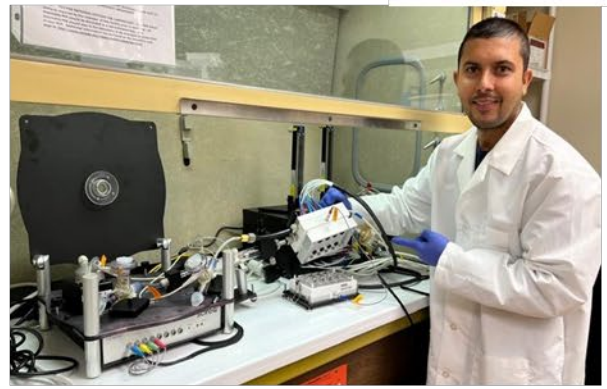
Dragan Isailovic, Ph.D.

Real world aerosolized toxin analysis in human lung cells

Healthy

Asthma

Cyanotoxins



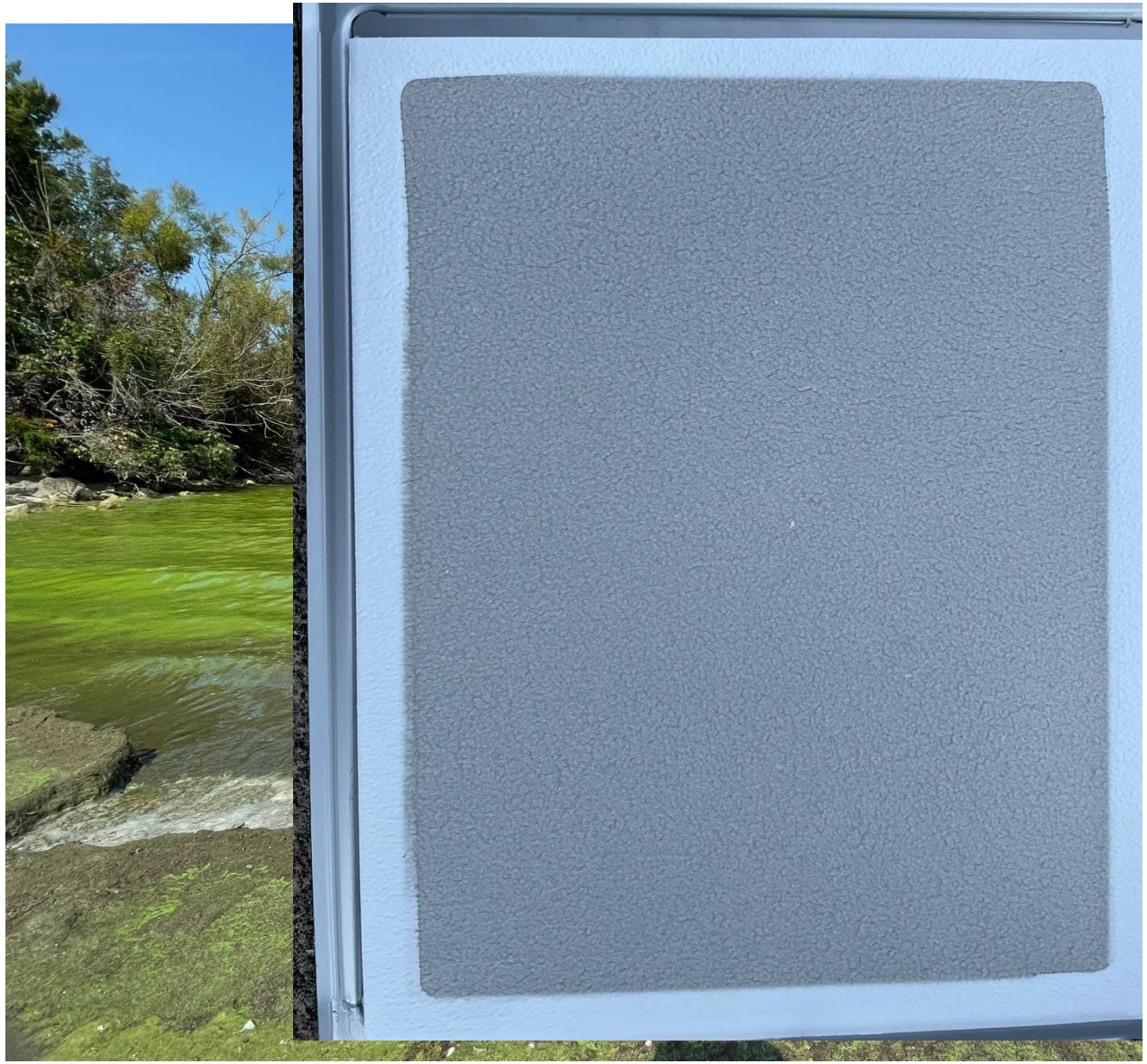
First in Nation ExpoCube™

UToledo Lake Erie Center Air Monitoring Field Station

Great Lakes Atmospheric Monitoring and Protection Research (GLAMPR) mobile laboratory

Differences in Blooms and PM10 collection filters

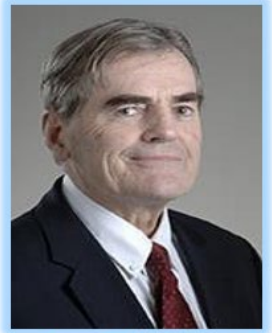
09.09.2024



09.11.2024

New Center Creates Community Health Study to Help Provide Evidence Based Medicine Guidelines for HABs

- 200 Patients from Lucas, Ottawa, and Sandusky Counties
- 5 year community health study
- Creates biobank of clinical samples used to develop new diagnostic methods and therapies for HAB exposures



Jim Willey, MD

Deepa Mukundan, MD

Joan Duggan, MD

Ragheb Assaly, MD

Steven Haller, PhD

Robert Smith, MD, PhD

Clinical Take Home Message 5:

We are making progress towards Evidence Based Medicine on HABs

GREAT LAKES CENTER
FOR FRESH WATERS AND HUMAN HEALTH

Key Take Home Messages:

- **Harmful Algal Blooms (HAB's) are on the rise and have significant public health implications**
- **HAB toxins such as microcystins can have both acute and chronic effects in multiple organ systems across the body**
- **Public health data suggests need for increased education and awareness, especially in vulnerable patient populations**
- **Recent experimental data suggests**
  - **Common pre-existing diseases in liver, gut, skin and lungs may increase susceptibility to HAB toxins**
- **Evidence Based Medicine and Policy is needed to address the health impacts of HABs and we need your help to do this!**

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Thank You!

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Department of Higher Education

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Steven.Haller@utoledo.edu
Andrew.Fribley@UToledo.edu

Women & Philanthropy

NIH National Heart, Lung, and Blood Institute

NIH National Institute of Environmental Health Sciences
Your Environment. Your Health.

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