Utah Lake: Public Health Issues

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Lindon Marina, Utah Lake
July 14, 2016
(Photo: Rich Egan, Salt Lake Tribune)

Escherichia coli

- Normal inhabitant of the mammalian lower digestive tract
  - One of many types of 'coliform' bacteria
  - Most strains not harmful to healthy people
    - Extremely diverse species (~20% of genes are 'core' in all strains)
  - Reliable indicator of fecal contamination & presence of other pathogens

1um
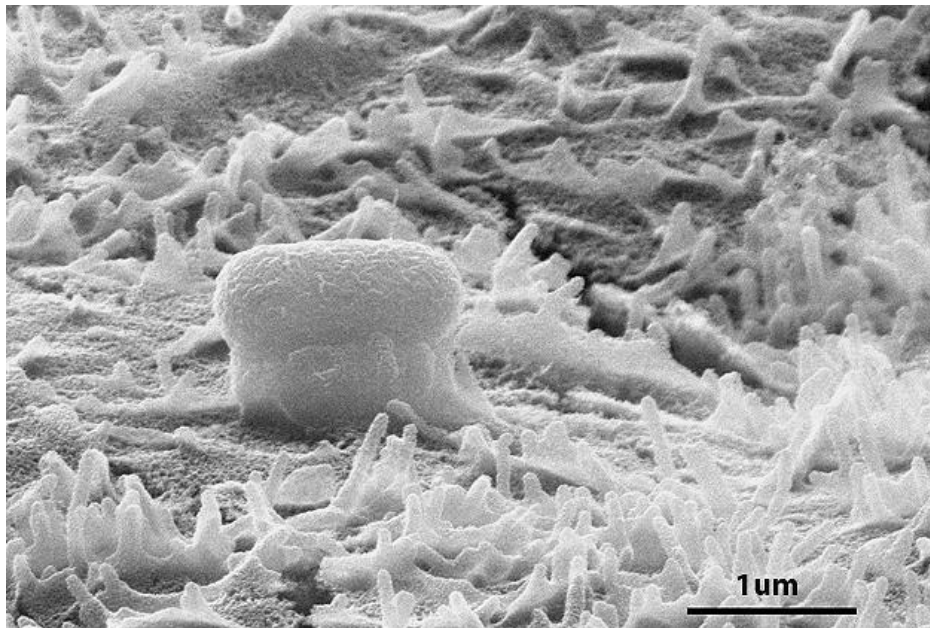
Ken Campellone/UConn Photo

Recreational *E. coli* Exposure

- Some *E. coli* can cause mild to severe health effects
  - Vomiting
  - Diarrhea
  - UTIs
  - Respiratory illness
- Most common via food
- Can be spread through ingestion of contaminated surface water
- Sources
  - Waste dumping, faulty septic or sewer systems, pets, livestock, wildlife, stormwater

CAUTION

WATER QUALITY ADVISORY

A temporary advisory has been issued for this area based on recent monitoring for E. coli bacteria.

FOR YOUR SAFETY

- Do not ingest lake water.
  No ingerir agua del lago.
- Water is unsafe for swimming and deep wading.
  Agua no es segura para nadar y vadear profundo.
- Wash hands after handling fish and lake water.
  Lávese las manos después de manipular el pescado y el agua del lago.

For more information visit:
http://deq.utah.gov/Divisions/dwq/health-advisory/index.htm

Contact your local health department:

UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

UTAH DEPARTMENT OF HEALTH

Current threshold: max of 409 per 100 mL for class 2A (~8 illnesses per 1,000 swimmers)
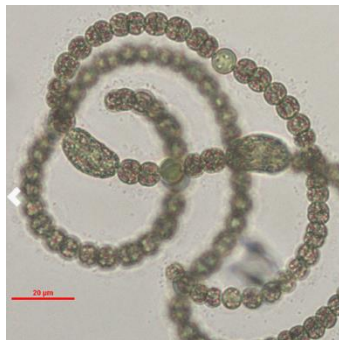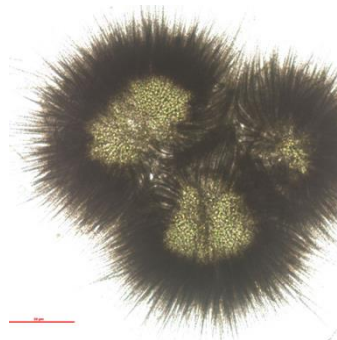
Cyanobacteria

- Photosynthetic bacteria
  - Commonly called blue-green algae (not true algae)
  - Thought to be some of the first oxygen producing organisms
  - Distributed worldwide
  - Natural part of nearly every ecosystem
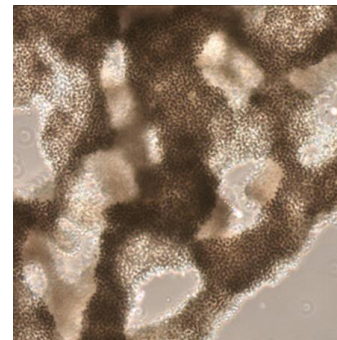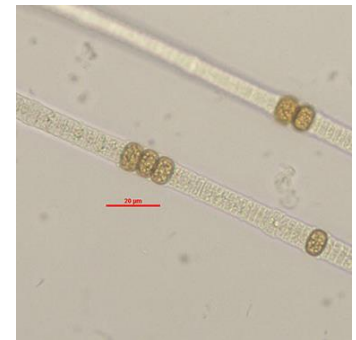 - Many genera/species

Aphanizomenon flos-aquae

Dolichospermum flos-aquae
(formerly *Anabaena*)

Gloeotrichia echinulata

Microcystis aeruginosa

Nodularia spumigena

Images from GreenWater Laboratories

Harmful Algal Blooms

- Rapid growth of cyanobacteria leading to areas with extremely high cell densities
    - Often in the millions of cells per mL
    - Can form scums and mats on the water's surface

Utah Lake
July 13, 2016

Image from UDEQ

HAB Impacts

- Many species can produce various toxins
  - Can affect humans, pets, livestock, wildlife
  - Exposure to cyanobacterial cells themselves also associated with health effects

- Impact drinking water & recreation

- Disrupt aquatic ecosystems
  - ↓ dissolved oxygen
  - ↑ turbidity
  - Toxins
  - Altered pH

Scofield Reservoir
August 29, 2016   Image from UDEQ

Cyanotoxin Production

- Conditions influencing toxin production are not well understood
  - Not all species can produce toxins (including within genera)
  - Species capable of toxin production do not always do so
  - Some species can produce multiple types and variants of cyanotoxins
  - Bloom constituents can shift over time
  - Many of the bloom-influencing factors also affect toxin production
    - Often inconsistent and/or contradictory

Cannot determine toxin presence or concentration by sight, smell, cell count, etc.

Image from UDEQ

Utah Lake
Jordan River Outlet
July 2016

Routes of Exposure

Ingestion   Inhalation   Skin Contact

- Recreational
  - Swimming, boating, water skiing, playing, etc.

- Drinking water

Image from the Ohio Department of Health

- Contaminated fish
  - Some cyanotoxins can accumulate in the tissue of fish and shellfish
    - Microcystins: primarily the liver, but also found at lower levels in muscle

- Contaminated crops
  - Relatively little research, but some studies have shown that cyanotoxins can accumulate to a degree in certain crops
    - Depends on the type of plant, the type of toxin, the method of irrigation, etc.

Common Symptoms of Cyanotoxin Exposure

- Symptoms can range from relatively mild to potentially severe
  - Depends on many factors: concentration of toxins, type of toxin, route of exposure, 'intensity' of exposure, characteristics of the person exposed, etc.

- Symptom onset
  - <u>Hepatotoxins</u> hours to days
 - <u>Neurotoxins</u> immediate to hours

Cyanotoxin	Number of Known Variants or Analogues	Primary Organ Affected	Health Effects[1]	Most Common Cyanobacteria Producing Toxin[2]
Microcystin-LR	> 100	Liver	Abdominal pain Vomiting and diarrhea Liver inflammation and hemorrhage	*Microcystis* *Anabaena* *Planktothrix* *Anabaenopsis* *Aphanizomenon*
Cylindrospermopsin	3	Liver	Acute pneumonia Acute dermatitis Kidney damage Potential tumor growth promotion	*Cylindrospermopsis* *Aphanizomenon* *Anabaena* *Lyngbya* *Rhaphidiopsis* *Umezakia*
Anatoxin-a group[3]	2-6	Nervous System	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death	*Anabaena* *Planktothrix* *Aphanizomenon* *Cylindrospermopsis* *Oscillatoria*

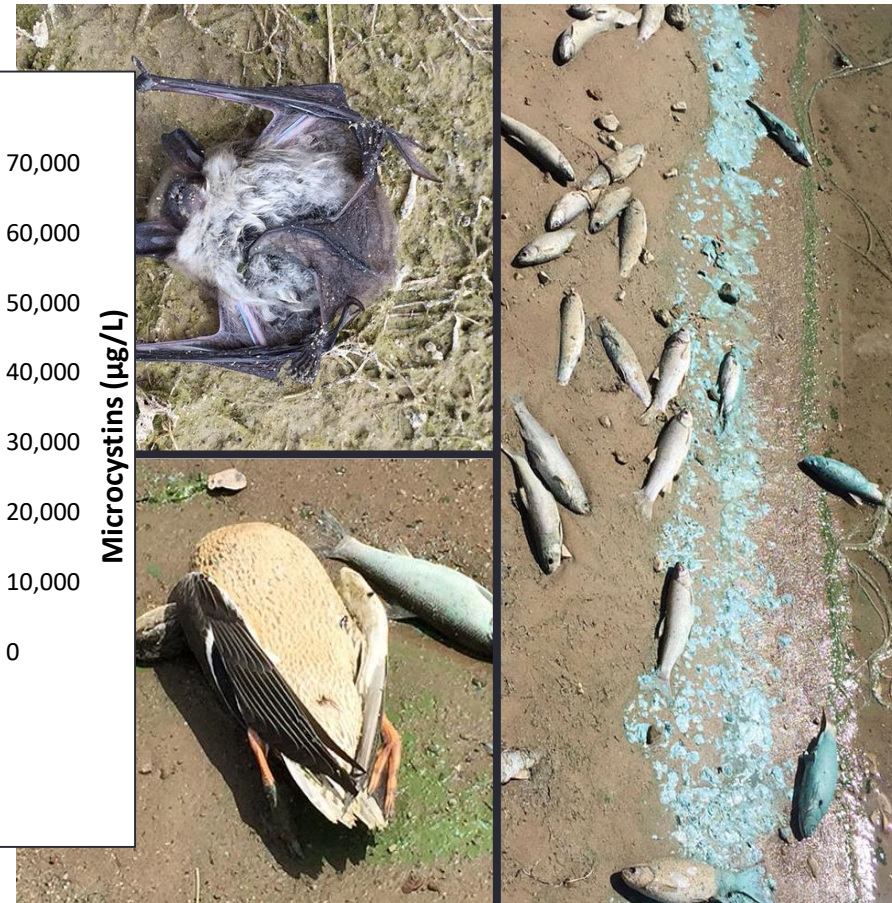EPA, *Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems (2014)*

Microcystins

- Exposure to microcystins can cause nausea, vomiting, diarrhea, liver damage, liver failure, and death
  - Short-term: bleeding in the liver and shock

Scofield Reservoir, 2016

2016 Scofield Reservoir Harmful Algal Bloom
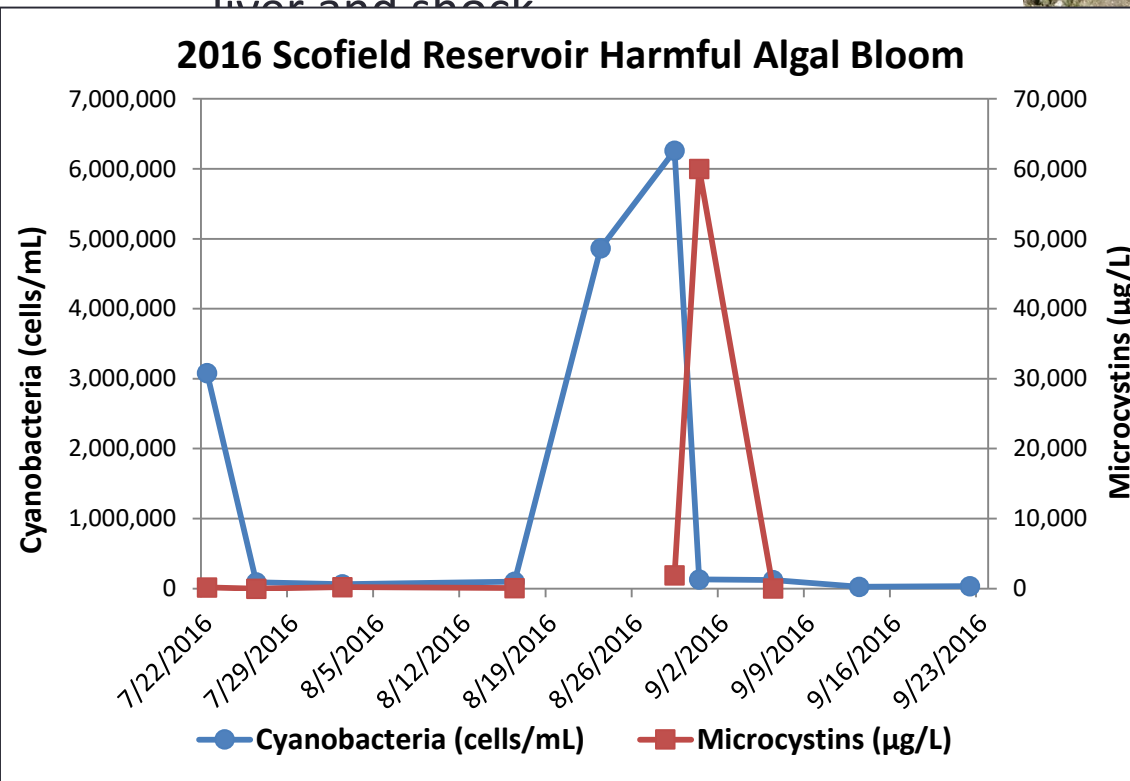
muscle

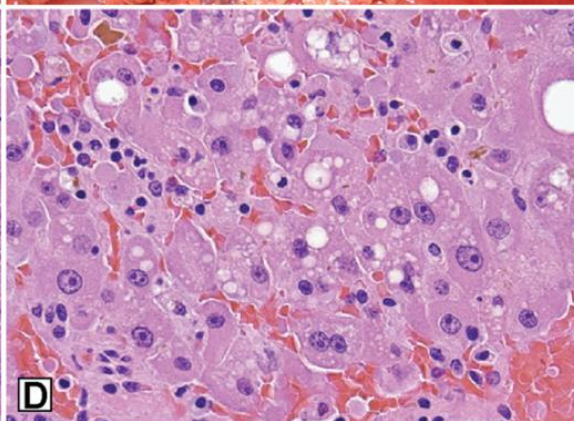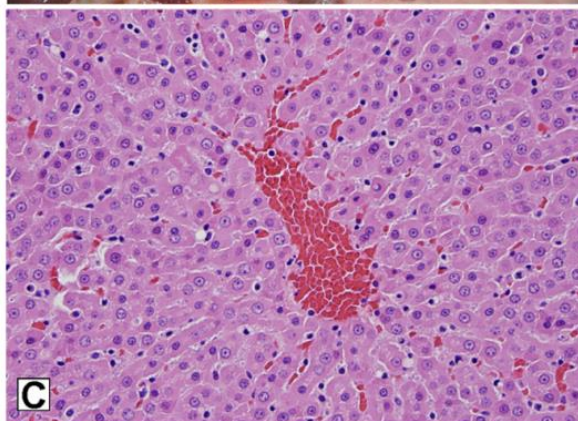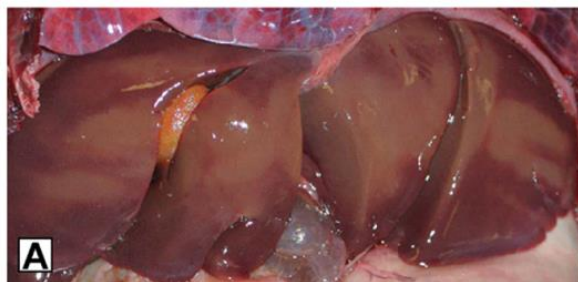Microcystins up to 60,000 µg/L in this HAB

Microcystins

Sea Otter Livers

Normal

Death due to
microcystin intoxication

Miller *et al.*, PLoS 2010

Uncertainty and Public Health

- Many sources of variability and uncertainty

- <u>Uncertainty factors (UF)</u>: full or partial order-of-magnitude values that help quantify our understanding of the uncertainty in a dose-response relationship
  - Differences between animals and humans
  - Variability within human populations
  - Use of a LOAEL rather than a NOAEL
  - Use of a short-term data for long-term exposures/effects
  - Database inadequacy (e.g., missing data on certain effects)

- The overall objective is to apply the information available to human populations in an appropriately protective way
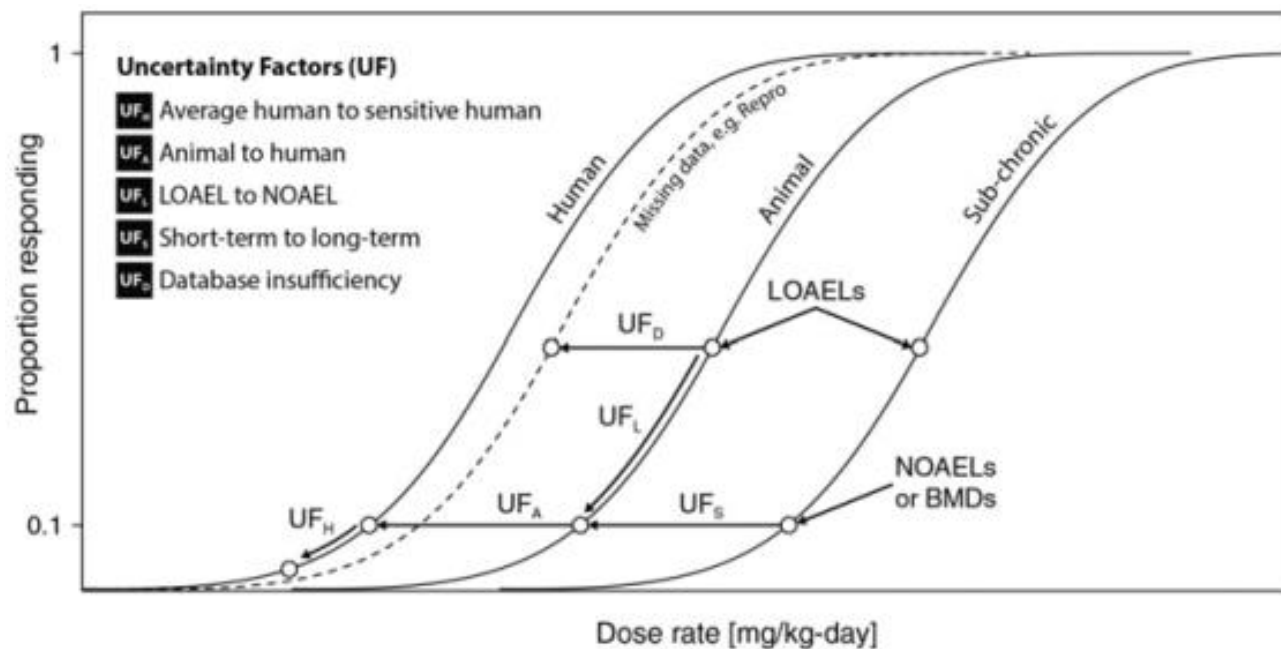
Uncertainty and Public Health

- <u>Reference Dose (RfD)</u>: an estimate of a daily exposure in humans, including sensitive populations, that is likely to be without appreciable risk of adverse effects during a lifetime

Uranium (soluble salts)

Reference Dose for Oral Exposure (RfD) (PDF) (8 pp, 92 K)   last updated: 10/01/1989

System	RfD (mg/kg-day)	Basis	PoD	Composite UF
● Urinary, Other	3×10^{-3}	Initial body weight loss moderate nephrotoxicity	LOAEL : 2.8 mg/kg-day	1000

Confidence   Medium

  - RfD: NOAEL (or LOAEL) / uncertainty factors
    - in milligrams per kilogram of body weight per day (mg/kg-day)

  - Example: LOAEL of 2.8 mg/kg-day determined for uranium
    - Uncertainty: 10 for interspecies, 10 for intraspecies, 10 for using a LOAEL
    - UF = 10 x 10 x 10 = 1,000
    - RfD = 2.8 / 1,000 = 0.0028 mg/kg-day, rounded to 0.003

Uncertainty and Public Health

Dankovic et al., 2015. Journal of Occupational and Environmental Hygiene

Uncertainty and Risk Communication

- **Transparency**: full and explicit disclosure of methodology, assumptions, rationale, uncertainties, etc.

- **Clarity**: concise, free of jargon, and readily understandable by readers unfamiliar with the risk assessment process

- **Consistency**: methodology and presentation is in a manner consistent with policy and other similar risk assessments

- **Reasonableness**: based on sound judgement; methods and assumptions consistent with the current state-of-the-science; presented in a complete, balanced, and informative manner
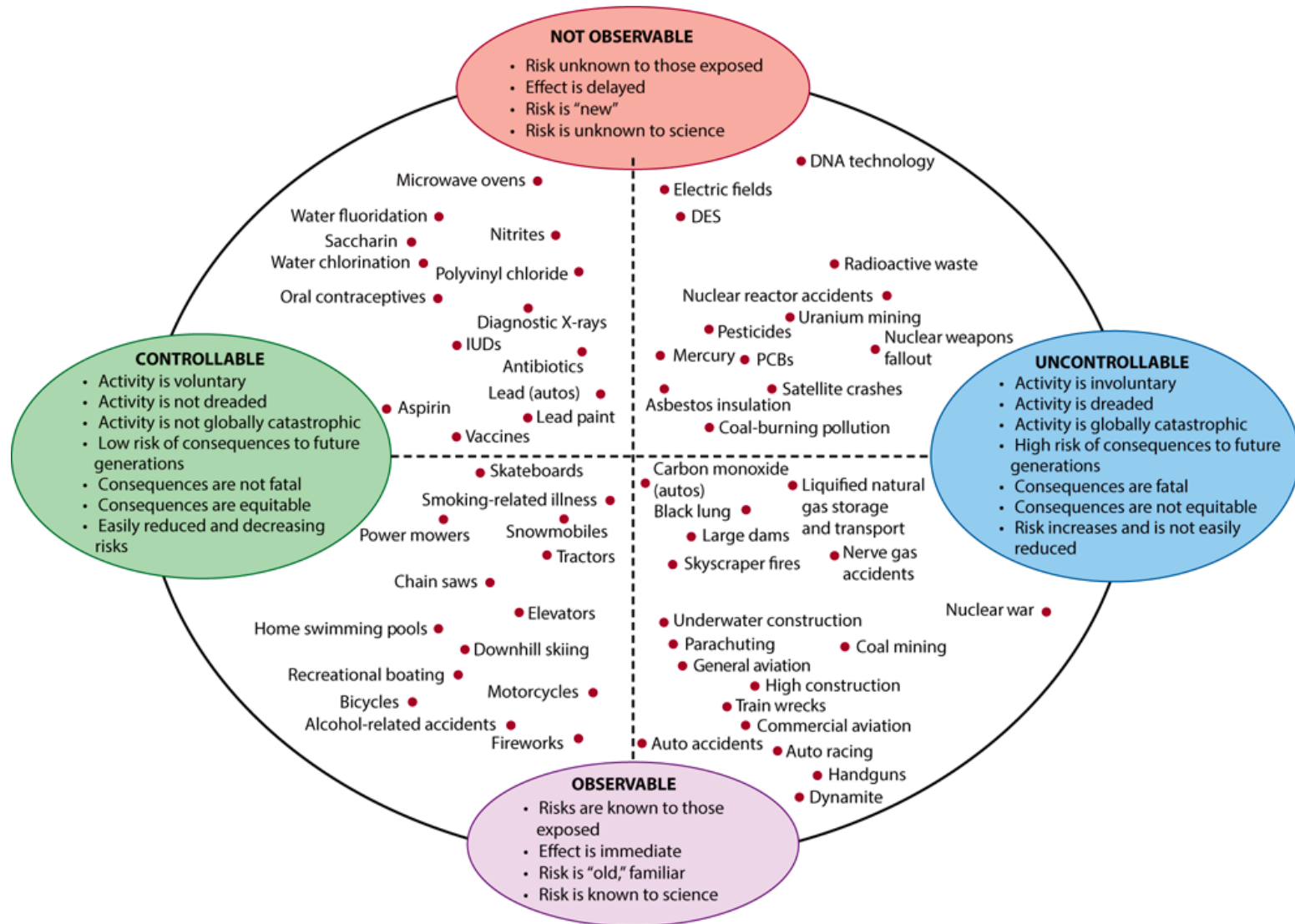
Risk Communication and Public Engagement

- <u>Health Risk</u>: the probability that a person will experience an adverse health effect if exposed to a hazard (source of harm)
  - Function of exposure to, and toxicity of, a hazard
  - ↑ exposure (duration, intensity, etc.) = ↑ health risk
  - ↑ toxicity (severity of effects) = ↑ health risk

Source ➡ Pathway ➡ Receptor

- <u>Real Risk</u>: must have all 3 components

- <u>Perceived Risk</u>: at least one component is missing
  - Does **not** mean that it is unimportant
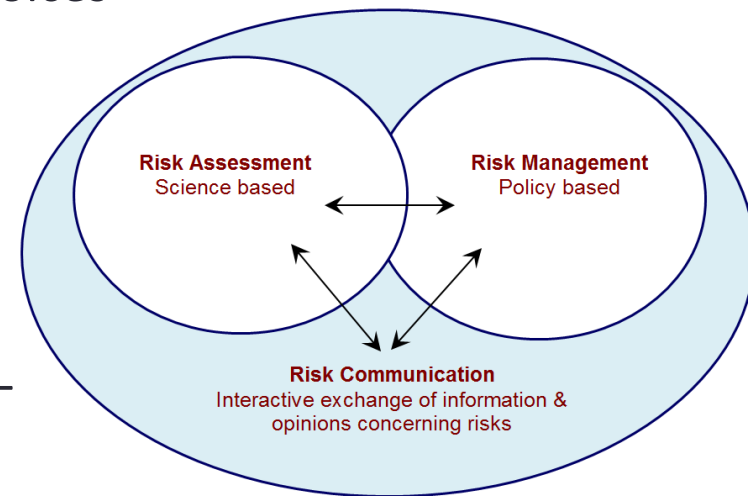 - Public concern/opinion strongly influences policy and legislation

Perception of Risk

Casarett & Doull's Essentials of Toxicology, 3rd Ed.

Risk Communication and Health Education

- Effectively communicating information about risk and public health events is one of our most important tasks
  - Health, informed citizens make better choices

- Some key elements:
  - Every situation is different
    - Identify questions and concerns
  - Coordinate between involved entities
  - Lots of partners with valuable expertise – use them
  - When people are angry or outraged, be calm and let them vent
  - Be open about what you know and what you don't
  - Don't get caught up in the minutia when communicating
  - When possible, don't be a dead end – give a path forward

Risk Assessment
Science based

Risk Management
Policy based

Risk Communication
Interactive exchange of information & opinions concerning risks

Food Standards Australia New Zealand

Some Questions to Consider

- What are the risks (if any) associated with residential secondary water use during a HAB?

- Are there 'typical' cyanobacteria species in Utah Lake HABs? If so, what is known about them?

- Is there a 'normal' frequency/severity/duration/etc. of HABs for Utah Lake (i.e., absent human influence)?

- Can we more strongly link HAB exposures to illness reports (primarily UPCC)?

Questions?

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