HAZARDOUS ALGAL BLOOMS

ODEQ'S EVOLVING PERSPECTIVE

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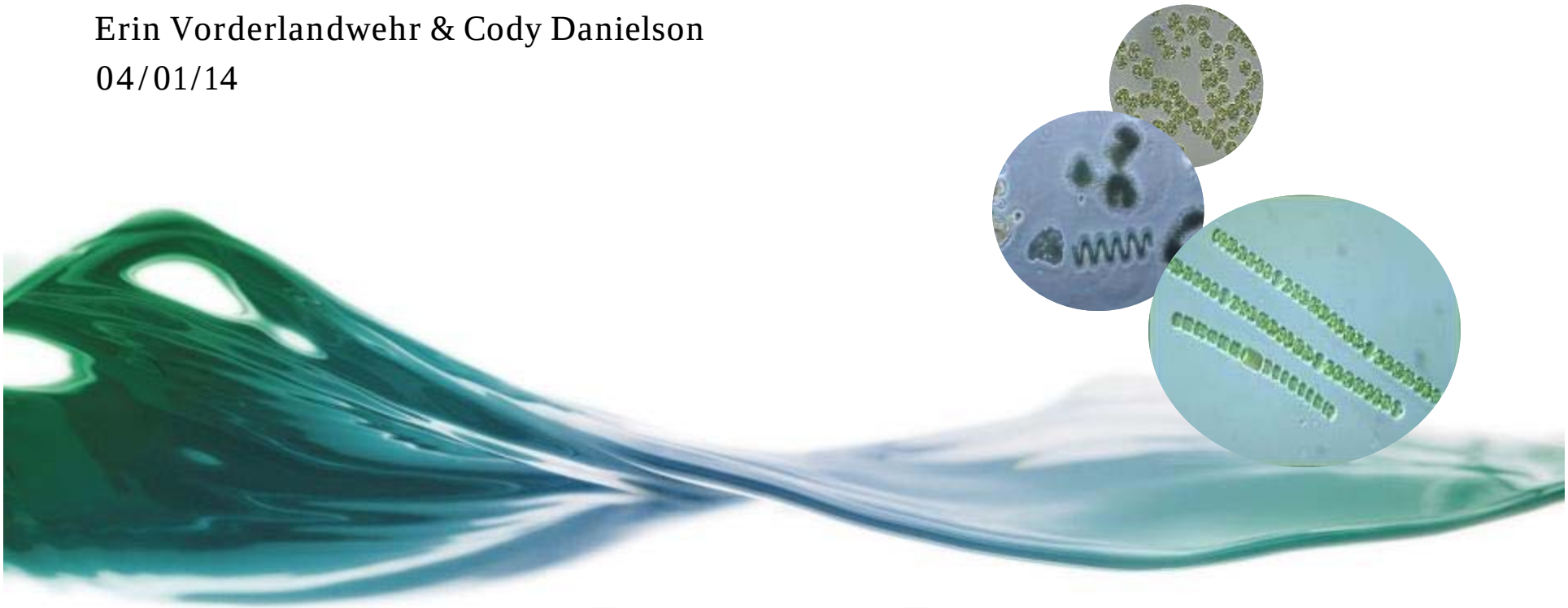

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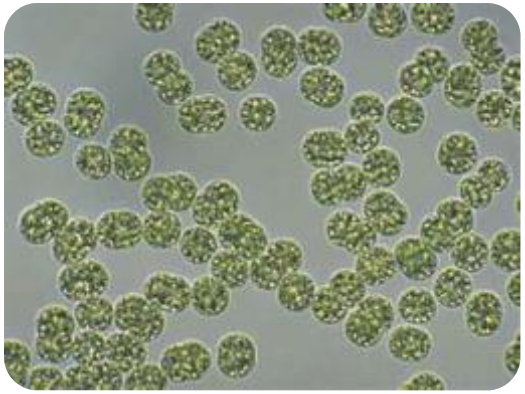
OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

STATE ENVIRONMENTAL LABORATORY

Topic Overview

- General Information & Background
  - Cyanobacteria
  - Golden Algae
  - *Euglena sp.*
- Sample Collection
- Sample Analysis
  - Microscopy
  - ELISA



BGA Facts

- Blue-Green Algae are not actually algae!
- They are cyanobacteria.
- In the past, cyanobacteria were called blue-green algae because they sometimes resemble green algae from a distance.
- They share traits of both bacteria and algae.
- Cyanobacteria blooms can be a variety of colors, not necessarily blue-green.
- BGA can not be treated/removed like regular green algae.
  - Copper sulfate is a common treatment for algae blooms. However, this will only kill/lyse the cyanobacteria cells, releasing the toxins.
  - Toxins can linger for up to two weeks and copper sulfate treatment will not prevent subsequent blooms.

BGA Facts

Some cyanobacteria have the ability to adapt to the environment. This is a big factor in determining whether a bloom will form. Adaptations include:

CYANOTOXINS

Why do we care about Hazardous Algal Blooms?

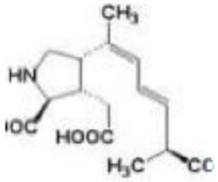
Table 11.1 Cyanotoxins produced by cyanobacteria

Toxic species	Cyanotoxins
Anabaena spp.	Microcystins saxitoxins, anatoxin-a, anatoxin-a(s)
Aphanizomenon spp.	Anatoxin-a, saxitoxins, cylindrospermopsins
Cylindrospermum spp.	Cylindrospermopsins, saxitoxins, anatoxin-a
Lyngbya spp.	Cylindrospermopsins, saxitoxins, lyngbyatoxins
Microcystis spp.	Microcystins anatoxin-a (minor amounts)
Nodularia spp.	Nodularins
Nostoc spp.	Microcystins
Oscillatoria spp.	Anatoxin-a, microcystins
Planktothrix spp.	Anatoxin-a, homoanatoxin-a, microcystins
Raphidiopsis curvata	Cylindrospermopsins
Umezakia natans	Cylindrospermopsins

HEALTH RISKS

Sometimes a mass-reproduction of cyanobacteria results in ecologically damaging Harmful Algal Blooms (HABs).

Some species of cyanobacteria produce cyanotoxins in such concentrations that they poison and even kill animals and humans.



These cyanotoxins are classified as neurotoxins, hepatotoxins and dermatoxins

Cyanotoxins can also accumulate in other animals such as fish and shellfish, and cause poisonings such as paralytic shellfish poisoning (PSP).

Most human cases of illness have been reported after oral consumption of contaminated drinking water or swimming in recreation waters where toxic blooms have occurred.

Identification in the field

What does a cyanobacteria bloom look like?

Identification in the field

What it isn't...

Regular green algae.

Identification in the field

What it can look like...

GOLDEN ALGAE

Another aspect to our evolving HAB program at ODEQ...

GOLDEN ALGAE
(*Prymnesium parvum*)

- Single-celled algae known to produce toxins that cause massive fish and bivalve kills
  - Unprotected exposed cells such as gills are damaged layer by layer, causing gills to bleed and lose function.
  - Toxins and other chemicals enter the fish, causing damage to internal organs.
  - All species of fish are susceptible to the toxins.
  - The amount of fish killed depends on the length of the bloom and concentration of toxin in the waters.
- No apparent adverse effect on humans and wildlife
  - Only seems to affect gill-breathing animals
  - Does not appear to be passed down in the food chain as the toxins appear to break down during digestion.
  - Do not pick up or consume dead or decaying fish

What does a golden algae bloom look like?

- Water can appear:
  - -yellowish
  - -yellowish-copper
  - -brownish
  - -tea colored
- Foam can be seen accumulating on the surface of the water

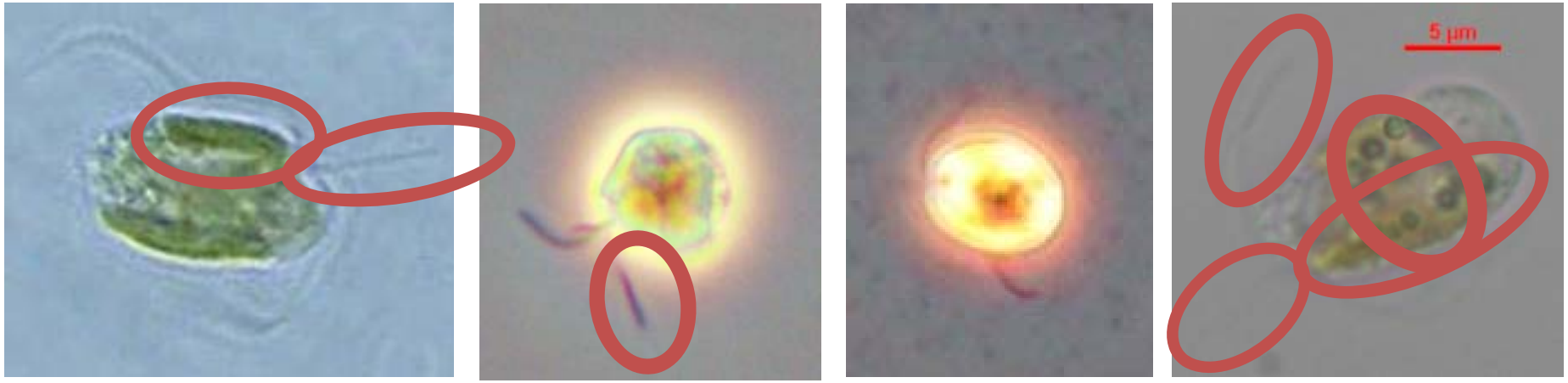
- Fish can appear:
  - -to swim slowly or erratically
  - -as if there is not enough oxygen
  - -to have redness or bleeding from gills or fins

Two C-shaped chloroplasts

Two flagella

Haptonema

Round shapes within (digested bacteria)



Above photo courtesy Texas Parks and Wildlife Department © 2006 (Dr. Carmelo Tomas UNC Wilmington)

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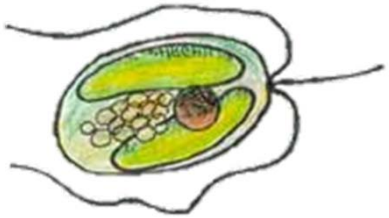
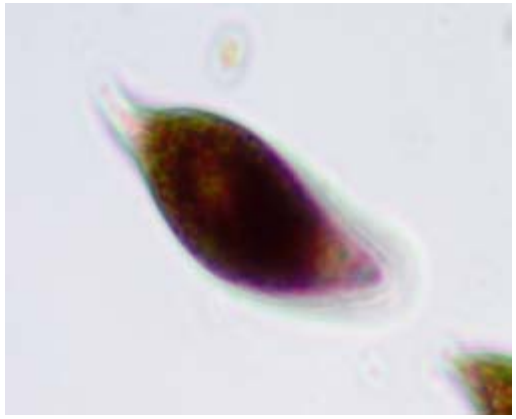
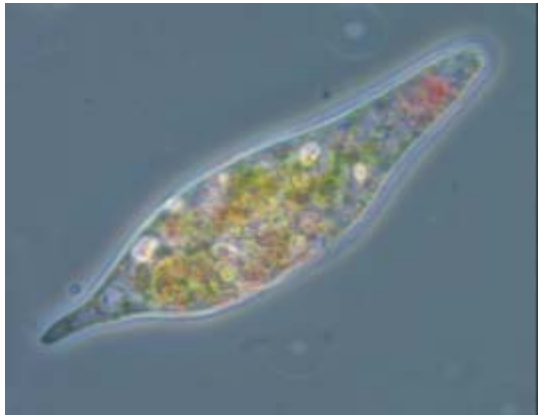


Euglena

Another organism to consider...

- *Euglen* in toxin which is letha*a Sanguinea.*
- Euglen t is new and not mu
- There i o human health, e determined.
- *Euglena Sanguinea blooms can cause the water to turn pink or red.*





COLLECTING HAB SAMPLES

Public Water Supply Concerns

Recreational Concerns

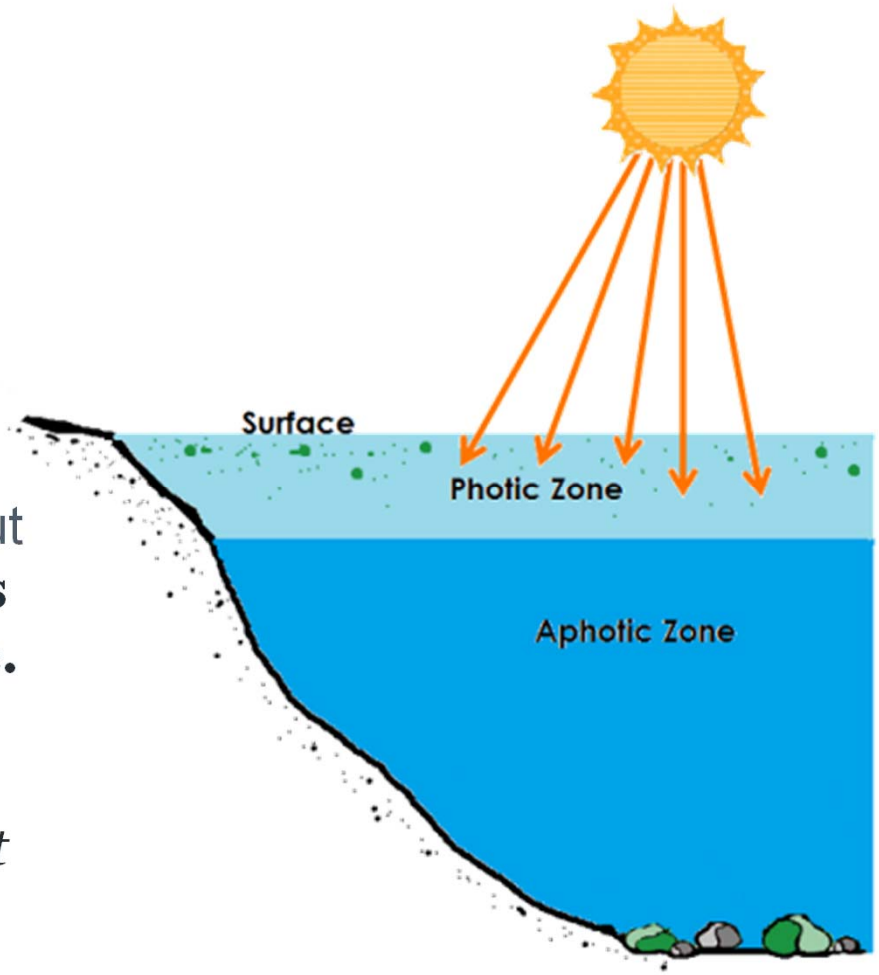
Fish Kills

Collection Locations

Some terminology…

Photic Zone- surface layer of a water body that receives sunlight and which is sufficiently illuminated to permit photosynthesis by phytoplankton and plants.
The photic zone is affected greatly by seasonal turbidity. Can be anywhere from a few inches to about 1 meter. **Best collection depth is up to 6 inches from the surface.**

(Except for cylindrospermopsis – cells are usually located several feet from the surface, ~3 ft. down.)



Collecting Samples

Sample collection protocol for identification & enumeration.

Check the accessibility of the sampling site.

Collect 1 liter of surface water in a clean plastic bottle.

Handle and store the sample properly.

Collecting Samples

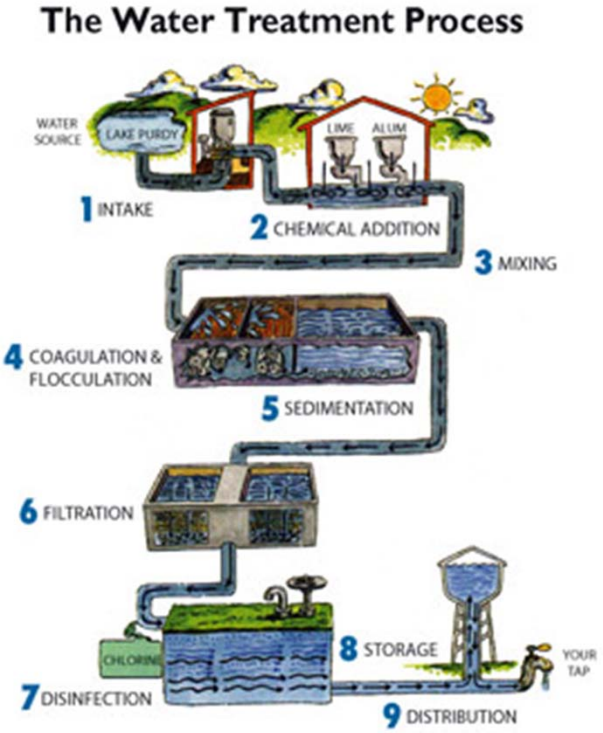
ID/E collection

Why can't I collect ID/E samples from the Water Treatment Plant?

We need surface samples, from the photic zone, to get intact cells from the source water.

RAW water samples collected from water treatment plants have been transferred via pipeline and through debris screens, this could rupture any viable cells. But, most importantly, the intake draws water from lower levels of the lake, not the photic zone.

So, intake water could contain toxins, but not the cyanobacteria cells that we need to identify and enumerate. We wouldn't know what toxins could be present without a surface source water sample.



Where?

Collecting Toxins

Collect in glass!

- Toxins adhere to plastics and will have low biased results.

Collect the correct amount.

- Fill the glass container directly from the RAW and FINISHED sampling points inside the water treatment plant.
- Pour off the excess until the water level is at the fill line.

Handle and store the sample properly.

Sample collection protocol for cyanotoxins.

Collecting Samples

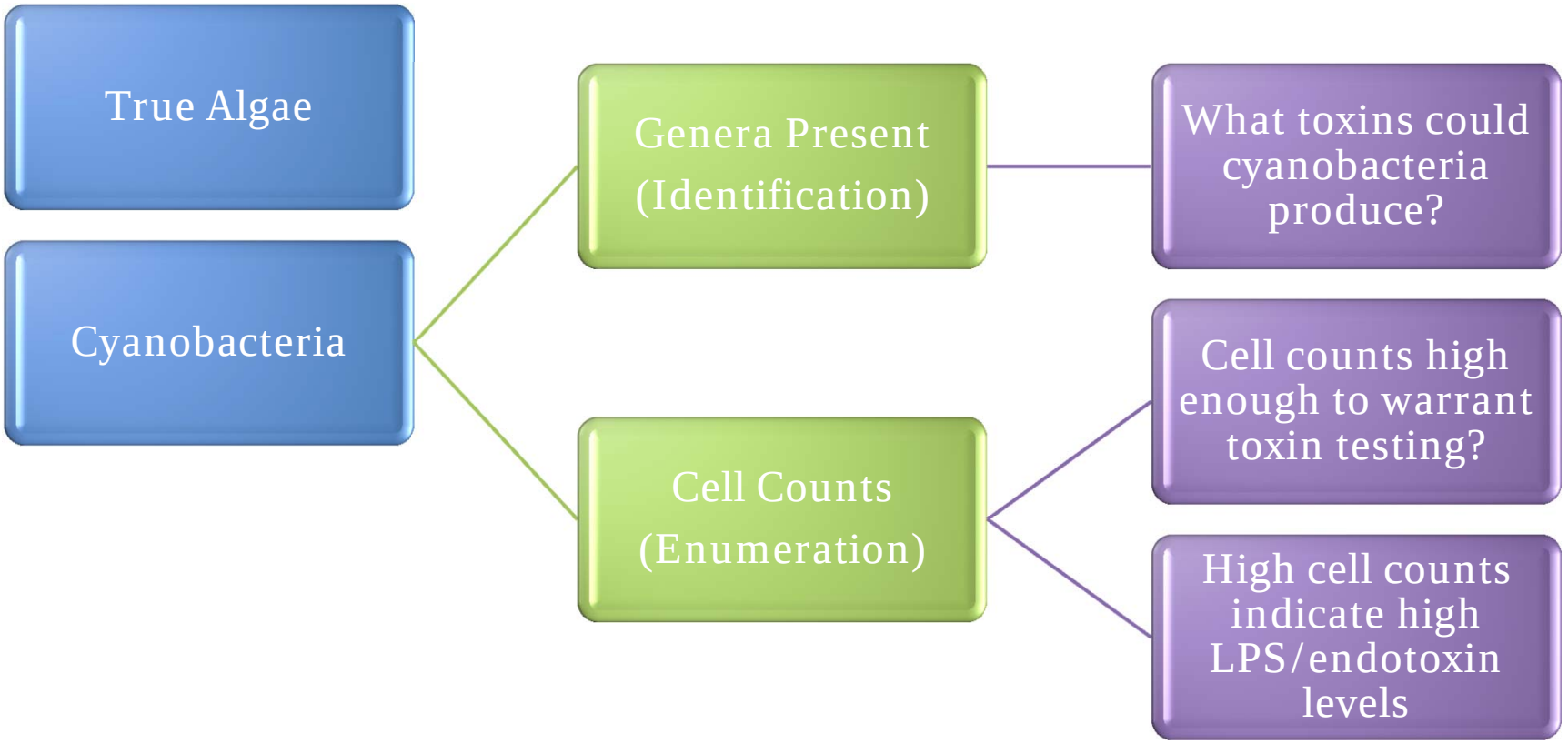
HAB ANALYSIS

Identification & Enumeration

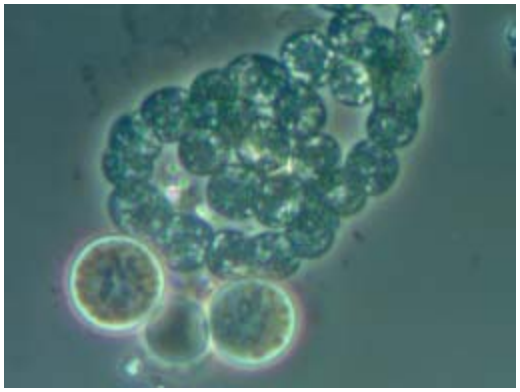
ELISA

MICROSCOPY VS. TOXIN ANALYSIS

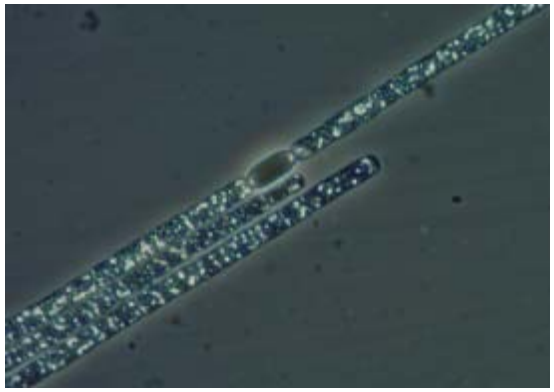
- Why do we need microscope analysis?
- Why do we need toxin analysis?



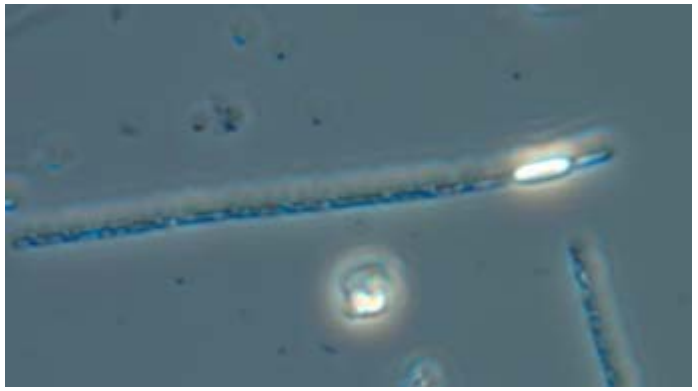
MICROSCOPY ANALYSIS



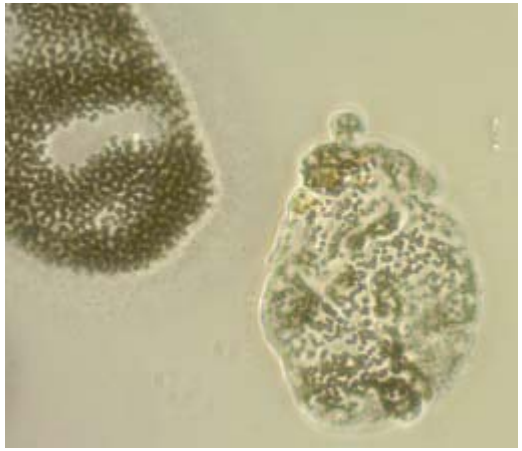
Anabaena sp.



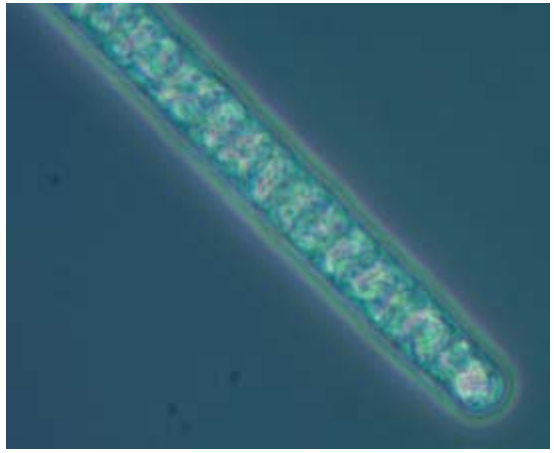
Aphanizomenon sp.



Cylindrospermopsis sp.



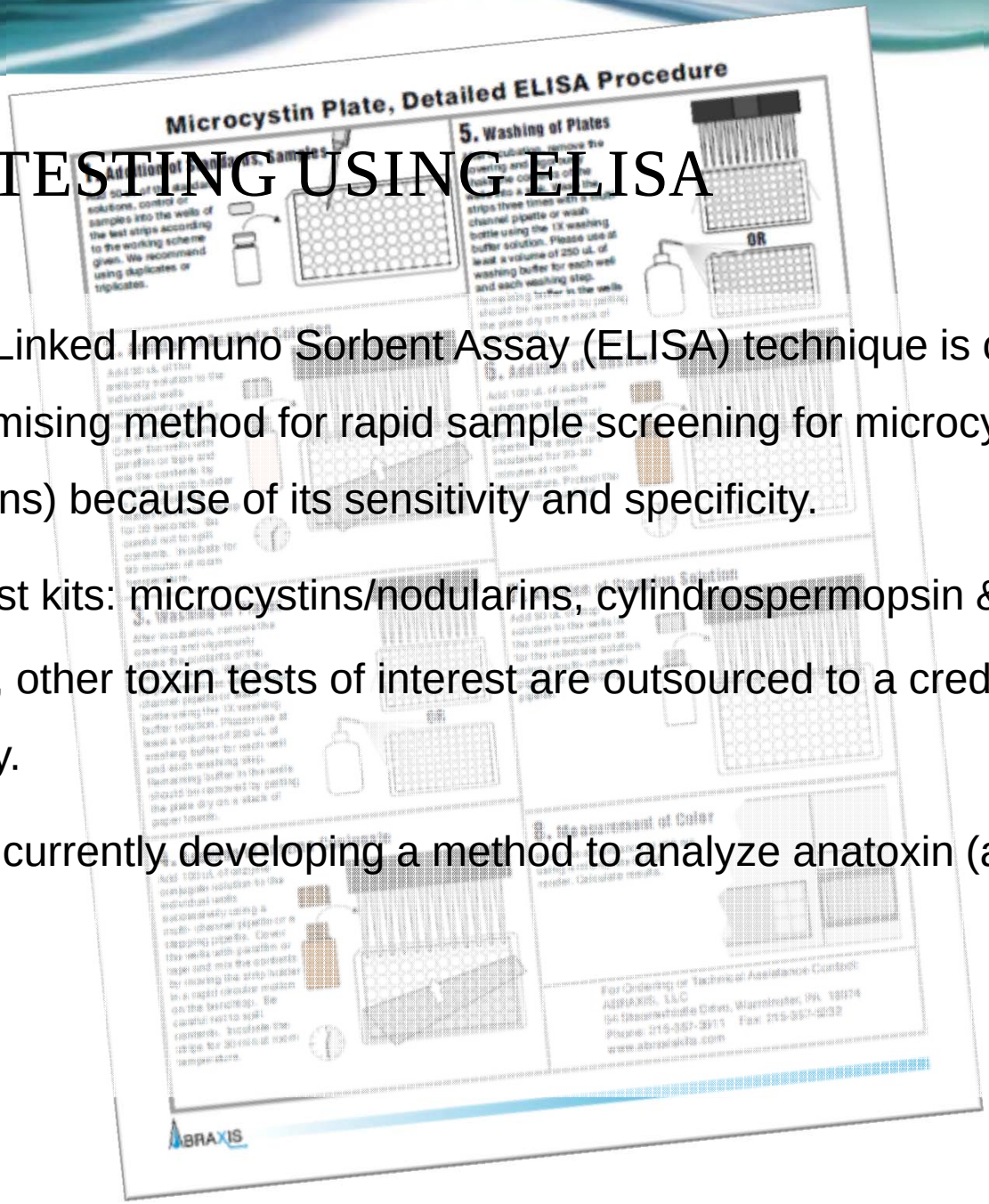
Microcystis sp.



Planktothrix sp.

Cuspidothrix sp.

TOXIN TESTING USING ELISA



- Enzyme-Linked Immuno Sorbent Assay (ELISA) technique is currently the most promising method for rapid sample screening for microcystins (and other toxins) because of its sensitivity and specificity.
- ODEQ test kits: microcystins/nodularins, cylindrospermopsin & saxitoxin
- Currently, other toxin tests of interest are outsourced to a credentialed laboratory.
- ODEQ is currently developing a method to analyze anatoxin (a) in house.

TOXIN ANALYSIS

This is not just a “black box” that gives us data. Lots of preparation and analysis goes into the sample before it ever reaches this point.

What happens next...

- ODEQ only has jurisdiction over Public Water Supply for BGA
- If cyanobacteria cells counts are high or toxins are present in measureable amounts, Water Quality Division will advise operators on which measures to take.
- To date, no toxins in finished drinking waters that are over thresholds for health advisories.
- Golden Algae?
- Euglena?

References

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2. http://www.tpwd.state.tx.us/landwater/water/environconcerns/hab/ga/bio.phtm
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