Phytoplankton Project Update

Meiyin Wu, PhD

Director, NJ Center for Water Science & Technology

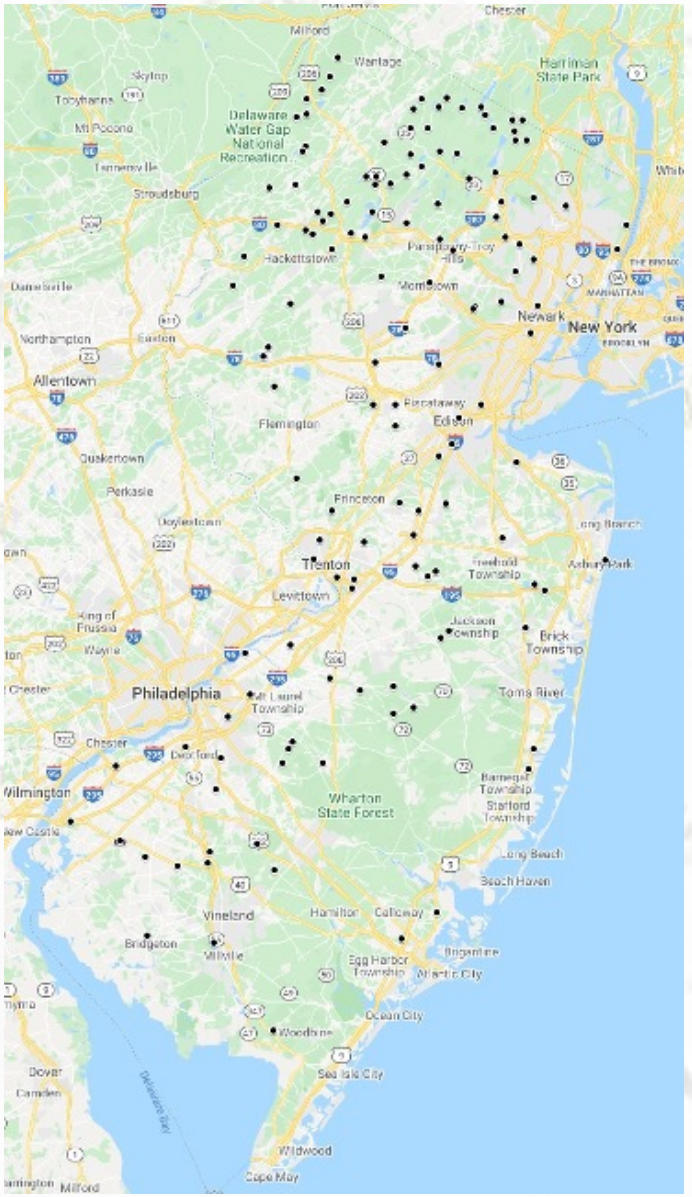
Professor, Department of Biology

Montclair State University

New Jersey Phytoplankton Occurrence & Distribution

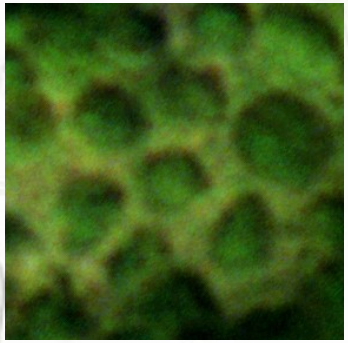
- 2016-2020
- 146 waterbodies in New Jersey
- 113 phytoplankton taxa recorded

Group	# of Genera	% of All Genera
Green Algae	**42**	**37.17%**
Cyanobacteria	**33**	**29.20%**
Diatoms	**25**	**22.12%**
Dinoflagellates	3	2.65%
Euglenoids	3	2.65%
Cryptomonads	3	2.65%
Synurophyte Algae	2	1.77%
Golden Algae	2	1.77%

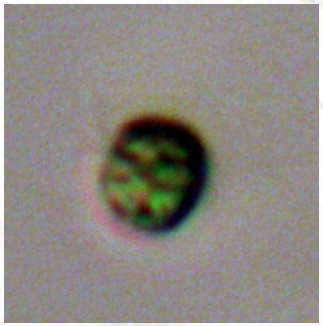


New Jersey Phytoplankton Occurrence & Distribution

Synechococcus



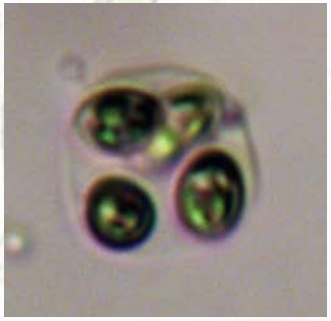
Chlorella



Chlamydomonas

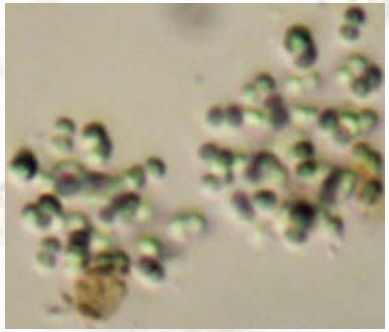
Selenastrum

Scenedesmus

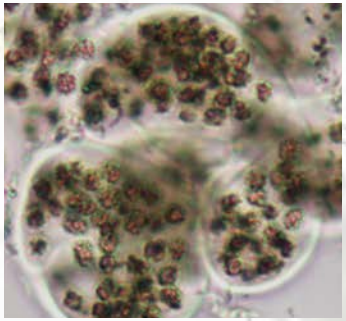


Oocystis

Dolichospermum

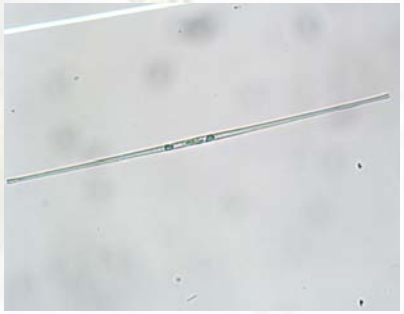


Aphanocapsa

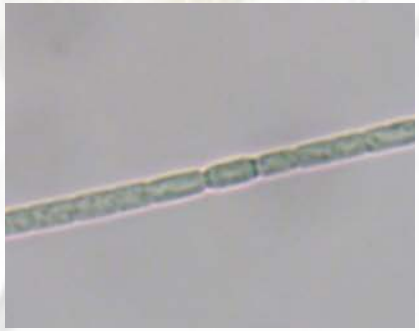


Microcystis

Chroococcus



Ulnaria



Aphanizomenon

New Jersey Phytoplankton Occurrence & Distribution

	Maximum	Minimum	Average
Phytoplankton richness	36	1	10
Cyanobacteria richness	12	0	3
Phytoplankton cell density (cells/mL)	11,730,000	300	187,523
Cyanobacteria cell density (cells/mL)	11,730,000	0	179,367
% Abundance of Cyanobacteria	100%	0%	65%

New Jersey Cyanobacteria Occurrence & Distribution

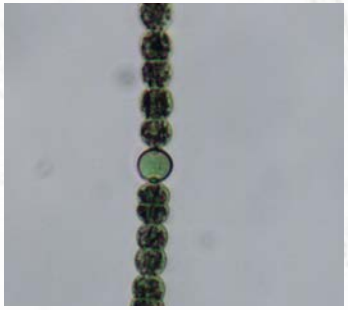
- 125/146 (86%) waterbodies with Cyanobacteria present
- 6 waterbodies were 100% Cyanobacteria:
  - Cupsaw Lake (9/4/2018; 8/28/2018)
  - Saddle River County Park (8/20/2018)
  - Strawbridge Lake (9/12/2018)
  - Weequahic Lake (8/9/2018)
  - Elmer Lake (9/3/2019)

Cyanobacteria cell density
11,730,000 cells/mL

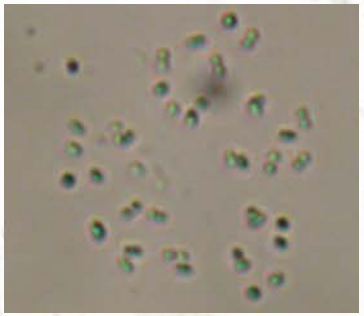
- 75% (212/303) samples >50% of Cyanobacteria
- 40% (120/303) samples > 20K cells/mL (Watch +)
- 25% (70/282) samples > 80K cells/mL (Advisory +)

New Jersey Cyanobacteria Occurrence & Distribution

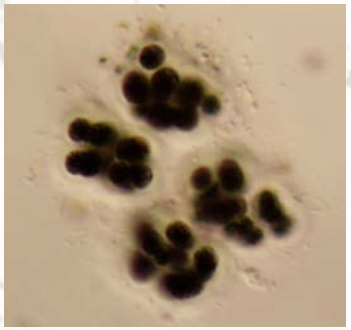
Synechococcus



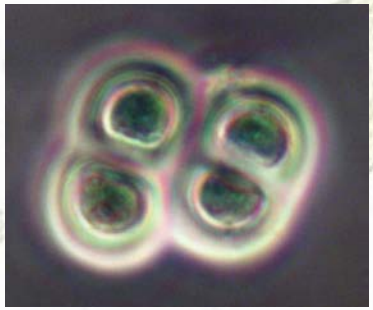
Dolichospermum



Aphanocapsa



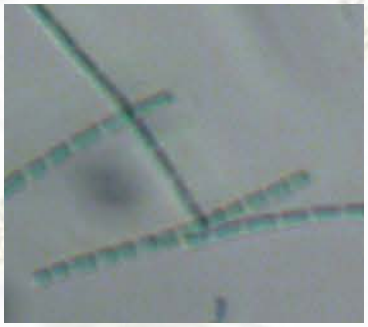
Microcystis



Chroococcus

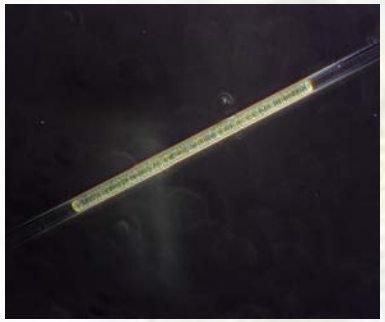
Aphanizomenon

Raphidiopsis

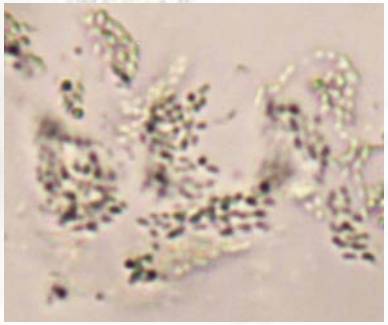


Pseudanabaena

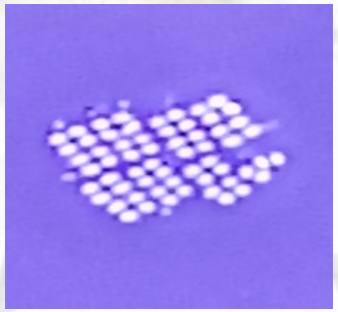
Planktolyngbya



Limnoraphis



Aphanothece



Merismopedia

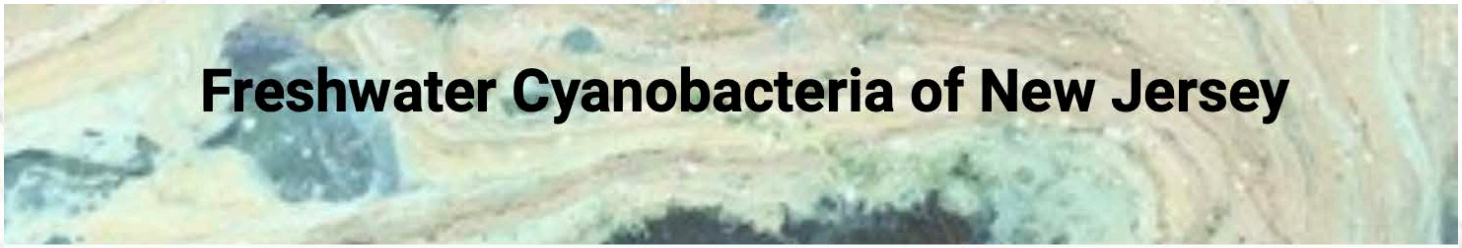
Sampling Depth Does Matter!

Waterbody	Manasquan Reservoir		
Site	MRT-TOP		
Sample ID	20-08-05-AGL-NJWSA- MRT-TOP		
Date	8/5/20		
Phytoplankton Cell Densit	17764	cells/mL	
Phytoplankton Natural Ur	4654	natural units/mL	
Phytoplankton Taxa	12		
Cyanobacteria Cell Densit	7136		
Cyanobacteria Taxa	5		

Group	Taxa	natural units/mL	cells/mL	% Abundance
Cyanobacter	*Aphanocaps*	310	1241	6.99%
Diatom	*Aulacoseira*	78	1319	7.43%
Green algae	*Chlamydomo*	1008	1008	5.67%
Cyanobacter	*Chroococcus*	465	931	5.24%
Golden-brow	*Dinobryon*	78	155	0.87%
Cyanobacter	*Dolichosperr*	233	465	2.62%
Synurophyte	*Mallomonas*	78	78	0.44%
Cyanobacter	*Planktothrix*	78	2948	16.60%
Green algae	*Scenedesmu*	155	465	2.62%
Green algae	*Sphaerocysti*	78	1707	9.61%
Cyanobacter	*Synechococ*	776	1551	8.73%
Green algae	*Tetraedron*	78	78	0.44%
	Subtotal	**4654**	**17764**	**100%**

Waterbody	Manasquan Reservoir		
Site	MRT-MID		
Sample ID	20-08-05-AGL-NJWSA- MRT-MID		
Date	8/5/20		
Phytoplankton Cell Densit	16911	cells/mL	
Phytoplankton Natural Ur	4111	natural units/mL	
Phytoplankton Taxa	17		
Cyanobacteria Cell Densit	13885		
Cyanobacteria Taxa	5		

Group	Taxa	natural units/mL	cells/mL	% Abundance
Cyanobacter	*Aphanocaps*	78	698	4.13%
Diatom	*Asterionella*	78	78	0.46%
Green algae	*Chlamydomo*	233	233	1.38%
Cyanobacter	*Chroococcus*	78	155	0.92%
Green algae	*Crucigenia*	78	776	4.59%
Green algae	*Desmodesm*	78	155	0.92%
Cyanobacter	*Dolichosperr*	2094	9541	56.42%
Diatom	*Fragilaria*	78	698	4.13%
Synurophyte	*Mallomonas*	78	78	0.46%
Diatom	*Navicula*	78	78	0.46%
Green algae	*Oocystis*	233	233	1.38%
Cyanobacter	*Raphidiopsis*	155	2560	15.14%
Green algae	*Schroederia*	78	78	0.46%
Green algae	*Staurastrum*	78	78	0.46%
Cyanobacter	*Synechococ*	465	931	5.51%
Euglenoid	*Trachelomor*	78	78	0.46%
	Unknown	78	465	2.75%
	Subtotal	**4111**	**16911**	**100%**



Freshwater Cyanobacteria of New Jersey

Welcome!

Our aim is to provide a visual resource for identification of common cyanobacteria found in lakes, rivers and reservoirs of New Jersey.

To explore our visual guide to the types of cyanobacteria found in New Jersey, begin by clicking the "Visual Guide to Cyanobacteria in New Jersey" button below. Clicking the button will take you to the first step in our flowchart-style identification tool: at each step, you'll choose the option that best describes the cyanobacteria you want to identify. After you progress through all the steps, you'll arrive at a list of only those cyanobacterial genera that fit your description, thus making identification easier for you! Click here to explore a glossary of selected relevant terms.

Visual Guide to Cyanobacteria in New Jersey

Freshwater Cyanobacteria in New Jersey (Selected Genera)

Anabaena

Aphanizomenon

Aphanocapsa

Aphanothece

Chroococcus

Cuspidothrix

Cyanodictyon

Dolichospermum

Gloeothece

Visual Guide to Cyanobacteria in New Jersey
https://www.montclair.edu/water-science/phytoplankton-lab/

Limnoraphis

Merismopedia

Visual Guide to Cyanobacteria in New Jersey

Choose which general growth type--*coccoid* or *filamentous*--describes your cyanobacterial specimen. To help you understand what these terms mean, each option is accompanied by a text description and photographic examples. Click either the "***Coccoid***" or "***Filamentous***" button to procede to the next step.

Coccoid

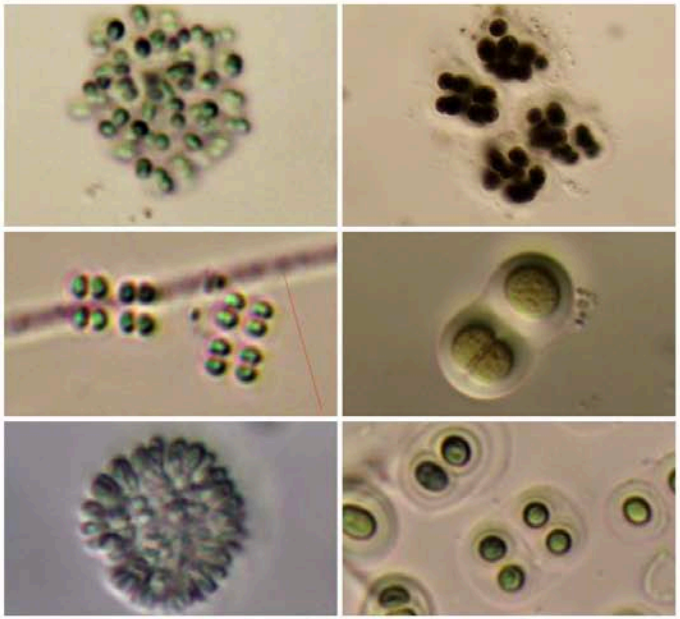
Coccoid cyanobacteria exist as solitary cells, as irregular agglomerations of cells, or as distinct colonies of cells. Cells vary in shape, but are generally "rounded" in nature: spherical, oblong, rod-shaped, and hemispherical are some examples.

Filamentous

Filamentous cyanobacteria form chains, or "filaments," of cells that are connected end-to-end. The width and length of these filaments varies widely; the filaments can be perflectly straight to corkscrew-like coiled; and they may be solitary or gathered into masses of many filaments. Individual cells within the filaments can also take on a variety of different shapes and sizes.

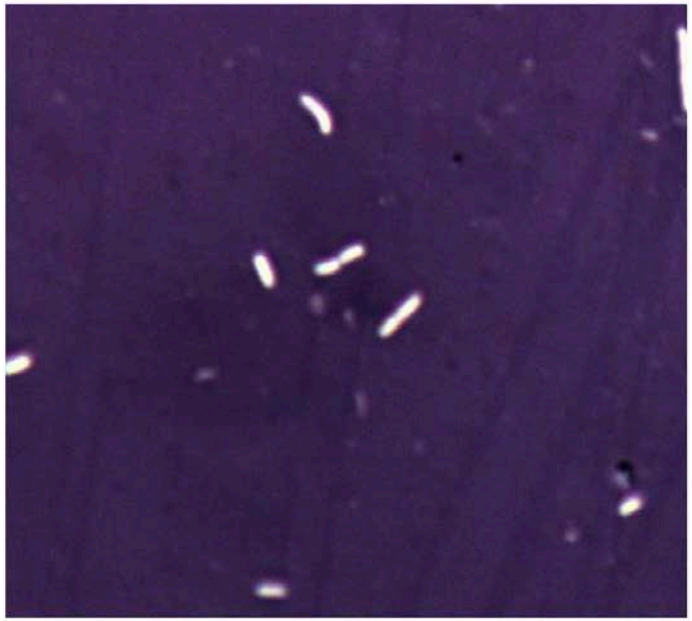
Coccoid Cyanobacteria

Decide whether your cyanobacterial specimen is *solitary* or *colonial*. Scroll down for explanations of both of these terms, as well as photographic examples of each, and then click either the "***Colonial***" or "***Solitary***" button to proceed to the next step.



Colonial

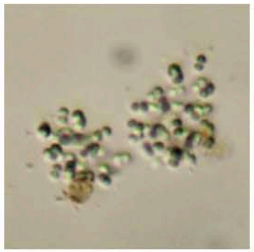
Colonial coccoid cyanobacteria form colonies of cells held together by *mucilage* (slimy, viscous material produced by the cells). Colony shapes include spherical, sheet-like, and irregular, among other forms. Some colonies contain only a few cells, while others contains hundreds.



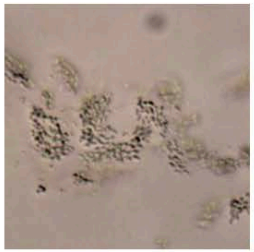
Solitary

Solitary coccoid cyanobacteria may occur as single cells, as pairs of cells (following cell division), or in irregular groups or agglomerations of cells. Though these cells may aggregate into groups, they do not form distinct colonies of cells.

Colonial Coccoid Cyanobacteria

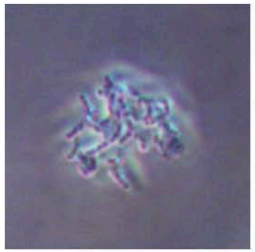


Aphanocapsa

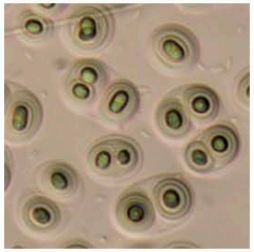


Aphanothece

Chroococcus

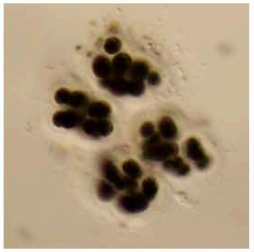


Cyanodictyon



Gloeothece

Merismopedia



Microcystis

Snowella

Woronichinia

Filamentous Cyanobacteria

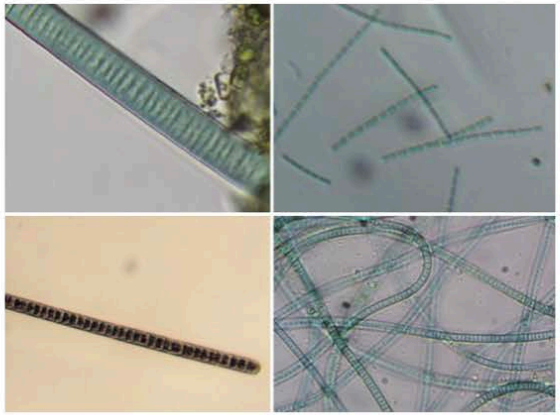
Some types filamentous of cyanobacteria are capable of forming *heterocytes* and *akinetes*, which are specialized cell types.

Heterocytes contain an enzyme called nitrogenase, which allows these cyanobacteria to fix atmospheric molecular nitrogen. Heterocyte production tends to decrease as the amount of biologically available nitrogen in the environment increases. Akinetes are thick-walled resting (non-dividing) cells capable of surviving harsh environmental conditions; they possess an accumulation of the chemical compounds necessary for new growth once environmental conditions improve. Though many of the heterocyte-forming taxa also form akinetes, this is not always the case; in some taxa, heterocyte production is well-known, but the presence of akinetes has not been reported.

Click either the "***heterocyte-forming***" or "***non-heterocyte-forming***" button below to continue to the next step of the visual guide. If you're not sure how to identify these cell types, scroll further down this page for a more thorough description of what heterocytes and akinetes look like.

Heterocyte-forming

Heterocyte-forming ("heterocytous") cyanobacteria are capable of forming heterocytes, and many can also form akinetes.



Non-Heterocyte Forming

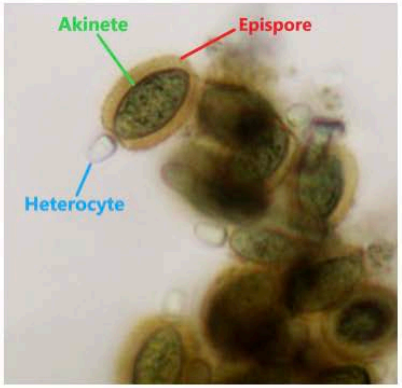
Non-heterocyte forming cyanobacteria are just what they sound like: they don't form heterocytes (or akinetes)! Because heterocyte production can vary, the absence of heterocytes in any one trichome cannot be taken as a definite indicator that the trichome belongs to a non-heterocyte forming genus! For this reason (and others), it is best to observe as many trichomes as you can before deciding that you are truly looking at a cyanobacterium that cannot form heterocytes.

What do heterocytes look like?

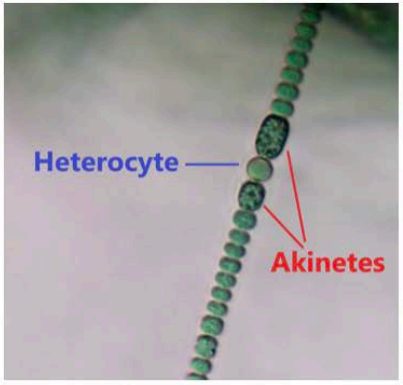
- Possible shapes include spherical, cylindrical, flattened, and pointed
- Usually not much wider than vegetative cells, but could be a different length and/or shape (for instance, cylindrical heterocytes of *Aphanizomenon* may be noticeably longer than the vegetative cells in the trichome)
- Cell content pale and homogeneous
- Their thick cell walls may be visible as a distinct halo, ring, or border around the cell
- Heterocytes may be situated exclusively at trichome ends, or they can occur in the middle of the trichome
- Heterocytes can occur singly withtin the trichome, in pairs, or in short rows
- May develop directly adjacent to akinetes

What do akinetes look like?

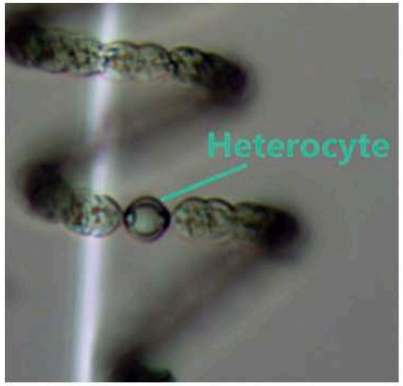
- Commonly have a cylindrical or oval shape; can also be spherical
- May be much larger than the vegetative cells in the trichome, which is often the case for mature akinetes. Typically, they are at least a little bit bigger than the vegetative cells
- Cell content often has a granular appearance
- The outer layer of the cell wall--called an epispore--may be widened, textured, and/or yellowish to orange-brownish in color
- Might be solitary within the trichome, develop only near the trichome ends, or develop in rows of many akinetes between heterocytes
- May develop directly adjacent to heterocytes; sometimes heterocytes are flanked by an akinete on both ends



These granular, oval-shaped cells are akinetes that are no longer attached to trichomes of vegetative cells. The orange-brown layer surrounding the akinete is the *epispore*. Some of the akinetes have transparent, bluntly-pointed heterocytes attached.



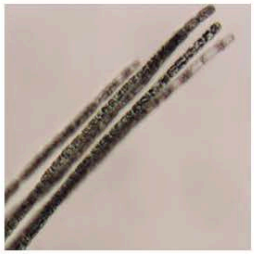
Here, akinetes develop on either side of a heterocyte, directly adjacent to it.



The thickened cell wall of this heterocyte is clearly visible as a ring-like border.

Heterocyte-Forming Filamentous Cyanobacteria

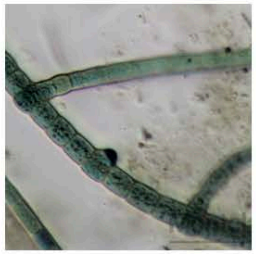
Anabaena



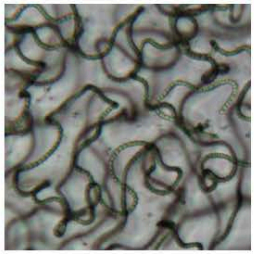
Aphanizomenon

Cuspidothrix

Dolichospermum



Hapalosiphon



Nostoc

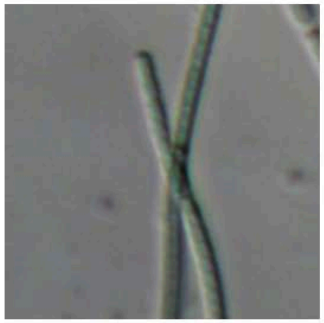
Raphidiopsis

Rivularia

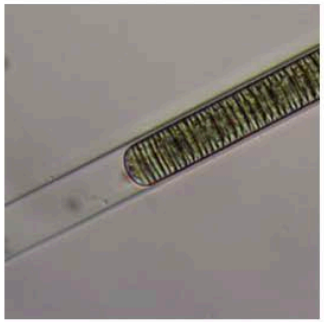
Tolypothrix

Non- Heterocyte Forming Filamentous Cyanobacteria

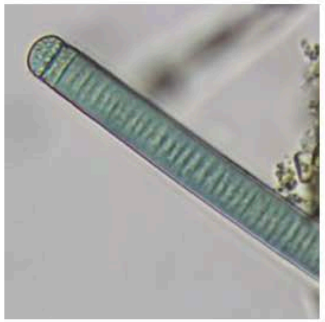
Jaaginema



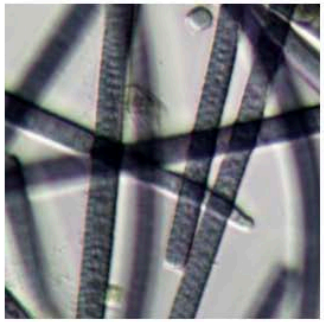
Leptolyngbya



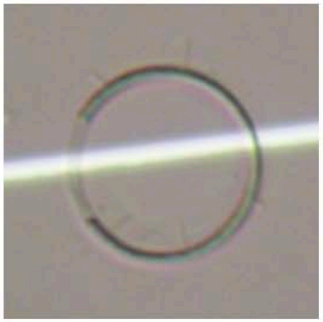
Limnoraphis



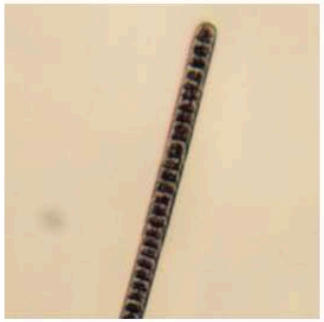
Oscillatoria



Phormidium



Planktolyngbya



Planktothrix

Pseudanabaena

Chroococcus

Taxonomy

Order Chroococcales
Family Chroococcaceae
Genus *Chroococcus*

Morphology

Colonies are gelatinous, irregular to roughly spherical in shape; usually composed of a small group of up to 16 cells, and commonly with only one to four cells per colony; within colonies, cells sometimes form packet-like groups of 2-8 cells. Colonies usually do not contain a large number of cells; only rarely forming large agglomerations of many cells. Cells, or groups of cells, are surrounded by colorless or yellowish mucilaginous envelopes; envelopes typically copy the cell outline and have distinct margins, and are often concentrically lamellated (layered). Cells are at first oval to spherical in shape; following division, hemispherical or in the shape of a segment of a sphere (often looks like a sphere cut into four slices); cells do not reach their original spherical shape before the next round of division*. Cell size can reach up to 50 µm in diameter. Cell content may be grey, greenish-grey, blue-green, olive-green, yellowish, orange, reddish, or violet in color; homogeneous or granular; aerotopes present only in a few planktic species.

*The genus *Limnococcus*, whose cells *do* reach (roughly) their original form before dividing again, was derived from *Chroococcus*; *Limnococcus* was previously classified as a subgenus of *Chroococcus*.

Ecology

Chroococcus is distributed across North America. Most species are metaphytic, and the most common are found in somewhat acidic wetlands, but the genus also includes epiphytic and periphytic species, and may be found in ponds and lakes (freshwater). More rarely aerophytic or in thermal springs.

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Johansen, J. R., & Komárek, J. (2015). Coccoid Cyanobacteria. In J. D. Wehr, R. G. Sheath, & J. P. Kociolek (Eds.), *Freshwater Algae of North America: Ecology and Classification* (2nd ed., pp. 97-109). Waltham, MA: Elsevier.

Komárek, J. & Anagnostidis, K. (2008). Cyanoprokaryota-1. Teil/Part 1: Chroococcales. In H. Ettl, G. Gärtner, H. Heynig, & D. Mollenhauer (Eds.), *Süßwasserflora von Mitteleuropa* (Vol. 19/1, pp. 279-281). Heidelberg, Germany: Spektrum.

400X total magnification; 10 µm scale bar. Phase contrast.

400X total magnification.

Dolichospermum

Taxonomy

Order Nostocales
Family Aphanizomenonaceae
Genus *Dolichospermum*

Morphology

Trichomes usually solitary, or in small, irregular clusters; straight, curved, or coiled; isopolar; not narrowed towards the ends; usually with clear constrictions at crosswalls; metameric. Never with firm sheaths; sometimes with fine mucilaginous envelopes. Cells spherical, barrel-shaped, or nearly cylindrical; usually isodiamteric, sometimes longer than wide (up to 2x longer than wide). Terminal cells not different from other vegetative cells; rounded at the ends. **Obligately with aerotopes.**

Heterocytes intercalary (but can be found in a terminal position only after disintegration of a trichome); solitary; usually spherical, sometimes barrel-shaped; as wide as vegetative cells (or nearly so; slightly wider or narrower). Akinetes intercalary; solitary, or sometimes in rows of up to 5; cylindrical, ovoid, oval, or spherical in shape; developing paraheterocytically, adjacent to or slightly distant from heterocytes.

Ecology

Trichomes are planktic, or rarely metaphytic. Mostly reported in temperate zones, in freshwater mesotrophic lakes and ponds. Capable of forming surface blooms.

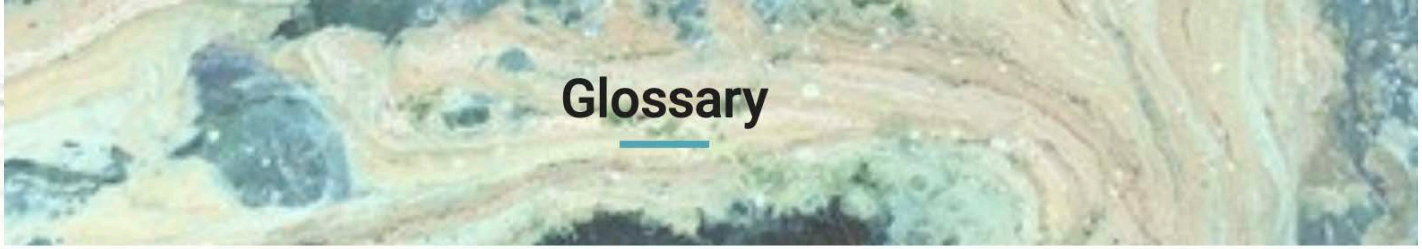
Note that *Dolichospermum* was formerly classified as a cluster of "planktic *Anabaena*" species; the two genera are distinct phylogenetically, morphologically, and ecologically. Unlike *Anabaena*, *Dolichospermum* is planktic, cells obligately contain aerotopes, and trichomes are mostly solitary (not forming mats).

References

Johansen, J. R., & Komárek, J. (2015). Filamentous Cyanobacteria. In J. D. Wehr, R. G. Sheath, & J. P. Kociolek (Eds.), *Freshwater Algae of North America: Ecology and Classification* (2nd ed., pp. 183-214). Waltham, MA: Elsevier.

400X total magnification; 10 µm scale bar.

400X total magnification; 20 µm scale bar.



Glossary

Morphological Terms

Aerotope
A group of gas vesicles. Aerotopes appear as brownish, refractive bodies within cells. There may be numerous aerotopes distributed all throughout the cell contents, or there may be only one or a few, localized to a specific area within the cell. When aerotopes are distributed throughout the cell contents, the cell may look dark brown and grainy/mottled (for example, *Microcystis*). These structures influence the buoyancy of cyanobacteria cells, and are found mostly in planktic species; many of the genera very common in surface blooms (*Aphanizomenon*, *Dolichospermum*, *Microcystis*, *Woronichinia*) have aerotopes distributed throughout their cells.
See also: gas vesicles

Akinete
Specialized cell type. Dormant cells, occurring in some filamentous taxa (for example, *Anabaena*), which allow cyanobacteria to survive harsh environmental conditions and to begin growing when conditions improve; they also aid in dispersal. Akinetes arise from one or more vegetative cells. They have thickened cell walls and contain reserves of the materials needed for sustained survival and eventual germination into new vegetative cells. They are typically larger than vegetative cells.
Scroll through this page for information about what akinetes are, and what they look like.
See also: vegetative cell, epispore

Apical (apical cell; apical end)
When used generally (as "terminal cell" or "end cell"), "apical cell" refers to the cell at the very end (either end) of a trichome. When describing heteropolar trichomes, the term "apical" is more specific, because there is also a "basal" end; if the trichome is attached to the substrate, the apical end is the free (unattached) end.
See also: heteropolar, basal

Apical hair
Apical end of a trichome with especially elongated and narrowed (only rarely not narrowed) cells. Almost exclusively a feature of heteropolar types, but may develop in some isopolar types as well.

Apoheterocytic
Describes a certain type/pattern of akinete development: akinetes start developing roughly halfway between two distant heterocytes ("distant" meaning not directly adjacent to the akinete). They develop successively in rows, proceeding in both directions *towards* the heterocytes. All vegetative cells may may change into akinetes (only in some taxa).
See also: akinete, paraheterocytic

Arcuate
Arched; crescent-shaped.

Basal (basal end or base; basal heterocyte)
In heteropolar trichomes, the basal end or base is the end by which the trichome is attached to the substrate. However, such trichomes are not always attached to the substrate. For instance: in younger, more spherical colonies of *Rivularia*, the basal ends of trichomes are oriented towards the center of the colony. A basal heterocyte--meaning a terminal heterocyte at the basal end--is often associated with heteropolarity. The cells and sheath at the base of a trichome may be morphologically differentiated.
See also: apical, heteropolar

Calyptra
A morphological feature of some filamentous cyanobacteria; a thickened, cap-like structure formed on the outside wall of the terminal

Visual Guide to Cyanobacteria in New Jersey
https://www.montclair.edu/water-science/phytoplankton-lab/

End cell
See "Terminal cell"

MONTCLAIR STATE UNIVERSITY

Meiyin Wu, Ph.D.

Director, New Jersey Center for Water Science & Technology

Professor, Department of Biology

Montclair State University

wum@montclair.edu

973-655-3704