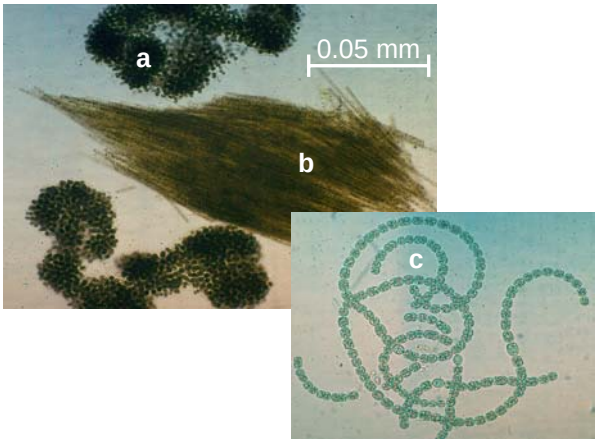
Cyanobacterial Blooms in Surface Waters

What are Blooms? – Many Alberta lakes undergo visible changes during the summer months. Otherwise clear, transparent water may suddenly become soupy in appearance, often turquoise, bright blue, grey, tan or even red in colour. In very rare instances this change is due to the excessive growth of microscopic plants called algae. Typically however, the organisms responsible for these changes are photosynthetic bacteria called **cyanobacteria**. When cyanobacteria grow profusely and congregate, they make lake water look like pea soup. This phenomenon is called a **bloom**.

Cyanobacterial bloom on a Central Alberta lake

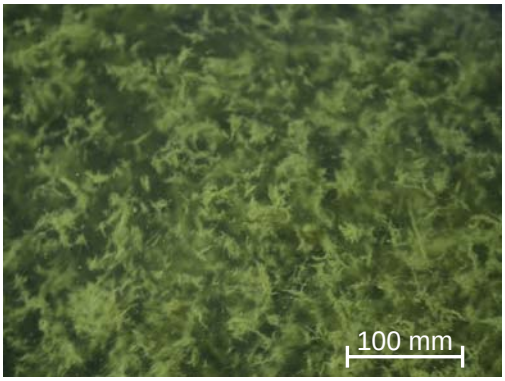
Because cyanobacteria share many similarities in overall appearance, nutrient requirements, and habitat with algae, they were originally classified as algae, and commonly called **blue-green algae**. Even today, many people still refer to them as blue-green algae and their accumulation at the water's surface as a blue-green algal bloom, or simply – algal bloom. We now understand cyanobacteria to be a truly unique group of bacteria capable of photosynthesis. That is, in the same fashion as algae and plants, cyanobacteria convert sunlight and nutrients into energy required for growth and reproduction.



Bloom-forming Cyanobacteria: a) *Microcystis*, b) *Aphanizomenon*, and c) *Anabaena.*

More than 100 species of cyanobacteria have been recorded in Alberta. A typical water sample collected from a lake during the summer can often contain 10 or more species of cyanobacteria. Some are tiny cells that cannot be seen with the naked eye, but for most species found in Alberta lakes, the cells are grouped into larger colonies that may look like fine grass clippings, small shapeless clumps, or spheres. Under the microscope the colonies may look like filaments, strings, bundles or clusters and can reach a size of several millimetres.

Why do Blooms Occur? – Cyanobacteria possess many unique adaptations allowing optimal growth and persistence and the ability to out-compete algae during favorable conditions. For instance, many species produce resting stages or cells that remain dormant until suitable conditions arise. Some possess specialized cells that convert nitrogen gas into forms required for nutrition (nitrogen fixation). And unlike algae, which require carbon dioxide gas for photosynthesis, most cyanobacteria can utilize other sources of carbon, like bicarbonate, which are more plentiful in alkaline or high pH environments (a common characteristic in many Alberta lakes).



Clumps of cyanobacteria (mainly *Anabaena* and *Lyngbya*) near surface, Pigeon Lake, AB

The adaptation believed largely responsible for the success of cyanobacteria and the formation of blooms, however, is the regulation of buoyancy. Cyanobacteria possess the ability to form gas-filled cavities that reduce cell/colony density making them float to the surface. This allows vertical migration through the water column, affording access to optimal levels of light and nutrients. Once established, cyanobacteria may further alter water conditions to favor their own growth, while reducing growth rates of algae. For instance, cyanobacteria may reduce light availability to algae through shading and may elevate the water's pH by reducing carbon dioxide levels. As a result, many cyanobacteria become particularly visible near the surface of nutrient-rich (eutrophic) lakes, reservoirs and ponds. During windy periods cyanobacteria may produce a large number of gas-filled cavities to counter the downward drag of water currents. When calm stable conditions ensue, the now over-buoyant colonies may rise to the surface en masse creating severe blooms. Conditions can worsen if wind concentrates these scums into bays, or along the shorelines and beaches.

Interestingly, several species of cyanobacteria actually prefer lower light intensities and concentrate as distinct bands at intermediate depths in what is called a metalimnetic bloom. Though less common than surface or epilimnetic blooms, metalimnetic blooms occur periodically in lakes with moderate to low nutrient levels. So, even Alberta's clear-water lakes are susceptible to cyanobacterial blooms, we just can't see them.

Where and When Do Blooms Occur? – The more nutrient-rich (eutrophic) the lake, the more likely it is to sustain surface blooms of cyanobacteria. With the exception of the mountain lakes and those situated in the Canadian Shield in the extreme north east of the province, most of Alberta's lakes reside in glacial till basins comprised of nutrient-rich sedimentary bedrock. Consequently, many Alberta lakes are sufficiently eutrophic to **naturally** support cyanobacterial blooms. Furthermore, the transport of nutrients to lakes may be exacerbated by extensive watershed development (such as, urban, agricultural, and industrial activities) and shoreline disturbance (such as, removal of natural vegetation). In general, lakes with large watersheds in relation to their surface areas will experience blooms of greater magnitude and duration than those lakes of similar size with smaller watersheds.

Blooms are most common in Alberta lakes from early July to mid-September. In many lakes, blooms only last for two or three weeks and are characterized by either one prevailing cyanobacterium or several co-occurring species. But in some extremely fertile lakes, cyanobacteria persist throughout summer and into fall as several species dominate the open water in succession (of one another).

Cyanobacteria bloom, Pigeon Lake, AB

Are Blooms Predictable? – Blooms usually develop in nutrient-rich lakes during the summer months when the water is warm and slightly to moderately alkaline. However, variations in air and water temperatures, total sunlight and wind velocity also influence bloom development. Because these factors vary from year to year, blooms cannot be accurately predicted. Blooms may not occur every year in a given lake, or they may not develop at the same time, or with similar intensity each year. Furthermore, the species responsible for the bloom may differ.

Why are Blooms Undesirable? – Floating scums or shoreline accumulations of cyanobacteria are not aesthetically appealing, and people often complain about the appearance and odour of the water during the summer months. Blooms occurring in municipal water supplies may also impart unpleasant tastes and odours to finished drinking water.

Decomposing cyanobacterial bloom

Problems worsen as the blooms decompose. Pigments in the cells are released, often causing the water to turn a vivid purple, red or turquoise. The sand and rocks along the shore may be coated with what looks like bright blue-green paint. Odours intensify often becoming reminiscent of raw sewage. Rapid decomposition may deplete the water of oxygen and can produce high concentrations of ammonia, occasionally resulting in die-offs of fish and other aquatic organisms.

Blooms may pose a serious health threat to other animals and humans as some common cyanobacteria produce potent liver or nerve toxins. Livestock, pets and wildlife are most at risk of consuming toxic cyanobacteria, and cases of illness and death occur periodically in Alberta. Though humans are less likely to intentionally consume cyanobacteria, illness can result following contact during water sports like swimming and water skiing. Hence, lake users should take special care during blooms and should treat any intense bloom with caution. Humans should not drink water from bloom-infested lakes and reservoirs, nor should they swim or wade in water containing concentrated cyanobacteria. Children should be supervised very closely. People should take care to provide alternative water sources for domestic animals and pets.

What Can We Do About Cyanobacterial Blooms? – Chemicals can be used to kill cyanobacteria. Unfortunately, many of these chemicals are toxic to other forms of life, including fish and organisms they eat. The use of chemicals in natural lakes could create more problems than they solve and hence, is not permitted.

A long-term solution is to reduce the amount of nutrients entering lakes. The main nutrient sources that can be controlled are sewage effluents, agricultural runoff, and industrial effluents. Cottage owners and recreational users of lakes can help reduce the nutrient inputs into lakes through awareness, and individual and group action.

If you have a concern about a lake, contact the nearest Alberta Environment office in your region. If you have a health related concern or questions about swimming, please contact your local regional health authority.

For more information on this issue read about Cyanobacterial Toxicity.