Cyanobacteria characteristics and effects

Cyanobacteria or blue-green algae are single-celled organisms whose existence dates back nearly four billion years, placing it among the earth oldest and most primitive forms of life. Cyanobacteria thrive in almost every environment like hot springs, salt marshes, moist soils etc. They are found most frequently in freshwater lakes and rivers throughout the world, but can exist almost anywhere where there is water, including inside of other organisms such as protists, plants and lichen, Cyanobacteria have thicken cell walls to protect them from the outside and preserve homeostasis. Cyanobacteria usually exist in low concentrations, and are not visible without the use of a microscope. However the organism can multiply rapidly, in favorable conditions, such as slow flowing nutrient-rich fresh or marine waters in warm climates or during the late summer periods in the cooler parts of the world. Rapid bacterial growth results in the formation of cyanobacteria blooms or mats which can accumulate to form surface scum in shallow inlets and bays, and along the shoreline of lakes and rivers. This surface scum can block sunlight and decrease oxygen in the water below, which can lead to plant and animal death.

Cyganobacteria blooms may occur as a result of high quantities of nutrients in the water. This can be as a result of: Inadequate water flow or stagnated water , Increase in nutrients such as phosphorus and nitrogen agricultural process and in lawn and landscape work, sewage waste, industrial waste, etc. being drained into watercourses, changes in streams/rivers and their surroundings due to urbanization , farming practices, construction and housing.

There are five classifications of cyanobacteria: chroococcales, pleurocapsales, oscillatoriales, nostocales and stigonematales. They are photosynthetic organisms like green plants that consume carbon dioxide and produce oxygen. Scientists believe that cyanobacteria were among the first photosynthetic organism to occur on the earth’s surface and the oxygen produced by these bacteria enriched the earth’s atmosphere and transformed it to its modern form. Cyanobacteria also has the ability to fix nitrogen, therefore, the bacteria plays a significant role in the nitrogen cycle as well as in the cycles of oxygen and carbon.

Chlorophyll is a major used by Cyanobacteria to absorb light and conduct photosynthesis. Cyanobacteria also contain other pigments such as the phycobiliproteins which include phycocyanin (blue), allophycocyanin (blue) and sometimes phycoerythrine (red). These pigments absorb light in the green, yellow and orange part of the spectrum. The phycobiliproteins, together with chlorophyll enable cyanobacteria to absorb light energy and to survive in an environment with only green light. Photosynthesis in cyanobacteria generally uses water as an electron donor and produces oxygen as a by-product, though some may also use hydrogen sulfide a process which occurs among other photosynthetic bacteria. Carbon dioxide is reduced to form carbohydrates via the Calvin cycle.

Dinitrogen fixation is one of the fundamental metabolic processes of cyanobacteria, providing them with the simplest nutritional requirements of all living organisms. By using the enzyme nitrogenase cyanobacteria converts N2 into ammonium (NH4) and by using solar energy to support their biosynthetic and metabolic machinery, only N2, CO2, water and mineral

elements are required for growth in the light. Nitrogen-fixing cyanobacteria are prevalent among the filamentous, heterocyst forming genera. However, there are also several documented examples of nitrogen fixing among cyanobacteria not forming heterocysts (e. g. Trichodesmium). Under predominantly nitrogen limited conditions, but when other nutrients are available, nitrogen fixing cyanobacteria may be favoured. This usually results in rapid growth and blooms.

Cyanobacteria structure and organization are studied using electron microscopes and light. The basic form and structure comprises unicellular, colonial and multi cellular filamentous forms. Reproduction is asexual. Filamentous forms reproduce by formation of special hormogonia, or by trichome fragmentation. Hormogonia are distinct reproductive parts of the trichomes. They develop into new trichomes by exhibit active gliding motion upon their liberation.

Many species of cyanobacteria possess gas vesicles. These are cytoplasmic insertions that enable variation in buoyancy and are gas-filled, cylindrical structures. Their function is to allow for adjustment of vertical position in the water, to optimize position, and to find a suitable habitat for survival and growth, cyanobacteria use different environmental stimuli (e. g. photic, gravitational, chemical, thermal) as clues. Gas vesicles increases when light decreases and the growth rate decreases. Increases in the turgor pressure of cells, as a result of the accumulation of photosynthate the buoyancy reduces and the bacteria settles at a lower level in the water column. As it consumes photosynthate the buoyancy starts to increase and the bacteria starts movement up the water column. Other ecologically significant mechanisms

of movement shown by some cyanobacteria are photo-movement by slime secretion or surface undulations of cells.

Some strains of cyanobacteria are known to produce toxins that affect humans and animals. These toxins affect different parts of the body, from the skin and upper respiratory system to the neurons. Some of the toxins can affect the liver, causing hemorrhaging, vomiting, cancer, and even death. Swimming or drinking from contaminated water source is the most common cause of poisoning.

There are various classifications of cyanobacteria toxin, each of which affects the body differently. Among these toxins are Hepatotoxin which affects the liver and is produced by strains of the cyanobacteria Microcystis, Oscillatoria, Anabaena, Nostoc, Nodularia, Umezakia and Cylindrospermopsis. Neurotoxin affects the nervous system and is produced by strains of Aphanizomenon and Oscilatoria. Cyanobacteria from the species Cylindroapermopsis raciborski can produce the toxic alkaloids that cause kidney disease and gastrointestinal symptoms in humans.

Detoxification of contaminated water sources is a complex process and the best option is to institute measure to prevent or suppress bacterial growth by reducing or eliminating the food source and allow the bacteria to die slowly, this is usually a lengthy process and can take years. Some toxin breaks down naturally in lakes, and conventional water treatment facilities can remove cells by adding binding chemicals and allowing the cells to coagulate. As the cells coagulate, they increase in density and moves to the bottom of the water treatment tank, where they can be easily removed by

filters. This method will only remove cyanobacteria cells; it dooes not remove the harmful toxins. Toxins can be removed using specialized oxidation procedures or activated charcoal. The World Health Organization (WHO) says that 100, 000 cells/mL is a moderate human health risk.

Researchers are conducting studies into cyanobacteria as a source for producing renewable biofuels and chemicals. This is because of their ability to capture solar energy and CO2, and their relatively simple genetic background allows for easy genetic manipulation. Scientist has successfully modified cyanobacteria for various biotechnological applications.