

Aquatic microbiology: Influence of physical, chemical and biological factors on aquatic microbes

Physical factors

a. Temperature

- Bacteria have a minimum, optimum, and maximum temperature for growth and can be divided into 3 groups based on their optimum growth temperature:
 - 1. Psychrophiles are cold-loving bacteria. Their optimum growth temperature is between -5C and 15C. They are usually found in the Arctic and Antarctic regions and in streams fed by glaciers.
 - 2. Mesophiles are bacteria that grow best at moderate temperatures. Their optimum growth temperature is between 25C and 45C. Most bacteria are mesophilic and include common soil bacteria and bacteria that live in and on the body.

- 3. Thermophiles are heat-loving bacteria. Their optimum growth temperature is between 45C and 70C and are commonly found in hot springs and in compost heaps.
- 4. Hyperthermophiles are bacteria that grow at very high temperatures. Their optimum growth temperature is between 70C and 110C. They are usually members of the Archaea and are found growing near hydrothermal vents at great depths in the ocean.

b. Oxygen requirements

- Bacteria show a great deal of variation in their requirements for gaseous oxygen. Most can be placed in one of the following groups:
 1. Obligate aerobes are organisms that grow only in the presence of oxygen. They obtain their energy through aerobic respiration .
 2. Microaerophils are organisms that require a low concentration of oxygen (2% to 10%) for growth, but higher concentrations are inhibitory. They obtain their energy through aerobic respiration.
 3. Obligate anaerobes are organisms that grow only in the absence of oxygen and, in fact, are often inhibited or killed by its presence. They obtain their energy through anaerobic respiration or fermentation .

- 4. Aerotolerant anaerobes , like obligate anaerobes, cannot use oxygen to transform energy but can grow in its presence. They obtain energy only by fermentation and are known as obligate fermenters.
- 5. Facultative anaerobes are organisms that grow with or without oxygen, but generally better with oxygen. They obtain their energy through aerobic respiration if oxygen is present, but use fermentation or anaerobic respiration if it is absent. Most bacteria are facultative anaerobes.
- **c. pH**
- Microorganisms can be placed in one of the following groups based on their optimum pH requirements:
 1. Neutrophiles grow best at a pH range of 5 to 8.
 2. Acidophiles grow best at a pH below 5.5.
 3. Alkaliphiles grow best at a pH above 8.5.

Chemical factors

a. Energy source

1. Phototrophs use radiant energy (light) as their primary energy source.
2. Chemotrophs use the oxidation and reduction of chemical compounds as their primary energy source.

b. Carbon source

- Carbon is the structural backbone of the organic compounds that make up a living cell. Based on their source of carbon bacteria can be classified as autotrophs or heterotrophs.
- 1. Autotrophs : require only carbon dioxide as a carbon source. An autotroph can synthesize organic molecules from inorganic nutrients.
- 2. Heterotrophs : require organic forms of carbon. A Heterotroph cannot synthesize organic molecules from inorganic nutrients.

1. Sulfur is needed to synthesize sulfur-containing amino acids and certain vitamins. Depending on the organism, sulfates, hydrogen sulfide, or sulfur-containing amino acids may be used as a sulfur source.
2. Phosphorus
 - Phosphorus is needed to synthesize phospholipids , DNA, RNA, and ATP . Phosphate ions are the primary source of phosphorus.
3. Potassium, magnesium, and calcium
 - These are required for certain enzymes to function as well as additional functions.
4. Iron Iron is a part of certain enzymes.

- 5. Trace elements Trace elements are elements required in very minute amounts, and like potassium, magnesium, calcium, and iron, they usually function as cofactors in enzyme reactions. They include sodium, zinc, copper, molybdenum, manganese, and cobalt ions. Cofactors usually function as electron donors or electron acceptors during enzyme reactions

Biological factors

- The survival and persistence of microorganisms in the natural aquatic environment has been of interest to public health and microbial ecology.
- There are various physico-chemical and biological factors involved in the disappearance of pollutant microorganisms in the aquatic environment.
- Among biological factors, grazing by protozoans especially nano-flagellates and ciliates have been identified as a significant factor in modifying bacterial populations in aquatic ecosystems .

- The specific role of bacteriophages in the removal of bacterial communities has been reported.
- It has been also documented that competing autochthonous microbiota also affects the bacterial population.