**Aquatic microbiology**

Aquatic microbiology is the study of microorganisms and their activities in fresh, estuarine, and marine waters, including springs, lakes, rivers, bays, and seas. It is the study of the microorganisms—viruses, bacteria, algae, protozoa, and microscopic fungi—which inhabit these natural waters. Some of these microorganisms are **indigenous** to natural bodies of water; others are **transient**, entering the water from air or soil or from industrial or domestic wastes. For example, wastewater can be pumped into rivers and coastal waters, or it can be disposed of in deep ocean dump sites. **Wastewater** usually contains microorganisms which will influence the activities of microorganisms already present in the receiving waters.

Aquatic microorganisms and their activities are of great importance in many

ways. They may affect the health of humans and other animal life; they occupy

a key position in the food chain by providing rich nourishment for the next.

higher level of aquatic life; they are instrumental in the chain of biochemical

reactions which accomplish recycling of elements, e.g., in mineralization.

Aquatic microbiology, which in previous decades was studied by a relatively

few microbiologists, has emerged as one of the more important areas of applied

microbiology. Urbanization and consequently the growing demand for water by

communities, the importance of natural water as a major food source, the offshore

exploration for oil and minerals, and other developments have resulted

over many aspects of natural bodies of water.

**Natural Water**

The earth's moisture is in continuous circulation, a process known as the **water**

**cycle or hydrologic cycle** . It has been estimated that about 80,000 cubic miles of water from oceans and 15,000 cubic miles from lakes and land surfaces evaporate annually. The total evaporation is equaled by the total precipitation, of which about 24,000 cubic miles fall on land surfaces. Microorganisms of various kinds are present at different stages of this cyclic process—in atmospheric water, surface water, and groundwater. Because the kinds of aquatic environments are so different it is not surprising that different species of microbes are considered to be indigenous to specific habitats

 **Atmospheric Water**

The moisture contained in clouds and precipitated as snow, sleet, hail, and rain

constitutes atmospheric water. The microbial flora of this water is contributed

by the air. In effect, the air is 'washed" by atmospheric water, which carries

with it the particles of dust to which microorganisms are attached. Most of the

microorganisms are thus removed from air during the early stages of precipitation.

 **Surface Water**

Bodies of water such as lakes, streams, rivers, and oceans represent surface water. To a greater or lesser degree, these waters are susceptible to contamination with microorganisms from atmospheric water (precipitation), the surface runoff from soil, and any wastes deliberately dumped into them. Microbial populations vary in both number and kind with the source of water, with composition of the water in terms of microbial nutrients, and with geographical, biological, and climatic conditions .

**Groundwater**

Groundwater is subterranean water that occurs where all pores in the soil or rock- containing materials are saturated. Bacteria as well as suspended particles are removed by filtration, in varying degrees, depending on the permeability characteristics of the soil and the depth to which the water penetrates. Springs consist of groundwater that reaches the surface through a rock fissure or exposed porous soil. Wells are made by sinking a shaft into the ground to penetrate the groundwater level. Wells less than 100 deep are considered to be shallow. Bacteriologically speaking, wells and springs that are properly located produce water of very good quality. If precautiors are taken to avoid contamination, the microbial content is negligible.

**The aquatic environment**

The microbial population in a body of natural water is, to a large extent, determined by the physical and chemical conditions which prevail in that habitat. . Some of these conditions are described below.

 **Temperature** : The temperature of surface waters varies from near 0°C in polar regions to 30 to 40°C in equatorial regions. More than 90 percent of the marine environment (by far the major aquatic habitat) is below 5°C. a condition favorable for the growth of psychrophilic microorganisms. Microorganisms do occur in natural

hot springs where temperatures as high as 75 to 80°C prevail (Thermos aquatic us,

a common bacterial inhabitant of hot springs, has an optimum growth temperature of 70 to 72℃). extreme thermophilic microorganisms associated with geothermal vents in the Pacific Ocean floor. These unusual microbes are said to be capable of growing at 250°C and 265 atm of pressure. Aside from this extreme, the temperature in lakes, streams, and estuaries is influenced by the seasons, and there are corresponding shifts in the microbial flora.

 **Hydrostatic Pressure**: There are striking differences in the hydrostatic pressure of surface waters and of water in oceanic depths. Hydrostatic pressure affects chemical equilibrium which, in turn, results in lowering the pH of seawater, resulting in a change in the solubility of nutrients such as bicarbonate, HCO 3 '. Hydrostatic pressure

also increases the boiling point of water, thereby maintaining water in its liquid

state at high temperatures and pressures. By definition hydrostatic pressure

increases with depth at the rate of I atm per 10 m. Barophilic microorganisms,

organisms which cannot grow at normal atmospheric pressures, have been isolated

from Pacific trenches (depth 1000 to 10,000 m), where enormous hydrostatic pressures exist (>100 atm). Hydrostatic pressure of the deep sea is an

important factor in the occurrence and growth of marine microorganisms in this

environment. Deep sea bacteria have now been isolated from sediment, water,

and deep sea animals by using special pressure-retaining sampling devices. In

general, barophilic bacteria grow best at pressures slightly less than the pressure

of the site from which they were isolated, and almost all must be grown under

psychrophilic conditions (about 2°C).

**light :** aquatic life depend, directly or indirectly, upon the metabolic products of photosynthetic organisms. in most aquatic habitats these primary producers are algae, and their growth is restricted to the upper layers of waters through which light can penetrate. The depth of the photic zone varies depending on such local conditions as latitude, season, and particularly the turbidity of the water. Generally, the photosynthetic activity is confined to the upper 50 to 125 m. Carbon dioxide is available largely from HCO 3 , although some gaseous CO2 is available.

**Salinity**: The degree of salinity in natural waters ranges from near zero in freshwater to saturation in salt lakes. A distinctive characteristic of sea water is its high salt content, which is remarkably constant. The concentration of dissolved salts

varies between 33 and 37 g /kg water. The major mineral constituents of 1sèa

water are listed. The principal salts are the chlorides, sulfates,and carbonates of sodium, potassium, calcium, and magnesium. The concentration of salts is usually less in shallow offshore regions and near river mouths.

Most marine microorganisms are halophilic; they grow best at salt concentralions of 2.5 to 4.0 percent, whereas those from lakes and rivers are salt sensitive and do not grow at a salt concentration of more than 1 percent.

**Turbidity** :

 there is marked variation in the clarity of surface waters. The Adriatic Sea is sparkling clear at great depths, whereas some near-shore rivers are often turbid.

The suspended material responsible for the turbidity includes (1) particles of

mineral material which originate from land; (2) detritus, predominantly particulate

organic material, such as cellulose, hemicellulose, and chitin fragments;

and (3) suspended microorganisms. As previously mentioned, turbidity of the

water influences the penetration of light, which in turn affects the photosynthetic

zone. Particulate mailer also serves as a substrate to which microorganisms adhere or as substrates that are metabolized.

**Hydrogen-Ion :** Aquatic microorganisms, in general, can be grown at pH 6.5 to 8.5.

THE (PH) the sea is 7.5 to 8.5. Optimum growth of most marine species is obtained on

media adjusted to pH 7.2 to 7.6. Lakes and rivers may show a wider range in

pH depending upon local conditions.

**Inorganic and Organic Constituents:**

The quantity and type of inorganic and organic materials present in the aquatic environment are important in determining the microbial flora. Nitrates and phosphates are important inorganic constituents, particularly for the growth of algae. Organic compounds are required for the growth of saprophytic bacteria and fungi. Near-shore waters, which receive domestic wastewater, are subject to intermittent variations in their nutrient load, whereas the nutrient load of the open sea is very low and stable. The industrial wastes may contribute antimicrobial

Substances to estuaries and coastal waters. Mercury and other heavy metals in small concentrations may inhibit growth of some microorganisms while simultaneously

permitting the growth of resistant forms. Resistance is usually coded for ‘by genes associated with R (resistance) plasmids. For example, many pseudomonads and staphylococci are capable of volatilizing mercury, thereby removing its toxic effects from their immediate environment**.**