Aquatic Communities

Aquatic environments represent about 70% of the Earth's surface area and include oceans, seas, rivers, lakes, streams, springs, and groundwater, among others. Most M.O. that inhabit aquatic environments are primary producers in the food web because they are responsible for fixing carbon dioxide (CO_2) and converting it into organic matter through photosynthesis, contributing to half of the primary productivity found in the biosphere.

Microbial communities in aquatic environments

Microbial communities in aquatic environments are highly diverse, including plankton, sediments, microbial Mats and Biofilms

1- **Plankton** are the microbial communities suspended in the water column. and include

- Phytoplankton :autotrophic M.O. such as microalgae and cyanobacteria.
- Bacterioplankton :heterotrophic M.O. such as Bacteria.
- Zooplankton: Protozoa that ingest bacteria.

-- together, these three communities are referred to as microbial planktonic populations.

Phytoplankton represent primary productivity because convert CO2 to organic matter by photosynthesis. Therefore, they represent a source of energy that transfers to higher trophic levels within the food web.

The organic compounds produced by phytoplankton classified into two categories:

- Particulate organic matter (POM): are large organic particles such as polymers like cell walls and membranes.
- Dissolved organic matter (DOM): are small soluble matters such as amino acids, sugars, organic acids, and nucleic acids that lysis quickly.

The primary productivity in the oceans represents about 50% of the primary productivity in the biosphere and depends on several environmental factors, including:

1- The concentration of essential inorganic nutrients, especially N and P
2- Water temperature.
3- Water turbidity, which affects the amount of light penetrating through the water column.

In seas the transference of energy between microbial trophic levels is complex and the primary productivity in water column produced as DOM, some of DOM consume by Bacterioplankton by mineralization to produce minerals and CO_2, while others in synthesis of Bacterial biomass that represents secondary productivity.

Sources of Dissolved organic matter (DOM) are :

- The dead phytoplankton (as a result of environmental stress conditions such as wind, high temperatures, exposure to ultraviolet radiation due to prolonged periods of light, and irregular feeding of large animals)
- some zooplankton (such as excretion and ammonia release, which are nitrogenous nutrients, and the decomposition of dead cells)
- Bacterioplankton (due to viruses lyse bacteria).

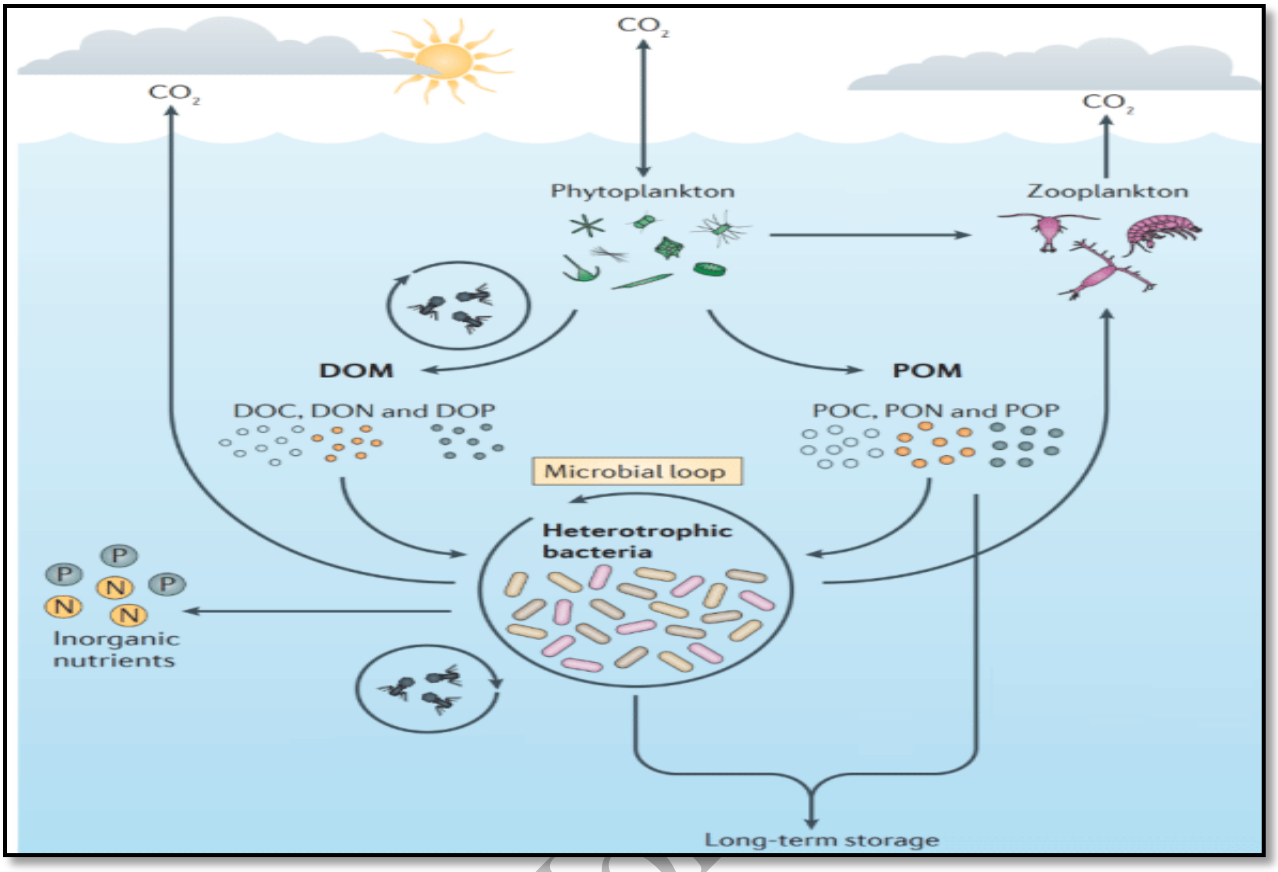

Figure 7-1 . Microbial loop in aquatic ecosystem

2-Benthic communities: are M.O. presented between water column and the metallic surface of the water body bottom. These surfaces accumulate organic materials that sink from the water column .the benth is characterized by a huge numbers in M.O. (about five times that of the plankton). It is environmentally effective and physiologically diverse,

- Methanotrophic bacteria (obligate aerobic) oxidize CH_4 and consume O_2 rapidly to decomposing organic matter. The lack of O_2 stimulates facultative anaerobic and obligate anaerobic Bacteria.
- Sugar-fermenters bacteria (facultative anaerobes) decompose DOM and release CO2 and acetic acid,

- Methanogenic bacteria (obligate anaerobes) convert CO_2 to CH_4 under anaerobic conditions. This methane is then used by aerobic methanotrophic bacteria as an energy source under aerobic conditions, resulting in the production of CO_2. Thus, there is an **interconnection in this area between aerobic and anaerobic microbial transformations**.

3-**Microbial Mats**: They are compressed microbial groups arranged in layers resembling thin carpet, with a thickness ranging from (several mm) to (1cm),present in extreme environments, floating in hot springs or depths of sea, highly saline lakes, and river mouths. Cyanobacteria thrive in Mats and perform photosynthesis, which releases abundant amounts of O_2 during the day. At night, in the absence of light and respiration of M.O. decrease O_2, which stimulates sulfate-reducing bacteria .

4- Biofilms : are microbial communities linked together by Exopolysaccharide matter known as **glycocalyx**, which connects bacterial cells within the biofilm and gives biofilms a viscous appearance. Biofilms present submerged in water or on wet solid surfaces such as rocks, ship structures, submerged parts of plants. Biofilms differ from microbial mats in that microbial mats serve as habitats for M.O. that perform photosynthesis, such as cyanobacteria. Biofilms in aquatic ecosystems play an important role in nutrient cycling and pollution control, but in biological ecosystems like humans, biofilms have a pathogenic effect.

The importance of Biofilm for the microbial communities that live within are:

1- Have a negative charge that filtrates and collects nutrients for the cell.
2- Protect the cell from dehydration.
3- Protect the cells from changes in temperature and pH .
4- protect bacteria from predation by protozoa.
5- Protect the cell from antibiotics and disinfectants , so **glycocalyx** prevent these matters to penetrate plasma membrane.

6- Cause health injure, such as dental caries and hospital infections like urinary tract infections.

There is a type of communication between bacterial cells in biofilm where a single cell senses its maximum of population number by releasing a type of signaling molecules called autoinducers to regulate the gene expression responsible for a specific phenomenon or function that the cells perform together in biofilm. This phenomenon is called Quorum Sensing.

For example marine bacteria ***Vibrio fisheri*** do not emit light when they are plankton in water, but when they present on the light-emitting organs of squid and their numbers reach or exceed 10^{11}, begin to produce enzyme called luciferase responsible for the luminescence of the cells and the emission of light.

Pseudomonas aeruginosa bacteria can grow in humans without causing illness, but when their numbers reach a maximum, they begin to sense this and start to form a biofilm, leading to disease and the root nodule **Rhizobium** use this phenomenon to produce the enzyme Nitrogenase to fix nitrogen.