

MICROBIAL DIVERSITY

Microbiology is the study of microorganisms that is the organisms which are of microscopic dimensions. Microbes, also called as microorganisms. They are Minute, living things- too small where human eye cannot resolve an object less than 0.1mm. They include- bacteria, fungi, protozoa, many algae and viruses. Microbiology is the study of very small organisms. Play important roles in medicine, agriculture and industry. They are dominating the environment.

At present, there five major groups as microorganisms: the subdivisions of virology, bacteriology, mycology, phycology and protozoology.

Hierarchical Organization: In the early 19th century the micro organisms were fitted into two kingdoms of organisms

ANIMALIA- Animals

PLANTAE- Plants

Algae- immobile, photosynthetic- (Plants)

Fungi- Plants

Microscopic motile forms were grouped together as a group- **Infusoria** under animals.

In 1840 biologists perceived that Infusoria were heterogeneous group-cellular organisation.

The simpler unicellular forms were sub-divided into two groups.

Protozoa- large and complex cells

Bacteria- smaller and simple cells

Infusoria was split into three groups

Metazoa- multicellular, invertebrate animals

Protozoa- unicellular animals and

Bacteria, that were transferred to plants.

Division of living world into these two kingdoms can no longer be maintained.

Protists- Third kingdom proposed by E. Haeckel in 1886. It includes protozoa, algae, fungi and bacteria. Both photosynthetic and non-photosynthetic forms. Protists are simple eukaryotic organisms that are neither plants nor animals or fungi. Protists are unicellular in nature but can also be found as a colony of cells. Most protists live in water, damp terrestrial environments or even as parasites.

With respect to the internal architecture of the cell, the more complex is the eukaryotic cell. The less complex is the prokaryotic cell. The two microbial groups

Eubacteria- Blue green algae

Archaeobacteria- microbes.

Whittaker's five- kingdom system

In 1969, Robert Whittaker was the biologist who proposed the Five Kingdom Classification. The Kingdoms in this classification were classified based on cell structure, thallus organisation, mode of nutrition, reproduction, and phylogenetic relationships.

Earlier, the organisms were classified into just two kingdoms- the classification of kingdom Plantae and animals. The classification of plants kingdom included every living organism that did not eat or move and grow continuously throughout their lives. The animal kingdom during this time included organisms that moved, ate, and stopped growing after a specific size.

R. H. Whittaker proposed the Five Kingdom Classification, and this classification made it easier to classify organisms into five different kingdoms-

Monera

Protista

Fungi

Plantae

Animalia

The five kingdoms in this widely accepted classification consist of species of similar characteristics concerning their growth and functioning. The organisms are divided into the five kingdoms based on their general features like:

1. Cell type: Organisms can have either prokaryotic cells (cells lacking membrane) and be prokaryotes or have eukaryotic cells (a membrane covers genetic material) and be eukaryotes. The kingdom Monera is the only kingdom that consists of prokaryotes, as the other four kingdoms have eukaryotic organisms.
2. Cell wall: The kingdoms Monera, Fungi, and Plantae consist of organisms that have cell walls in their cells. Some of the Protists also have cell walls. But, the cells of the organisms of the Animalia kingdom do not have cell walls.
3. Nuclear membrane: The organisms under the Protists kingdom have cells without a nuclear membrane, while the others have a nuclear membrane.
4. Cell organization: This characteristic divides organisms into unicellular and multicellular.
5. Nutrition mode: The Plantae kingdom consists of autotrophs, i.e., they make their food. Fungi and Animalia kingdom consist of heterotrophs,

i.e., organisms under this kingdom depend on others for food. Monera and Protista consist of both- autotrophs and heterotrophs.

Monera.

The kingdom Monera of the five classification system categorizes bacteria underneath it has the following characteristics:

- It contains all microscopic living organisms.
- Kingdom Monera groups the prokaryotes together.
- The monerans can be found in all habitats.
- They are single-celled organisms with an absence of a well-defined nucleus.
- The cells of monerans have cell walls formed from amino acids and polysaccharides.
- The mode of nutrition of monerans can be either autotrophic or heterotrophic.

Based on their shape, bacteria are divided into four categories- cocci, bacilli, spirilla, and vibrio.

Protista

The general characteristics:

1. The cell type of the Protists is eukaryotic.
2. The organisms under Protista are unicellular.
3. These organisms usually use cilia, flagella, or amoeboid movement to move.
4. It has both autotrophs and heterotrophs.
5. The presence of a nuclear membrane marks the kingdom.
6. Some Protists have cell walls.
7. Cell fusion or zygote formation is used for sexual reproduction by Protists.

The kingdom Protista is further divided into Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds, and Protozoans.

Fungi

General characteristics of Fungi are:

1. The kingdom contains eukaryotes.
2. A non-cellulosic cell wall made of chitin and polysaccharides is present in species of this kingdom.
3. A nuclear membrane is present in the organism's cells.
4. Fungi consist of heterotrophs, which can be parasitic or saprophytes.
5. Few Fungi are classified as symbionts. The symbionts living with algae are called lichens. At the same time, the ones living in association with higher plants are known as mycorrhiza.
6. Fungi species contain slender hyphae with long thread-like constructions. The mycelium is a web of hyphae.
7. Some hyphae are unbroken tubes with multinucleated cytoplasm called coenocytic hyphae.

Plantae

The features of the classification of plants kingdom are:

1. The classification of kingdom Plantae consists of eukaryotes that have chloroplasts.
2. The kingdom mostly has autotrophs, but there are certain exceptions.
3. Plants have a cellulosic cell wall with the presence of a nuclear membrane.
4. They are multicellular.
5. The diploid saprophytic and the haploid gametophytic phases have two different life phases.

Animalia

This kingdom has the following features:

1. Animals are eukaryotes.
2. They do not have cell walls.
3. Unlike the classification of kingdom Plantae, there are heterotrophs underneath the Animalia kingdom.
4. Most species of this kingdom are adept at locomotion.
5. The reproduction mode for animals is sexual.

Carl Richard Woese's three-domain system

The three-domain system was first introduced by **Carl Woese in 1990**.

In this classification, Carl Woese uses 16S ribosomal RNA (rRNA) as a 'Chronometer', because of;

It is universally distributed means its presence in all species.

It is functionally similar in all organisms.

It can change its sequence slowly.

Its sequences can be aligned, or matched up, between 2 organisms.

Classification is made of three domains such as

Domain Archaea

Domain Bacteria

Domain Eukarya

Domain Archaea

The Archaea domain includes all prokaryotic cells, they lack nuclear membrane;

Have distinct biochemistry; contain RNA markers from bacterial cells.
The Archaea are considered as the oldest species of organisms on Earth.
They can survive in extreme, harsh environments that differentiated them from other domains.

The cell wall of archaea lacks peptidoglycan. Archae also contains ether leakage in their membranes.

Archae has three phyla such as;

Crenarchaeota: They can survive at extremely high temperatures and extremely low temperatures.

Euryarchaeota: Some of them are known as extremely halophiles, which can prevent inhibit highly saline environments.

Konarchaeota: It includes all those species were found in a single hot spring, Obsidian Pool, present in Yellowstone National Park (USA).

Domain Bacteria

These are also prokaryotic cells with bacterial rRNA and contain diacyl glycerol diester lipids in their membrane.

They are also called eubacteria or “true bacteria”. Their cell membrane contains ester linkage between unbranched fatty acid chains and glycerol. Their cell wall made up of peptidoglycan.

There are present 5 phyla of the bacterial domain such as;

Proteobacteria: The example of proteobacteria is *E. coli*, *Salmonella typhus*, *Legionella*, *Heliobacter pylori* (cause of many ulcers), *Neisseria gonorrhoea* (cause of gonorrhoea).

Cyanobacteria: The example of Cyanobacteria is Photosynthetic ‘blue-green’ bacteria which produces O₂ gas.

Eubacteria: The example of Eubacteria is *Clostridium* (tetanus, botulism), *Bacillus*, *Mycoplasma* (walking pneumonia).

Chlamydias: The example of Chlamydias is *Giardia*, *Chlamydia* (STD), etc.

Spirochaetes: The example of Spirochaetes is Spiral bacteria that cause syphilis, Lyme disease.

Domain Eukarya

These are eukaryotic cells with a membrane-bound nucleus.

Their membranes contain their membranes between unbranched fatty acid chains and glycerol.

They lack peptidoglycans on their cell wall. Eukarya inhibit the antibacterial antibiotics but sensitive to antibiotics that affect eukaryotic cells.

There are presently four Kingdoms of Eukarya

Protista: These are slime molds, euglenoids, algae, and protozoans.

Fungi: These are sac fungi, club fungi, yeasts, and molds.

Plantae: These are mosses, ferns, conifers, and flowering plants.

Animalia: These are sponges, worms, insects, and vertebrates.

Distribution of microbes in soil

All regions of the earth that contain living organisms are known as

Biosphere. Includes principally soil, water and air.

Soil are excellent cultural media for growth of many types of organisms.

Includes bacteria, fungi, algae, protozoa, and virus.

Many types of bacteria are found in the soil. Autotrophic and utilize inorganic compounds for their energy and growth. Majority are heterotrophic- use organic matter. Genera- *Streptomyces*, *Nocardia* and *Micromonospora*.

Fungi- Include a group of organisms from moulds to large fleshy fungi- mushrooms. Fungi develops where there is soil having acidic reaction

and aerobic condition present near the surface. Active in decomposition of cellulose and lignin of plant tissue. Mycelium penetrates the soil and forms a network- entangles soil particles .Agricultural importance- improve physical condition. Yeasts present in vineyards and orchids.

Protozoa-Many found in soil. Exist as vegetative or cyst forms. Use decaying organic matter for food and consume both dead and living bacteria.

Algae-Found on the surface of moist soil. Sufficient light for their photosynthetic reactions. *Chlorophyceae* and *Diatoms*

Viruses- In contrast to the oceans, little is known about the role of viruses in soils. A new study found that soils can contain **many kinds of RNA viruses**. Most of these RNA viruses likely infect fungi, but they could also infect bacteria, plants, and animals. The study found that viral populations in soil change quickly.

Microbes in Water

The study of microbial communities and their activities in natural water environments-lakes, ponds, etc is known as aquatic microbiology. Microbial communities include viruses, bacteria, fungi, algae, protozoan's and other microorganisms.

Ground water- originates from deep wells, subterranean springs. Free of bacteria due to filtering action of soil, deep sand and rock. May become contaminated when it flows along the channels
Surface water- streams, lakes, and shallow wells.

The air through which the rain passes may contaminate the water. Agricultural runoff, farm animals, rain water, industrial waste, discharges from sewage treatment plants.

Portability refers to the drinkability of water. When potable, it is fit for drinking.

When unportable it is unfit due to some contaminant or pollutant.

Biochemical oxygen demand (BOD)

The amount of dissolved oxygen used by microorganisms in the biological process of metabolizing organic matter in water.

Biochemical oxygen demand is the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic conditions.

The common lake or stream contains small amounts of oxygen in the form of dissolved oxygen (DO). Dissolved oxygen is a crucial component of natural water bodies, maintaining the aquatic life and quality aesthetic of streams and lakes. The decay of organic matter in water is measured as biochemical oxygen demand. Environmental stresses and other human-induced factors can lessen the amount of dissolved oxygen in a water body.

The more organic matter there is the greater the BOD; the greater the BOD, the lower the amount of dissolved oxygen available for higher animals such as fishes.

One of the main reasons for treating wastewater prior to its discharge into a water resource is to lower its BOD—i.e., reduce its need of oxygen and thereby lessen its demand from the streams, lakes, rivers, or estuaries into which it is released.

Microbes in Air

The term aerobiology was coined in the 1930s by F.C. Meier.

It is defined as ‘the study of aerosolisation, aerial transmission, and deposition of biological materials’.

Aeromicrobiology is the study of all forms of microbial life in air.

The study of spores as that of algal, bryophytes and Pteridophytes are also studied under aerobiology.

The aero-microbiology is the study of those invisible microorganisms which are less than size of 1 mm and not visible with naked eye which are present in the air. Airborne microbes are important pathogens causing diseases in plants, animals and humans.

The bioaerosol is used to describe living airborne particles or those originating from living organisms.

Bioaerosols vary considerably in size their composition depends on several factors including the type of microbe or toxin, type of particles they are associated with (as mist or dust), and the gases in which the bioaerosol is suspended.

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