MICROBIAL INTERACTION

1. Clay-Humus-Microbe Interaction:

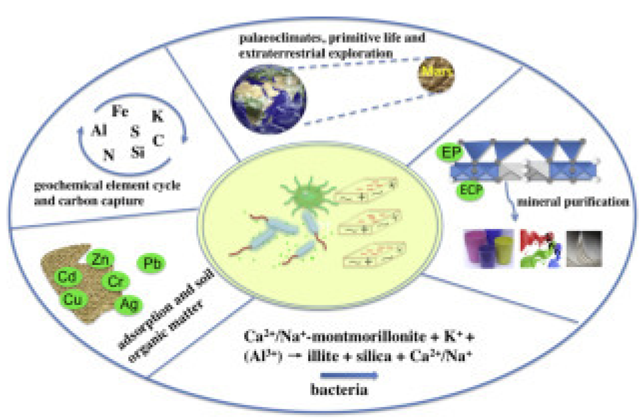
Clay mineral (and humic substances) affects the activity, ecology and population of microorganisms in soil. Clays modify the physicochemical environment of the microbes which either enhance or attenuate the growth of individual microbial population.

After release from clays, the organic material is either degraded by microorganisms or again bind to clays. Microorganisms have a negative charge at the pH of most microbial habitats. The magnitude of electronegativity on cell walls of bacteria and fungi is regulated by pH, amino acid residues and changes in wall composition.

Clay minerals get adsorbed and bind with proteins, amino acids, small peptides and humic substrates. Microorganisms utilize the nutrients for their growth and activity directly from clay- protein, clay-amino acids or peptides, and clay-humic substrate complexes.

Moreover, high levels of clay (e.g. montmorillonite) soil interferes and restricts infection of banana rootlets by Fusarium oxysporum f.sp. cubense, and thus exerts natural biological control of panama disease.

The clays and humic colloids influence the distribution and activity of Streptomyces, Nocardia and Micromonospora. Clay particles (e.g. kaolinite) is known to reduce the toxicity of cadmium (Cd) on Macrophomina phaseolina.



2. Plant-Microbe Interactions:
The above ground (foliage) and below ground (roots) portions of plants are constantly interact with a large number of microorganisms (e.g. bacteria, actinomycetes, fungi, amoebae, nematodes, and algae) and viruses, and develop several types of interrelationships.

Microbial interactions with both above ground and below ground parts of plants are briefly discussed in this section. Moreover, considering the result of interactions, it may develop destructive, neutral, symbiotic or beneficial association with plants.

Interactions on Above Ground Parts:
Microbial interactions on above ground part of plant occur in a varieties of ways where the foliage especially leaf surface (phyllosphere and phylloplane) acts as microbial niche.

i. Destructive Associations (Diseases):
Plants provide a substantial ecological niche for microorganisms. However, the abundance of this potential niche with respect to any individual microbe is more apparent than real, since a few are able to grow on a wide range of plant species.

Microorganisms show specificity with the hosts, organ, tissue and age of plants. The microorganisms that lead to destructive association are called pathogens.

Disease development is governed by the resultant of three important factors:
(a) Host susceptibility,

(b) Congenial environment

(c) Virulent pathogen.

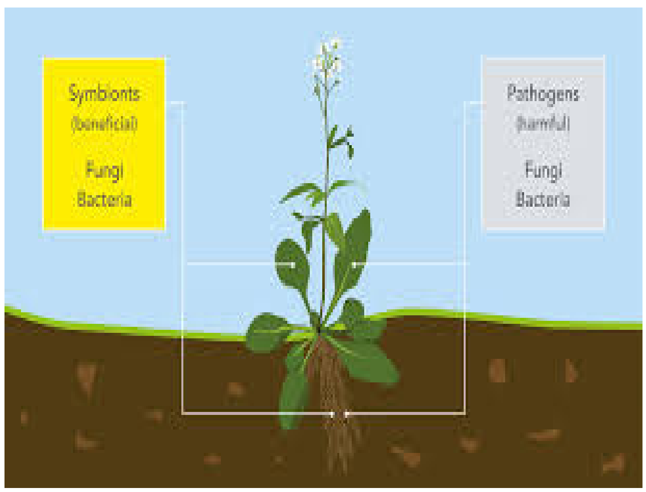
ii. Beneficial Association (Symbiosis):

The excellent example of plant-microbe interaction resulting beneficial association visualised on above ground part is the development of stem nodules. There are three known genera of legumes which are known to bear stem nodules are

Aeschynomene, Sesbania and Neptunia. The stem nodules develop as a result of interaction between these plants and Azorhizobium species.

Rhizobia develop symbiotic association with hosts, fix atmospheric nitrogen and benefit the plants. S. aculeata is the most popular green manure in north India which contributes about 70 kg of nitrogen and 15-20 tonnes/ha wet biomass to the soil. A. americana is a wild annual legume which is also used as green manure. S. rostrata bears both stem as well as root nodules.

In addition, Anabaena azollae establishes symbiotic association with Azolla which is a member of pteridophyta. Species of Nostoc establishes symbiotic relationship with Anthoceros and Blasia, members of Bryophyta.



3. Animal-Microbe Interactions:
There are many kinds of microorganisms that interact with different groups of animals and develop a variety of relationships.

Some of the relationships have been discussed in this section:
i. Destructive Associations:
Pathogenic microbes interact with animals including man and cause many kinds of disease.

ii. Neutral Association (Nutralism):
Normal microbiota of human body:
There is a large number of microorganisms that normally act as the resident of different body organs of humans such as skin, nose and nasopharynx, oropharynx,

respiratory tract, mouth, eyes, external ears, stomach, small intestine, large intestine (colon), and genitourinary tract

iii. Symbiotic Associations:

Symbiotic associations of bacteria, fungi and protozoans with insects, birds and herbivorous mammals are discussed below:

(i) Ectosymbiosis of Protozoa, Bacteria and Fungi with Insects and Birds:

Most of the animals such as insects (termites and cockroaches) cannot utilize the cellulose and lignin components of woody tissues of tree due to lack of cellulose and lignin degrading enzymes. Therefore, several insects develop ectosymbiotic association with cellulose- and lignin-decomposing microorganisms that can degrade these substrates.

All termites and cockroaches that eat upon wood, harbour flagellated protozoa in their guts. These protozoa digest cellulose. In turn the protozoa develop symbiotic association with certain N_2-fixing bacteria and spirochetes which perhaps also help in cellulose degradation. In addition, during moulting season of cockroaches hormones (e.g. ecdysone) are secreted which induce cyst formation in symbiont protozoan.

(ii) Endosymbiosis of Bacteria and Fungi with Birds and Insects:

Moreover, there is a group of birds belonging to the genus Indicator which are commonly known as honey guides. These birds are found in Africa and also in India. These birds eat upon remnants of exposed honey comb but cannot digest bees wax. Therefore, they harbour in their intestine the two microbes. Micrococcus cerolyticus and Candida albicans for carrying out the digestion of bees wax.

Except carnivorous insects, the others that live upon blood or plant sap develop symbiotic association with bacteria such as coryneforms and Gram-negative rods, and Nocardia (a member of actinomycetes). These microsymbiont are present in insect hosts in specialised cells.

The cells that contain fungi are called mycetocytes, and those that contain bacteria are called bacteriocytes. These microsymbionts provide to the insects with some growth factors (that are lacking in insects) and some essential amino acids. Also the microsymbionts assist in breakdown of certain waste products.

(iii) Ruminant Symbiosis:

The herbivorous mammals (e.g. catties, sheep, goats, camels, etc) are known as ruminants because they have a special region of gut which is called rumen. These animals use plant cellulose as the source of carbohydrate which is not digested in normal gut. The cellulosic material is digested in rumen which acts as incubation chamber teeming with protozoa and bacteria. In some animals like cow, the size of rumen is very large.

Some of anaerobic cellulose-digesting bacteria (e.g. Bacteroides succinogens, Ruminococcus flavofaciens, R.albus and Botryovibrio fibrisolvens) develop mutualistic symbiosis, and hydrolyse cellulose and other complex polysaccharides to simpler forms which in turn are fermented to fatty acids (.g. acetic acid, propionic acid, butyric acid) and gases (methane and carbon dioxide).

Some of the bacteria are capable of digesting proteins, lipids and starch as well. Lignin fraction of plant remains undigested.

The rumen bacteria ferment proteins and lipids and produce hydrogen and carbon dioxides gase, which in turn is converted into methane by Methanobacterium ruminantium. The bacteria of rumen multiply into a large population. However, most of them are passed into stomach along with undigested material where they are killed by proteases and other enzymes. The fatty acids in rumen are absorbed and gases are passed out.