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Q1: Write a detail note on roles and regulation of microbes in natural and manmade environment.

Ans: Roles and regulation of microbes in natural environment:

* Industrialization and other human activities produce pollutants, which accumulate in soils or aquatic environments, contaminating them.
* Not only is human well-being at risk, but also environmental health.
* Currently, recycling, land-filling, incineration and pyrolysis are being used to reduce the concentration of toxic pollutants from contaminated sites, but too have adverse effects on the environment, producing even more resistant and highly toxic intermediate compounds.
* These methods are expensive, and are difficult to execute for soil, water, and air decontamination.

1. Microorganisms as plant growth promoter:

* Plant growth promoting rhizobacteria are the soil bacteria that colonized plant root.
* Facilitate the plant growth directly or indirectly.
* Decrease the global dependence on hazardous agricultural chemicals.
* Stimulate plant growth through mobilizing nutrients in soils.

Plant growth promoting rhizobacteria:

Characteristics of PGPR:

* Proficient to colonize the root surface.
* Survive, multiply and compete with other micro biota.
* Promote plant growth.

Classification based on their functional activities as:

* Biofertilizers
* Phytostimulators
* Rhizoremediators
* Biopesticides.

Direct effect on plant growth:

The most important direct effects involved in plant growth promoting include;

* Biological nitrogen fixation.
* Phytohormone production.
* Nutrient solubilization
* Siderophore production.
* ACC deaminase activity.

Indirect effect on plant growth:

* Antibiotic production
* Hydrolytic enzyme production
* Induced systemic resistance (ISR)
* Exopolysaccharide production

PGPR as biofertilizers:

* The search for PGPR and investigation of their modes of action are increasing at a rapid pace as efforts are made to exploit them commercially as biofertilizers.
* PGPR help in fixing N2, increasing the availability of nutrients, positively influencing root growth and morphology and promoting other beneficial plant-microbe symbioses.
* The combination of these modes of action in PGPR is also addressed and widespread utilization of PGPR as biofertilizers.

1. Microbial remediation of environmental pollution:

* There is an urgent need to treat industrial effluents to remove contaminants prior to discharge into the surrounding soil and water bodies.
* Attention has been given to remediation strategies of these pollutants due to their persistent nature and increased awareness among the global community
* Several physicochemical methods have been used to detoxify industrial effluents. However, these methods are expensive and not environment friendly as they generate large amounts of sludge, which also requires safe disposal and can also cause secondary pollution
* Microorganisms are being used for removing the pollutants from environment.
* Bioremediation is a strategy that relies on the metabolic capabilities of microbes to transform aromatic compounds into essentially harmless or at least less toxic compounds
* It has a number of advantages compared to physicochemical methods. For example, microbial treatment is effective to degrade persistent and recalcitrant compounds.
* Other advantages include a reduction in sludge production, shorter treatment time, applicability over a wide range of temperatures, and are easy and simple to handle.

Organic pollutant:

* Persistent organic pollutants (POPs) include;
* Dyes used in textile and other industries
* Pesticides and polycyclic aromatic hydrocarbons.
* These are toxic chemicals that have adverse effects on human health and environment around the world.
* Most of the POPs are generated in one country and affect human and wildlife far from where they are generated, used or released.
* Chemically these are complex compounds which are classified as xenobiotics thus barely removed from the environment.

Q2: Write a detail note on microorganisms in terrestrial environment.

Ans: Microorganism in terrestrial environment:

* Terrestrial (Latin terra means earth) environments are dominated by inert solid materials. Organic substances, including microorganisms, are usually a minor part of a soil.
* Soil is the habitat for a variety of organisms, including bacteria, fungi, protozoa, insects, nematodes, worms, and many other animals. Viruses also are present in soils.
* This complex biological community contributes to the formation, maintenance, and in some situations, the degradation and disappearance of soils.
* Microorganism in the soil environment:
* Most soil bacteria are located on the surfaces of soil particles and require water and nutrients that must be located in their immediate vicinity.
* Bacteria are found most frequently on surfaces within smaller soil pores (2 to 6 µm in diameter).
* Terrestrial filamentous fungi bridge across open areas between soil particles or aggregates called peds, and are exposed to high levels of oxygen
* These fungi will tend to darken and form oxygen-impermeable structures including sclerotia and hyphal cords.
* A wide variety of insects and animals also are present in soils, and these often use the fungi and bacteria as food sources, as well as processing plant residues.
* The microbial populations in soils can be very high. In a surface soil the bacterial population can approach 108 to 109 cells per gram dry weight of soil as measured microscopically. Fungi can be present at up to several hundred meters of hyphae per  
  gram of soil.
* The gram-positive bacteria, which show varied degrees of branching and mycelial development, are an important and less studied part of the soil microbial community. They include the coryneforms, the nocardioforms, and the true filamentous bacteria  
  or actinomycetes.
* These bacteria play a major role in the degradation of hydrocarbon.
* The filamentous actinomycetes, primarily of the genus Streptomyces, produce an odor-causing compound called geosmin, which gives soils their characteristic earthy odor.
* The microbial community in soil makes important contributions to biogeochemical cycling that includes;
* Carbon cycle
* Nitrogen cycle
* Sulfur cycle
* Iron cycle
* And manganese cycle
* This process of microbivory, or use of microorganisms as a food source, results in higher rates of nitrogen and phosphorus mineralization, thus increasing the availability of nutrients for plant growth.
* Microorganism and the formation of different soils:
* Once they are formed, most soils are rich sources of nutrients. Nutrients are found in organic matter, microorganisms, soil insects, and other animals.
* Plants grow, senesce, and die—and at each of these phases, they provide nutrients for soil organisms.
* Different plant parts vary in their nutrient content and biomasses.  
  In addition, the turnover times for the various plant parts are quite  
  different.
* The components in the plant-soil system with the lowest carbon-nitrogen ratios (most nutrient-rich) are soil organic matter, microorganisms, soil insects, and other soil animals.
* Soils in cold environments, whether in Arctic, Antarctic, or alpine regions, are of extreme interest because of their wide distribution and impacts on global-level processes.
* The colder mean soil temperatures at these sites decrease the rates of both decomposition and plant growth.
* In these cases soil organic matter accumulates, and plant growth can become limited due to the immobilization of nutrients in soil organic matter.
* Soils of hot and cold arid and semiarid deserts are dependent on periodic and infrequent rainfall. When these rainfalls occur, water can puddle in low areas and be retained on the soil surface by microbial communities called desert crusts.
* These consist of cyanobacteria and associated commensalistic microbes, including Anabaena, Microcoleus, Nostoc, and Scytonema.
* An important microorganism found in heated mining wastes is Thermoplasma. These soils are populated by bacterial and archaeal procaryotes, many of which are chemolithoautotrophs.
* Soil microorganism and human health:
* Humans are in constant contact with soils. This occurs directly as when children or adults play in the “dirt,” or even when leafy and root vegetables, covered with soil dust, are eaten. In most cases the contact with soil is harmless.
* However, soils do contain a wide variety of pathogenic organisms. What is needed is an entry point and favorable conditions within or on the human body. A wide variety of anaerobes, including Clostridium, are present in soils.
* Soils contain other pathogens. Organisms such as Acanthamoeba, which can be inhaled from dust, may cause primary amebic meningoencephalitis.
* When soils are used for surface disposal of human wastes without sewage treatment, the transmission of a wide variety of pathogens, including protozoa such as Acanthamoeba and Cyclospora can occur.
* Soil and soil-related microorganisms also are of concern when they grow in buildings. This increasingly common problem, often linked to the flooding of houses located in low-lying districts or to moisture accumulation in sink and bathroom areas (even in large and modern homes), has led to major health problems.
* The major responsible fungi are Stachybotrys chartarum, Eurotium herbariorum, and Aspergillus versicolor. Fungal growth results in a black slime; when this fungal growth dries, a dry dusty layer remains and the spores can be dispersed into the air.
* These spores are particularly dangerous for infants, whose lungs are less developed.

Q3: Write a detail note on the following:

1. Commensalism:

* Commensalism is a type of symbiosis, which a biological relationship in which one species benefits from the interaction, while the host species is neither positively nor negatively affected.
* When the commensal is separated from its host experimentally, it can survive without being provided some factor or factors of host origin.
* Commensalistic relationships between microorganisms include situations in which the waste product of one microorganism is the substrate for another species.
* Commensalism also is important in the colonization of the human body and the surfaces of other animals and plants.

Examples:

* Mites: Mites may be the ultimate commensals. These tiny arachids live on the bodies or in the nests of hundreds of species (including humans), notably demodex filliculorum which is probably on your skin.
* Hermit crabs: Hermit crabs are an example of metabiosis, a type of commensalism in which one organism creates an environment suitable for another. These crab lives inside the shells of dead snails. Obviously the snail is unaffected, the crab gains shelter.

1. Predation:

* Predation is a widespread phenomenon where the predator engulfs or attacks the prey,
* The prey can be larger or smaller than the predator, and this normally results in the death of the prey.
* Predation is also known as positive/negative interaction.
* There are 5 types of predation;
* Herbivores
* Carnivores
* Insect parasitoids
* Parasites and disease
* Cannibalism.

Example:

* Lion and zebra
* Bear and fish
* Fox and rabbit.

Q4: Write a detail note on microbial habitats and function.

Ans: Microbial habitat and function:

* Microbes are found in almost every habitat.
* They incredibly diverse grow in environment from very cold very hot.
* They are also tolerant to many conditions like water availability, salt content, and low oxygen.
* Not every microbe can survive in every habitat.

Aquatic microbial habitat:

* Communities of organisms that are dependent on each other and their environment live in aquatic ecosystem.
* Microbes live in both fresh and salt water.
* These organisms include microscopic plants and animals as well as bacteria, fungi and viruses
* The temperatures within which microorganisms function is aquatic environment ranges from 5to15˚c at the lower range, to at least 11.3˚c.
* Examples are bacteria, cyanobacteria, algae, protozoa etc.

Types:

* Freshwater habitat (rivers, lakes and ponds)

Protobacteria, actinobacteria, cyanobacteria and bacteroidetes are present are present in this habitat.

* Marine habitat (oceans and seas)

Include all bacteria, archea, and most protozoa. Certain microscopic animals such as rotifers and copepods.

* Coastal habitat (region where the land meet the sea).

Q5: Define the following terms.

1. Phytoplankton:

* Phytoplankton is microscopic, photosynthetic organisms that live in the water of the oceans and bodies of freshwater.
* The word phytoplankton comes from the Greek word which means “drifting plants”.
* The most abundant organisms occurring within the phytoplankton are bacteria and blue-green algae.

1. Virioplankton:

* Virioplankton are an important part of the aquatic microbial community.
* They may influence the functioning of the microbial loop, be involved in horizontal gene transfer between procaryotes, and control microbial community diversity.

1. Barophiles:

* A barophiles is an organism that grows in high-pressure environments.
* Barophiles are a type of an extremophile.
* An example of barophiles is Gram-negative protobacterium

1. Epilimnion:

* The Epilimnion is the top-most layer in the thermally stratified lake, occurring above the deeper hypolimnion.
* It is warmer and typically has a higher PH and higher dissolved oxygen concentration.

1. Thermocline:

* A thermocline is a thin but distinct layer in a large body of fluid in which temperature changes more rapidly with depth.
* This prevents the mixing between the surface waters and those beneath the thermocline.