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RESEARCH ARTICLE

MICROORGANISMS IN ENVIRONMENT: BOON AND BANE.

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Abstract

Microorganisms or microbes are the minute living creatures in the universe which are invisible to the naked human eye, and are only visible with the help of a compound microscope. Microorganism is a broad term consisting of bacteria, microscopic fungi or moulds, protists and even viruses. Virus are even smaller than bacteria and are considered to be non-living beings, still their disease causative action includes them in the compass of microorganisms. Since ages, all these microbes were considered only to be harmful to human and animal life in particular and to the overall environment in general. But research in last few decades has proved that these microbes are actually helpful in maintaining the ecological balance in the environment by their important role in breaking down the dead organic matter to their basic constituents, thus returning it to earth's crust for possible recycling. This paper discusses the types of microorganisms and the damaging as well as the helpful role played by their different classes.

Introduction:-

Microorganisms or microbes are unicellular organisms which are only visible with the help of a compound microscope. Bacteria, microscopic fungi and moulds, protoctists and even virus are included under this broad term. Viruses are the smallest of all microbes and are actually non-living, but are included under the term microbes due to their functional role in causing of diseases that affect humans and animals alike. There are lakhs of species of microbes in our environment, out of which only 5 %, amounting to some 160000 known species to be identified so far. These microbes have a vast genetic diversity which is due to them being in existence and evolution as the first life on planet earth even before the existence of any plant or animal life. These microbes have an unique capacity to exist, live and thrive in all types of environment on earth. Some species of bacteria are able to survive in hot water springs up to 90 °C, while others have the capacity to thrive in the extreme colds of Antartica. Microorganisms are also known to live in extreme environments like highly alkaline pH soda lakes, and places of high concentration of heavy metals and sulfur, where all other life can never survive.

Microorganisms are basically of two types: beneficial microorganisms and harmful microorganisms. Microorganisms are broadly classified according to their nature and action. Many microorganisms are of great importance to the environment due to their beneficial capabilities without which any other life will not be able to survive. Some microorganisms are harmful to other life due to them being causative agents for various diseases that affect both humans and animals. Some organisms which are helpful in nature due to their saprophytic decomposing

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action in breaking down dead organic matter are also equally responsible for their damaging role in the spoilage of food and rotting of materials like wood, textiles, paper, and all other natural products[13].

Harmful Microorganisms:-

These microorganisms, also known as Pathogens, cause an unintended decay of organic matter due to which the physical characteristics and properties of the materials undergo a permanent change, and may render them useless. They are also known as Germs or Bugs in non-scientific terminology. Each of a pathogen is responsible for causing a particular disease. Those disease causing pathogens which are transmitted from one host to the other are known as infectious pathogens. Non-infectious diseases caused by pathogens are skin allergies, mental problems and carcinoma.

There are basically four different types of organisms in this group of harmful microorganisms. The following table describes each type of the organism and their detrimental role in propagation of diseases or unintended decay of organic matter:

Sr.	Type of Organism	Detrimental Role in Causing Diseases like
1	Bacteria	Cholera, Dysentery, Diptheria, Tuberculosis, Gangrene, Tetanus, Meningococcal meningitis, Plague and Pneumonia
2	Virus	Rabies, Influenza or Flu fever, Measles, Mumps, Polio, Chicken pox, Warts
3	Protoctists	Amoebic dysentery, Malaria, Giardiasis
4	Fungi	Ring worms

Some of these pathogens need vectors like water, air, mosquitoes, house flies and small rodents like rat for the spread of diseases. Typhoid and Cholera caused by water borne pathogens. Common colds and flu are caused by air-borne pathogens which are contained in the moisture in air, whereas mosquitoes and rodents are responsible for causing diseases like malaria and plague respectively. House flies are responsible for transmitting pathogens from dirt and feces to food and edible items[3, 12].

Human body has an inherent immune system which resists the affliction of many infectious diseases due to the presence of antibodies in our blood which attack the foreign bodies known as antigens entering the system. Wide therapeutic measures like vaccination, immunization are employed to prevent and cure these pathogenic diseases. Diseases like diphtheria, polio, measles are curbed by such immunization programs.

Antibiotics are used for the treatment of bacterial infections. Penicillin has been the first antibiotic discovered by Alexander Fleming. Recent years has shown that host resistance is a phenomenon in which the bacteria develop immunity towards the antibiotic drug. Antiseptics are directly applied on to the wounds and sores. Disinfecting agents are employed to destroy the microorganisms in the surrounding environment. Fungicidal agents are used to control fungal microorganisms like ringworms[12].

Some of the types of pathogens responsible for causing different diseases are[16]:

Sr.	Type of Microorganism	Name of the Microorganism	Disease caused
1	Bacteria	Bordetella pertussis	Whooping cough
2	Bacteria	Yersinia pestis	Plague (Bubonic)
3	Bacteria	Mycobacterium tuberculosis	Tuberculosis
4	Virus	Rhinovirus	Cold
5	Virus	Varicella zoster	Chicken pox
6	Virus	Rubella	German measles
7	Protoctists	Plasmodium falciparum	Malaria
8	Fungi	Trichophyton rubrum	Ring worm
9	Fungi	Trichophyton mentagrophytes	Athlete's foot

Microorganisms Useful in the Environment:-

a) Microorganisms Functioning as Organic Decomposers:-

Some bacteria and fungi are saprotrophic, playing a prominent role of degrading agents in the ecosystem. They break down the dead organic plant and animal matter to the basic products, returning back in to the soil. The dead plant matter includes leaves, trees, fruits and the dead animal matter is of the carcass of dead animals and human

beings which are buried in the soil. All these dead matter contains Carbon, which is used by the bacteria and fungi for their growth to some extent, and the rest of the carbon is released in the environment in the form of carbon dioxide by respiration. These break down materials act as nutrients for the growing plants and animals. This cycle is continuous and goes on repeating on and on for the ultimate sustenance of all living beings in particular and conservation of the environment in general[1].

b) Nitrogen Fixing Bacteria:-

Nitrogen is an essential component of all proteins. Nitrogen is present as an inert gas in air to an extent of 79 %. Plants and animals need nitrogen for their growth which is directly inaccessible from the air. But the Nitrogen Fixing Bacteria are able to convert nitrogen gas from the air into nitrogen compounds, which are ultimately used by the plants in combination with photosynthesis and herbivores for their growth by making proteins. Carnivores obtain the necessary nitrogen from the herbivores they eat. Some nitrogen fixing bacteria are found to be free living in the soil, while others are present in the root nodules of some plants belonging to the legume family like beans, clover and peas. These nitrogen fixing bacteria need carbohydrates for their growth which is obtained from the plants[1].

Sulphur and Phosphorus are the two basic minerals found in the earth's crust. Microbial activity inside the soil is able to release and make these two elements available for living organisms as a source of nutrition[18]. The enhanced microbial activity and availability in the rhizosphere is mainly due to an uncontrolled leakage or controlled exudation of organic substances like malate, citrate or oxalate. Plants are a nutrient hotspot in terms of Carbon, as by photosynthesis they provide up to 40 % of the fixed CO_2 to the microbes[15]. In return, microbes supply the plant with Nitrogen, Phosphate and other necessary nutrients required for their growth and also provide protection against herbivores or parasites[18].

c) Nitrifying Bacteria:-

Nitrifying bacteria are minute chemolithotrophic organisms of species belonging to the genera like *Nitrosomonas*, *Nitrococcus*, *Nitrosococcus* and *Nitrobacter*. These bacteria are able to grow by the energy obtained from the oxidation of inorganic nitrogen compounds. These species of bacteria possess a complex internal membrane system, which acts as a site for the main enzymes to catalyse the nitrification process. Examples of such enzymes are: Ammonia monooxygenase and Nitrite oxireductase which oxidizes ammonia to hydroxyl amine and nitrite to nitrate respectively[15]. Dead organic and plant matter consists of different ammonium compounds, which are converted to simple nitrates by nitrifying bacteria present in the soil, which are then taken up by the living plants[1]. Nitrifying bacteria are also very helpful in the maintenance of water quality for Aqua-culture industries as nitrification is accomplished using biofilters in which the nitrifying bacteria usually coexisting with heterotrophic microorganisms metabolize the biologically degradable organic compounds.

Nitrifying bacteria are known to play a prominent role of mineralization in aquaculture. Nitrifying bacteria have an ability to survive in anaerobic environment like waste water ponds and eutrophic sediments[8]. Administration of chemotherapeutic agents in aquaculture systems has led to ulterior effects on the fish[9]. Nitrification is very important in self purification of aquaculture systems by preventing the accumulation of toxic ammonia NH_4 by converting it to nitrite NO_2 and finally to nitrate NO_3[10]. Presence of Nitrogen in the form of nitrate NO_3 is preferable for crops and plants as this form of nitrogen is very easily absorbed by them for their growth[2].

d) Denitrifying Bacteria:-

Denitrifying bacteria are important for the functioning of the nitrogen cycle by their denitrifying action. Nitrogen is the largest gas compound in the atmosphere. Their primary purpose of these organisms is to metabolise the nitrogenous compounds, with the assistance of the enzyme *nitrate reductase*, by which nitrogen gas or nitrous oxides are released from the oxides, which is helpful in energy generation[7].These bacteria present in soil break down the nitrates and ammonium compounds from the soil by converting them into nitrogen gas[1].

Denitrification is also a much needed process in order to curb the over accumulation of Nitrogen in the soil in the form of nitrate which has been observed to leach into drinking water sources in the soil and creating health hazards to humans as well as animals. Denitrifying bacteria act in anaerobic conditions by reducing nitrates to an unstable nitrous oxide, which further breaks up to release nitrogen gas in the air[2]. Bacteria of the genus Pseudomonas, and Thiobacillus species can also reduce nitrates to liberate nitrogen gas into the environment.

Industrial revolution has been responsible for the disturbance in natural carbon cycle by an abnormal release of CO_2 into the atmosphere, mainly from the burning of fossil fuel for steam and heat generation, compounded with abnormal changes of natural ecosystems, which has rendered agricultural lands infertile and unable to support any form of life. The consequences of these actions on the global climatic environment are dangerous to the ultimate survival of future generations[4, 5, 19]. The contribution of microorganisms in prevention and maintenance of these abnormal changes in the environment by regulation of the carbon cycle has been proved to be very helpful[11].

e) Microorganisms in Sewage Treatment:-

Aerobic and anaerobic bacteria are used in sewage treatment plants to breakup harmful sewage ingredients into simple less harmful products. The action of aerobic bacteria starts by decomposing of the organic matter in presence of available oxygen. On depletion of the oxygen supply, the anaerobic bacteria come into action by decomposing the organic matter into methane gas, carbon dioxide, water and other minerals. The sludge obtained after the treatment is rich in nitrates and phosphates, which is utilized as fertilizer for agricultural growth. Methane obtained from the sewage plant is collected and supplied as a house-hold fuel[9].

f) Biodegradation of Xenobiotics from Environment:-

Biodegradation of naturally occurring organic compounds follows their synthesis. In contrast, man-made compounds, also known as xenobiotics, are often refractory to degradation. Such compounds are effluents from industries containing dyes, phenols, hydrocarbons, paints etc. It also includes plastics, insecticides, pesticides, pharmaceutically active compounds, pulp and paper effluents and many more. The main reason is that they cannot be recognized by naturally present organisms and therefore do not enter common metabolic pathways. The physical and chemical characteristics of the compounds, as well as environmental factors, may influence their biodegradability. Some compounds may be transformed only in the presence of another compound which appears as a carbon and energy source[17]. Very often compounds are degraded sequentially through the activity of a series of different bacteria like species of *Pseudomonas, Escherichia, Rhodococcus, Bacillus, Morexxella, Micrococcus, Desulphatomaculum, Methanospirillium, Methanosaeta, Cyanobacteria* and *Sphingomonads* The main degraders in nature besides bacteria are some fungi like *Peurotus pulmonarius, Trichoderma haizianum* and *Saccharomyces crerevesiae*[20]. These organisms, due to their rapid rates of multiplication and great metabolic potential, are able to adapt to new substrates. Selection of degradative potent microorganisms and their successive adaptation to a naturally persistent compound might be a powerful means for environmental detoxification. Although numerous laboratory experiments have given positive results, very few are applicable on a large scale. It is necessary to select microorganisms or microbial communities capable of controlled degradation of persistent organic chemicals without their transformation to other, more hazardous compounds[17, 20].

Conclusion:-

The general concept that any and all microorganisms are harmful to human life which was traditionally passed on through generations has been proved totally wrong by different researchers since last few decades. Harmful microorganisms need to be curbed by adopting different preventive and chemotherapeutic measures; but at the same time the better potential of microorganisms can be easily tapped to improve the life style of human beings in particular and the overall environment in general.

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