Chapter 5

SUMMARY
Unlike the early days of mankind, industrialisation as a part of human civilisation resulted in pollution. Now scientists are seeking ways to solve the severe problem of pollution. Microbial biotechnology offers a great hope to alleviate the problem caused by industrialisation.

There has been increasing concern over dangerous levels of heavy metals contaminating the aquatic environment and sources of potable water. The specific problem associated with heavy metals is their accumulation in food chain and persistence in nature. The ability of microorganisms such as yeast, bacteria and algae to accumulate heavy metals from the environment has long been observed. The microbe by virtue of its widespread occurrence and interaction with various fields of sciences, is an excellent tool for ventures in bioremediation of heavy metals of heavy metal contaminated sites. Further the escalating cost of polluted water treatment by chemical ways has directed man's attention towards the potential of microbial processes.

The major disadvantage in using microorganisms in the clean up process is the disruption of metabolic pathways causing the organism to enter the stationary phase. However microorganism when subjected to prolonged treatment have been found to develop resistance. In this context widely publicised 1981 patent awarded to Anand Chakrabarty is significant in being the first man made organism. To date the use of genetically modified organisms for metal bioremediation has been limited. So attempts were made to identify an organism which can remove heavy metals very effectively.
Metal tolerant strains of nitrogen fixing cyanobacteria have been isolated and can be deployed for heavy metal bioremediation and as biofertiliser in metal contaminated fields as they provide a temporal and spatial separation of heavy metals. In effluent treatment of large fields, dead biomass have some disadvantages as it may be difficult to get desired amount of material for large scale effluent treatment. So fast multiplying microorganisms as such or immobilised on substrates are suitable for application in various environments: contaminated rivers, coast lines, marine environments, process waste streams or storage tanks. We have limited our studies on bench scale. But the organism can be made fast multipliable on suitable modification of environmental conditions.

Bioremediation offers one of the several strategies for removing heavy metal contamination problems arising from human consumption and industrial pollution. The chemical reaction involved in metal microbe interaction can be divided into four or five distinct processes viz. intracellular accumulation, cell wall associated metals, extra cellular immobilisation, siderophore metal interaction, volatilisation and transformation of metals. In the present study kinetics of metal uptake by cyanobacteria is also envisaged. Cyanobacteria exist naturally in immobilised state and float on the surface of water with the help of gas vacuoles. This makes the possibility of harvesting cyanobacteria from polluted water and recovering the accumulated heavy metals with the help of suitable processes.

During the course of evolution cyanobacteria have successfully colonised wide range of ecosystem. They are known to have survived
a wide spectrum of environmental stresses. The mechanism of toxicity and tolerance to heavy metals and other stresses are debated widely. Toxicity mechanism can be classified as damage to DNA, protein or cell membrane. Stress induced gene activation and protein synthesis have been observed in plants, microbe and animals. No consensus has been arrived at the mechanism, which govern gene expression during heavy metal stress. Free radicals are one of those chemical entities which have high reactivity. The production of free radicals due to heavy metal toxicity is therefore an important mechanism through which heavy metals cause damage and elicit cellular response at the molecular level.

Adaptive processes under stressed condition include osmoprotective compounds, enhanced photo system activity, activation of ion export systems and synthesis of stress proteins. Strategies like transposon induced mutagenesis can lead to isolation of heavy metal resistant mutants. This strategy is restricted to genes that encode proteins essential for adaptive process.