Programme: M.Sc. (Marine Microbiology)

Course Code: MMO 104

Title of the Course: MARINE POLLUTION AND MICROBIAL REMEDIATION [T]

Number of Credits: 3

Effective from Academic Year: 2018-19

Prerequisites	It assumed that students have basic knowledge about marine environment and marine pollution.	
Objective:	This course develops concepts of Marine pollutants and their sources, Impacts of pollution on marine ecosystems and community structure, Biomonitoring and bioremediation of marine pollutants.	
Content:		
1.	**Coastal, estuarine and marine hazards**	**(12)**
1.1	**Marine pollutants and their sources** Oil spills, tar balls, heavy metals (Hg, Cd, Pb, Fe), metalloids (arsenic, selenium, tellurium), organo metal (Tributyl tin), radioactive waste, deep sea mining, ballast water, domestic sewage, industrial wastes, hotels along coastal belt, medical waste, inorganic nutrients (Fe, nitrate, phosphate) runoff from agricultural land (fertilizers and pesticides) into marine environments, nanoplastics.	
1.2	**Persistent organic pollutants in marine/coastal waters** Polyaromatic hydrocarbons, pesticides.	
1.3	**Coastal Environment related legislation in India** Marine parks, sanctuaries, mangroves, coral reefs.	
2.	**Impacts of pollution on marine ecosystems and community structure**	**(12)**
2.1	Eutrophication, anaerobiosis, biomagnification, biofouling, bioadhesion, biocorrosion.	
2.2	Effect of marine pollutants on productivity and sustainability of marine econiche:	
A.	Effect of marine pollution (toxicity) on phytoplankton, zooplankton, fishes, coral reefs, mussels, humans.	
B.	Environmental impact assessment (EIA).	
C.	Application of marine microorganisms towards pollution abatement and sustainable development.	
2.3	Effect of marine pollution on humans: Minamata, *itai itai* diseases, neurological disorders, reproductive disorder, carcinogenesis and teratogenic effects.	
3.	**Biomonitoring and bioremediation of marine pollutants**	**(12)**
3.1	Biomonitoring; Bioindicators –microbes, biotracers and biosensors. Quorum sensing	

3.2	Bioremediation	
A.	Bioremediation of metals mediated by marine microbes: Heavy metal resistant microbes from coastal waters, solar salterns, marine sediments hydrothermal vent and marine microbes associated with bivalves and sponges. Marine bacteria/fungi/archaea which can be harnessed for bioremediation technologies e.g. Efflux mechanism, intracellular bioaccumulation, extracellular sequestration and surface biosorption, bioprecipitation, biotransformation and redox reaction, volatilization.	
B.	Biodegradation: Bioremediation of hydrocarbons in marine environments, oil spill/ tar ball management. Biodegradation – reactions, enzymes and pathways. Biosurfactants (bioemulsifier), cometabolism, bioaugmentation, biostimulation.	
C.	Waste water treatment plants: Primary, secondary and tertiary treatment of waste water from industries and hotels before discharging into marine waters.	
D.	Microbial consortia: Applications in bioremediation of heavy metals and crude oil from polluted marine sites.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Cavera, J. H., Karl, D. and Buckley, M., Marine Microbial Diversity: Key to Earth's Habitability, ASM Press.	
	Mitchell, R. and Kirchman, D. L., Microbial Ecology of the Oceans, Wiley Publishers.	
	Belkin, S. and Cowell, R. R., Ocean & Health: Pathogens of the Marine Environment, Springer Publishers.	
	Meller, C. and Wheeler, P.A., Biological Oceanography, Wiley Publishers.	
	Satyanarayana, T., Johri, B. and Anil, T., Microorganisms in Environmental Management, Springer Publishers.	
	Prince, R. C., Bioremediation of Marine Oil Spills. In: Handbook of Hydrocarbon and Lipid Microbiology, Springer Publishers.	
	Judith, S.W., Marine Pollution: What Everyone Needs To Know. Oxford University Press.	
	Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y.	
	King, R. B., Sheldon, J. K. and Long, G. M. (1997) Practical Environmental Bioremediation: The Field Guide, Lewis Publishers.	
	Kennish, M. J. (1996) Practical Handbook of Estuarine and Marine Pollution. CRC Press, Francis and Taylor.	
	Naik, M. and Dubey, S. K., Marine Pollution and Microbial Remediation, Springer Publications.	

	Naik, M. M. and Dubey, S. K. (2013) Lead resistant bacteria: Lead resistance mechanisms, their applications in lead bioremediation and biomonitoring. Ecotoxicology & Environmental Safety, 98: 1-7.	
Learning Outcomes	1) Explains concept of Marine pollutants and their effect on marine biota and humans. 2) Application of marine microorganisms towards pollution abatement and sustainable development.	