Name of the Programme: M.Sc. Biotechnology

Course Code: GBT-625

Title of the Course: EMERGING TRENDS IN WASTEWATER TREATMENT

Number of Credits: 2

Effective from AY: 2022-23

Pre-requisites for the Course:	Basic knowledge in Microbiology or Environmental Science or Environmental Technology	
Course Objectives:	The primary objectives of the course are as follows: 1) Reinforcing the basic tenets of microbial treatment of wastewaters and waterborne pathogens (source, fate and factors affecting their survival in the environment). 2) Understanding the advantages and disadvantages between centralized wastewater systems, decentralized systems and onsite systems and appropriate application of each of these systems. 3) Understanding of emerging and novel biological treatment technologies and how these technologies need to be modified to address site specific conditions. 4) Gain insights into the use of biological treatment processes used to recover valuable constituents or produce valuable products from wastewaters. 5) Understanding of microbial or molecular based technologies used to monitor for the presence, sources and types of contaminants discharged in complex wastewater mixtures.	
Content:	**MODULE I** **Global Water Crisis** Overall trends and challenges in the treatment of wastewaters and provide an overview of water demands from a Global and India centric perspective. Issues and questions: • Consumption v/s supply; how does the treatment of water help to ensure a renewable and sustainable water resource • The major wastewater impacts on ecosystem integrity and human health. • Areas requiring treatment in India. • Major sector treatment issues (industrial,	**No. of hours** 15

	agricultural, domestic) • Impact of increasing complexity in the composition of wastewater on treatment strategies • Challenges in treatment of wastewater **<u>Decentralized Wastewater Treatment Systems</u>** The major drivers for decentralized systems: • Economics of decentralized systems v/s centralized systems. • Logistical Challenges: Impacts relating to urban sprawl and difficulty in connecting newly developed areas to centralized systems • Complexity and Site Specific Treatment Needs: Flexibility of decentralized systems. • Difference between decentralized and on-site systems: in terms of size and the transport and treatment of wastewaters **<u>Conventional Biological Treatment Processes</u>** • Overview of conventional biological treatment processes and commonality amongst centralized and decentralized systems dealing with the treatment of wastewaters and solids. • The efficacy and challenges associated with the use of biological treatment for major classes of wastewater constituents. • Examination of common biological treatment strategies associated with different domestic, agricultural, industrial and manufacturing sector needs. • Treatment Platforms: Review of treatment processes that are generally incorporated within a technology (e.g., fixed film biological treatment incorporated into a technology like a rotating biological contactor) • Hybrid systems and different treatment platforms nested with a hybridized system in order to develop a customized treatment strategy designed to deal with a specific suite of	

	contaminants (e.g. a hybridized system that combines fixed biological films with phytoremediation to acquire polished effluent). • Overview of case studies demonstrating hybridized decentralized approaches. • Use of wetland for effective treatment of domestic wastewaters.	
	MODULE II Emerging technologies and integration of nanotechnology to enhance biological performance. • Microorganisms utilized: bacteria, fungi and algal groups. • Bioaugmentation techniques designed to improve the biodegradation of contaminated soils and waters through the actions of microorganisms: - Autochthonous bioaugmentation - Allochthonous bioaugmentation - Gene bioaugmentation • Techniques for the treatment of a wide range of pollutants ranging from polycyclic aromatic hydrocarbons, nitrophenols, polychlorinated biphenyls, chlorophenols, crude oil, diesel oil, textile dyes and several pesticides. • Hybridized treatment systems integrating emerging biological treatment technologies with emerging nanoparticle applications. Integration systems range from the use of nanotechnology in the oxidation or sequestering of wastewater constituents that could harm or impede the function of downstream biological treatment, to the incorporation of biocide nanoparticles into compound membranes to prevent biofouling of the membrane or to inactivate waterborne pathogens. • Standardized test protocols or standardized operating procedures of these technologies. • Modification required in these technologies to	15

address site specific conditions.

- Unique opportunities existing to address difficult or unusual treatment challenges.
- Seaweeds/macroalgal wastewater treatment
- Examining factors such as the maturity and reliability of the technology and a discussion of factors such as wastewater constituents, site conditions, cost factors and time that influence the applicability and suitability of the technology.

Resource Recovery from Wastewaters

- An overview of the use of biological treatment processes used to recover valuable constituents or produce valuable products from wastewaters
- The recovery of valued nutrients such as nitrogen and phosphorus, to valued elements and metals, to the generation of energy though microbial fuel cells or the generation of biogas.
- Integration of nutrient recovery steps such as Microbial Electrochemical Cell (MEC) to recover valuable nutrients in treatment technologies
- Novel composting methods such as *terra preta* of the sludge (biomass) generated after treatment for increasing soil fertility

Environmental Monitoring

- Review and discussion of microbial and molecular based technologies.
- Types of testing.
- Application of biomarkers; advantages and limitations.

Types of biomarkers used for environmental monitoring:

- Ames *Salmonella* mutagenicity assay
- Microtox using bioluminescent bacteria
- Vitellogenin
- DNA adducts
- Sister chromatid exchange
- Aryl hydrocarbon ethoxylase (AHH)
- Ethoxyresorufin – o – deethylase (EROD) assay
- Yeast based endocrine toxicity assays (YES)

	- Other ELISA based tests	
Pedagogy:	Lectures, tutorials, assignments	
References/ Readings:	1. A. K. Chaterjee, Introduction to environmental biotechnology. PHI, India, 2000. 2. M. Colin, Marine Microbiology: Ecology and applications. Second edition. Garland science, 2012. 3. T. Satyanarayana, B. Johri, and T. Anil, Microorganisms in Environmental Management, Springer Publishers, 2012. 4. M. J. Kennish, Practical Handbook of Estuarine and Marine Pollution. CRC Press, Francis and Taylor, 2019. 5. R. B. King, J. K. Sheldon, and G. M. Long, Practical Environmental Bioremediation: The Field Guide, Lewis Publishers, 1998. 6. S.M. Meena, and M.M. Naik, Advances in Biological Science Research: a practical approach. Elsevier, 2019. 7. M. Prabhu, Resource recovery from wastewaters for sustainable development. 2016.	
Course Outcomes:	At the end of this course, students will be 1. able to understand the basic tenets of biological wastewaters treatment, the advantages and disadvantages between centralized and decentralized systems. 2. able to gain insights into the processes to recover or produce valuable products from wastewater. 3. able to understand emerging treatment strategies that combine both conventional biological approaches with emerging technologies in hybridized systems 4. exposed to how biological monitoring can be integrated with water quality monitoring to enhance our understanding of how wastewaters are impacting ecosystem health.	

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