



CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025-26/347 dated 20.08.2025

In supersession to the above referred Circular, the syllabus for Semester III and IV of the **Master of Science in Marine Microbiology** Programme approved by the Standing Committee of the Academic Council in its meeting held 24th & 25th November 2025, is attached.

Further, the Syllabus of Semester I and II approved earlier by the Standing Committee of the Academic Council in its meeting held on 24th & 25th June 2025 is also attached.

The Dean & Vice-Dean (Academic) of the School of Earth, Ocean and Atmospheric Sciences are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, School of Earth, Ocean and Atmospheric Sciences, Goa University.
2. The Vice-Dean (Academic), School of Earth, Ocean and Atmospheric Sciences, Goa University.

Copy to:

3. Chairperson, BoS in Marine Microbiology, Goa University.
4. Programme Director, M.Sc. Marine Microbiology, Goa University.
5. Controller of Examinations, Goa University.
6. Assistant Registrar Examinations (PG), Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY
MASTER OF SCIENCE IN MARINE MICROBIOLOGY
(Effective from the Academic Year 2025-26)

ABOUT THE PROGRAMME

The School of Earth, Ocean and Atmospheric Sciences (SEOAS) offers a two-year full time M.Sc. Marine Microbiology program. This Program was initiated in June 2012, under the award of UGC sponsored 'Innovative Program for teaching and research in interdisciplinary and emerging areas'.

The Program is meant for students to pursue higher studies in Marine Microbiology. Being an University in coastal state of India, Goa University provides a strategic advantage in learning microbiology of marine and coastal ecosystems. It serves to impart advanced training to students in the field of Marine Microbiology with focus on marine microbial diversity, bioprospecting and applications of marine microbes in the production of various biologically significant metabolites; and in bioremediation of polluted environments. Students undergo hands-on training with state-of-the art technologies and are trained so as to develop an aptitude for independent research. The Program equips students for higher research leading to the Ph.D. degree in India or in International Universities overseas, or for employment in Research Institutes, in teaching, and in Industry, the students finding speedy employment.

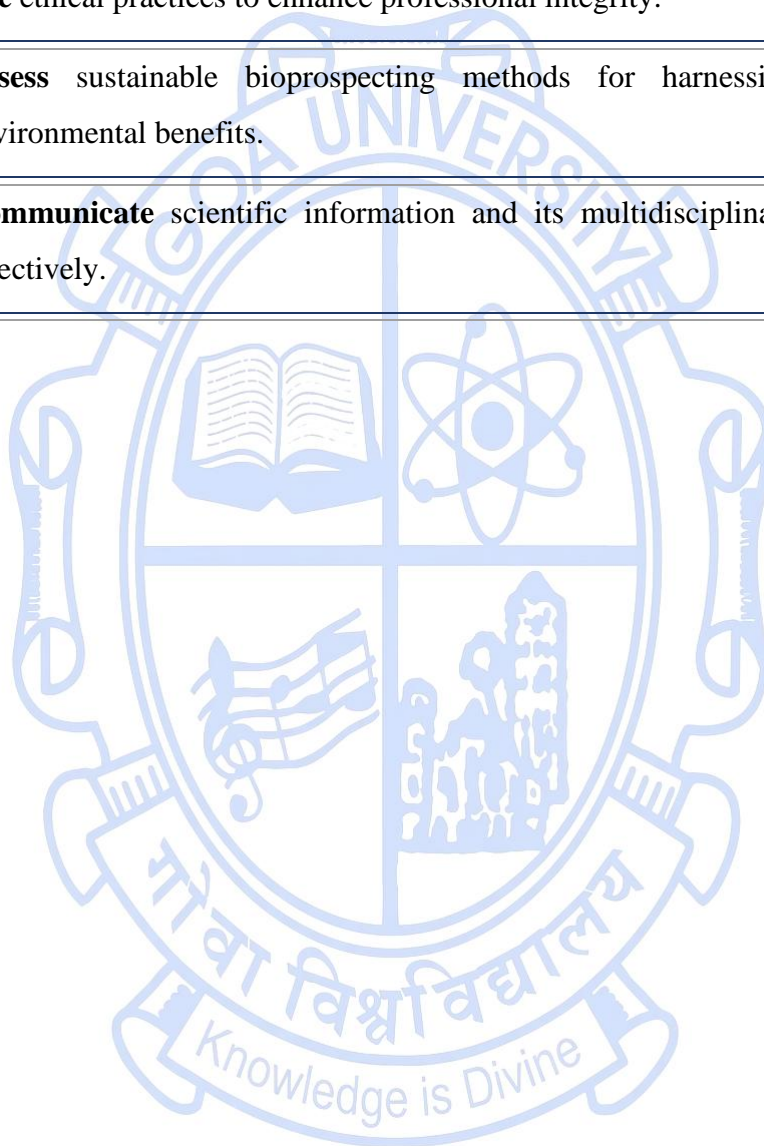
Eligibility: Bachelor's degree in Life Sciences subjects (Microbiology, Biotechnology, Biochemistry, Zoology, Botany, Marine Biology, and Biological Science), Marine Science, and Environmental Science.

OBJECTIVES OF THE PROGRAMME

- The programme is designed to offer comprehensive knowledge of the diverse aspects of microbiology within marine ecosystems.
- Fieldwork and laboratory studies will enable students to explore various marine habitats and understand their conservation. Through hands-on sampling, laboratory analysis, and data interpretation, students will develop essential skills in scientific inquiry and effective communication of their findings.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO 1.	Gain in-depth knowledge on various aspects of microbiology in marine ecosystems.
PSO 2.	Develop analytical skills in marine microbial diversity and ocean systems.
PSO 3.	Use ethical practices to enhance professional integrity.
PSO 4.	Assess sustainable bioprospecting methods for harnessing social and environmental benefits.
PSO 5.	Communicate scientific information and its multidisciplinary implications effectively.



PROGRAMME STRUCTURE
Master of Science in Marine Microbiology
Effective from Academic Year 2025-2026

Bridge Course				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<u>MMI-1000</u>	Introductory Microbiology and Microbial Techniques	2	100

Semester I				
Discipline Specific Core (DSC) Courses (16 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<u>MMI-5000</u>	Concepts in Oceanography	3T	400
2	<u>MMI-5001</u>	Practicals in Oceanography	1P	400
3	<u>MMI-5002</u>	Microbial Biochemistry	3T	400
4	<u>MMI-5003</u>	Practicals in Microbial Biochemistry	1P	400
5	<u>MMI-5004</u>	Microbial Taxonomy and Systematics	3T	400
6	<u>MMI-5005</u>	Practicals in Microbial Taxonomy and Systematics	1P	400
7	<u>MMI-5006</u>	Biostatistics	3T	400
8	<u>MMI-5007</u>	Practicals in Biostatistics	1P	400
Total Credits for DSC Courses in Semester I			16	
Discipline Specific Elective (DSE) Course (4 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	<u>MMI-5201</u>	Estuarine Ecosystems and Microbes	3T	400
2	<u>MMI-5202</u>	Practicals in Estuarine Ecosystems & Microbes	1P	400
3	<u>MMI-5203</u>	Microbial Pathogens of Fish and Shellfish	3T	400
4	<u>MMI-5204</u>	Practical in Microbial Pathogens of Fish and Shellfish	1P	400
5	<u>MMI-5205</u>	Marine Mycology	3T	400
6	<u>MMI-5206</u>	Practicals in Marine Mycology	1P	400
Total Credits for DSE Courses in Semester I			4	
Total Credits in Semester I			20	

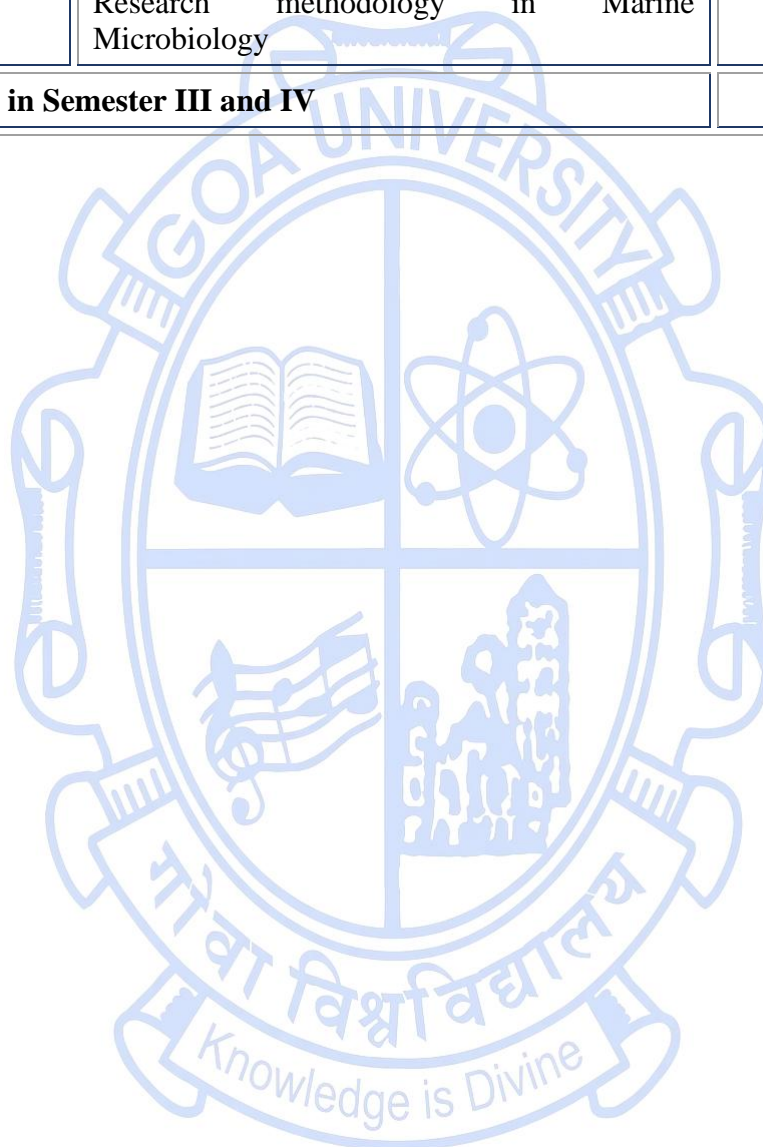
Semester II				
Discipline Specific Core (DSC) Courses				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-5008	Industrial Microbiology	3T	500
2	MMI-5009	Practicals in Industrial Microbiology	1P	500
3	MMI-5010	Microbial Genetics	3T	500
4	MMI-5011	Practicals in Microbial Genetics	1P	500
5	MMI-5012	Microbial Ecology	3T	500
6	MMI-5013	Practicals in Microbial Ecology	1P	500
7	MMI-5014	Analytical Techniques in Microbiology	3T	500
8	MMI-5015	Practicals on Analytical Techniques in Microbiology	1P	500
Total Credits for DSC Courses in Semester II			16	
Discipline Specific Elective (DSE) Courses (4 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-5207	Marine Extremophilic Microorganisms	3T	400
2	MMI-5208	Practicals on Marine Extremophilic Microorganisms	1P	400
3	MMI-5209	Marine Virology	3T	400
4	MMI-5210	Practicals in Marine Virology	1P	400
5	MMI-5211	Archaea	3T	400
6	MMI-5212	Practicals on Archaea	1P	400
7	MMI-5213	Microbial Physiology and Interactions	3T	400
8	MMI-5214	Coral Ecosystem and Associated Microbiota	3T	400
9	MMI-5215	Field Trip/Study Tour – Practical	1P	400
Total Credits for DSE Courses in Semester II			4	
Total Credits in Semester II			20	

40 Credits of Research Dissertation for Students opting for 40 Credits of Dissertation.

20 Credits of Research Specific Elective & Vocational Courses and 20 Credits of Dissertation for Students opting for 20 Credits of Dissertation.

Semester III				
Research Specific Elective (RSE) Courses (12 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-6000	Phytoplankton Ecology and Genomics	3T	500
2	MMI-6001	Practicals in Phytoplankton Ecology	1P	500
3	MMI-6002	Marine Zooplankton Ecology and Microbial Interactions	3T	500
4	MMI-6003	Practicals on Marine Zooplankton	1P	500
5	MMI-6004	Marine Microbial Prospecting and Technology	3T	500
6	MMI-6005	Practicals in Marine Microbial Prospecting and Technology	1P	500
7	MMI-6006	Microbial Growth and Enzyme Kinetics	3T	500
8	MMI-6007	Practicals on Microbial Growth and Enzyme Kinetics	1P	500
9	MMI-6008	Marine Pollution and Monitoring	3T	500
10	MMI-6009	Practicals in Marine Pollution and Monitoring	1P	500
11	MMI-6010	Seaweed Biology and Microbial Dynamics	3T	500
12	MMI-6011	Practicals in Microbiology Associated with Seaweeds	1P	500
13	MMI-6012	Research Methodology in Marine Microbiology	4T	500
Total Credits for RSE Courses in Semester III			12	
* MMI-6012 are over and above 12 credits of RSE courses				
Note: Students opting for the 3-credit RSE theory course are required to take the corresponding 1-credit practical course.				
Discipline Specific Vocational Elective (DSVE) Courses (8 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-6401	Sea Food Processing and Technology	2T+2P	500
2	MMI-6402	Genetic Engineering	2T+2P	500
3	MMI-6403	Bionanotechnology	2T+2P	500
4	MMI-6404	Bioinformatics in Marine Microbiology	2T+2P	500
Total Credits for DSVE Courses in Semester III			8	
Total Credits in Semester III			20	

Discipline Specific Dissertation (DSD) (40 Credit Dissertation)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-6501	Dissertation	32	500
		Dissertation related course by assigned dissertation supervisor	4	500
		Research methodology in Marine Microbiology	4	500
Total Credits in Semester III and IV			40	



Semester IV				
Generic Elective (GE) Courses (20 credits)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-6201	Ocean Observations and Techniques	3T	500
2	MMI-6202	Microbial Remediation in Marine Ecosystems	2T	500
4	MMI-6203	Marine Environment and Public Health	3T	500
5	MMI-6204	Probiotics and Prebiotics in Aquaculture	2T	500
6	MMI-6205	Deep Sea Microbiology	4T	500
7	MMI-6206	Blue Economy	2T	500
8	MMI-6207	Marine Drug Development and Metabolism	2T	500
9	MMI-6208	Bio-entrepreneurship	2T	500
10	MMI-6209	Interface of Cancer Biology and Marine Natural Products	2T	500
11	MMI-6210	Biosafety and Bioethics in Laboratory	2T	500
13	MMI-6211	Marine Microbiomes	2T	500
15	MMI-6212	Polar Microbiology	3T	500
16	MMI-6213	Marine Bioluminescence	2T	500
Total Credits for GE Courses in Semester IV			20	

Discipline Specific Dissertation (DSD)/ Internship (20 Credit Dissertation)				
Sr. No.	Course Code	Title of the Course	Credits	Level
1	MMI-6502	Dissertation	16	500
		Research Methodology in Marine Microbiology/ Dissertation related course by assigned dissertation supervisor	4	500
Total Credits in Semester IV			20	

BRIDGE COURSE

Title of the Course	Introductory Microbiology and Microbial Techniques
Course Code	MMI-1000
Number of Credits	2
Theory/Practical	Theory
Level	100
Effective from AY	2025-26
New Course	Yes
Bridge Course	Yes
Course for advanced learners	No

Pre-requisites for the Course:	Graduate in any science stream except Microbiology and Biotechnology	
Course Objectives:	To provide a foundational understanding of microbiological techniques in marine microbiology.	
Course Outcomes:		Mapped to PSO
	CO 1. To understand the different microbial groups	PSO 1, PSO2
	CO 2. To familiarize with microbiological techniques	PSO 1, PSO2
	CO 3. To apply microscopic techniques	PSO 1, PSO2
	CO 4. To learn microbial growth analyses methods.	PSO 1, PSO2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Binomial nomenclature; General characteristics of different groups: viruses, viroids, archaea and eubacteria, Eukarya: algae, fungi and protozoa, and prions; Bacteriological techniques: Pure culture isolation: streaking, serial dilution and plating methods; cultivation of aerobic and anaerobic, maintenance and preservation of pure cultures, colony characteristics; Sterilisation: Autoclave (moist heat), hot air oven (dry heat), pasteurization, Tyndallization, membrane filtration	15	CO1, CO2	K1, K2
Module 2:	Microscopy: Bright Field, Dark field Phase contrast, electron microscopy – SEM, TEM; stains, mordants, fixatives and decolorisers; Types of staining: Gram staining, monochrome staining and negative staining, special staining methods, differential staining methods, staining of cellular structures, motility of cells by hanging drop technique; Measurements of microbial growth: TVC, direct count, absorbance; bacterial growth curve	15	CO3, CO4	K1, K2
Pedagogy:	Lectures/assignments/self-study			
References/ Readings:	<ol style="list-style-type: none"> 1. Atlas R. M. (2020) Principles of Microbiology. 2nd Edition. WM.T. Brown Publishers. 2. Cappucino J. G. & Sherman N. (2014) Microbiology: A Laboratory Manual. 10th Edition. Pearson Education Limited 3. Madigan M.T., Martinko J.M., Dunlap P.V. & Clark D.P. (2017) Brock Biology of Microorganisms. 14th Edition. Pearson International Edition 4. Pelczar M.J., Chan E.C.S. & Krieg N.R. (2001) Microbiology. McGraw Hill Book Company. 5. Salle A.J. (2007) Fundamental Principles of Bacteriology. Dodo Press. 6. Stanier R. Y., Ingraham J.L., Wheelis M.L., & Painter P.R. (1999) General Microbiology. 5th Edition. McMillan 7. Tortora G.J., Funke B.R. & Case C.L. (2018) Microbiology: An Introduction. 13th Edition. Addison-Wesley 8. Wiley J.M., Sherwood L.M. & Woolverton C.J. (2019) Prescott's Microbiology. 11th Edition. McGraw Hill International 			

[\[Back to Index\]](#)

SEMESTER I

Discipline Specific Core (DSC) Courses

Title of the Course	Concepts in Oceanography
Course Code	MMI-5000
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide a foundational understanding of physical, chemical, geological, and biological processes in the ocean, essential for advanced studies in marine microbiology.	
Course Outcomes:		Mapped to PSO
	CO 1. Describe the physical, chemical, geological, and biological features of oceans.	PSO 1, PSO2
	CO 2. Explain the major oceanographic processes, such as currents, tides, and circulation.	PSO 1, PSO2
	CO 3. Explain the geological time scale and the composition of seawater.	PSO 1, PSO2

	CO 4. Describe the different marine habitats and explain primary and secondary productivity.		PSO 1, PSO2
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Origin of oceans - physical properties of the sea: temperature, salinity, density - mixed layer depth - ocean circulation: wind-driven and thermohaline circulation - ocean currents - water mass - Coriolis effect - upwelling - Ekman transport - tides - atmospheric circulation - albedo - land-sea breeze - Indian monsoon - El Niño - La Niña - Southern Oscillation - Indian Ocean Dipole	15	CO1, CO2 K2
Module 2:	Geological time scale - plate tectonics and seafloor spreading - sediment types - elemental composition of seawater - salinity and chlorinity - residence time of elements - dissolved gases: carbon dioxide and oxygen - nutrients - carbonate system - pH and alkalinity - calcium carbonate precipitation and dissolution - carbonate compensation depth - lysocline	15	CO3 K2
Module 3:	Habitat: estuaries, mangroves, wetlands, rocky, sandy intertidal, coral reefs, seagrass, kelps, mudflats, coastal and open ocean, hydrothermal vents - marine zonation - pelagic and benthic communities - marine photosynthesis - phytoplankton and primary production - Redfield ratio - gross and net productivity - new and regenerated productivity - f ratio - pigments - zooplankton and benthic production - measurement and control of secondary production - exclusive economic zone	15	CO4, CO5, CO6 K2
Pedagogy:	Lectures/assignments/field trip		
References/ Readings:	<ol style="list-style-type: none"> 1. Gross, M.G. (1990). Oceanography: a view of the Earth. Prentice-Hall, New York. 2. Miller, C.B. and Wheeler, P.A. (2012). Biological oceanography, Wiley-Blackwell Publishers, Oxford. 3. Munn, C.B. (2019). Marine microbiology: ecology and applications. CRC Press, Florida. 4. Pickard, G.L. and Emery, W.J. (1990). Descriptive physical oceanography: an introduction. Pergamon Press, U.K. 5. Sverdrup, H.U. Johnson, M.W. and Flemming, R.H. (1962). The ocean: their physics, chemistry and general biology, - Prentice-Hall, New York. 6. Thurman, H.V. (1988). Introductory Oceanography. Merrill Publishing, Columbus, Ohio 		

[\[Back to Index\]](#)

Title of the Course	Practicals in Oceanography
Course Code	MMI-5001
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To train students in standard oceanographic techniques for the quantitative estimation of key physicochemical and biological parameters in seawater using titrimetric and spectrophotometric methods.	
Course Outcomes:		Mapped to PSO
	CO 1. Recall the principles behind titrimetric and spectrophotometric methods used in seawater analysis.	PSO 1, PSO 2
	CO 2. Explain the significance of parameters such as salinity, pH, dissolved oxygen, nutrients, and chlorophyll <i>a</i> in marine environments.	PSO 1, PSO 2
	CO 3. Perform laboratory experiments to estimate salinity, dissolved oxygen, nutrients, and chlorophyll <i>a</i> concentration.	PSO 1, PSO 2

	CO 4. Interpret experimental data to assess the chemical and biological status of seawater samples.		PSO 1, PSO 2
Content:		No of hours	Mapped to CO Cognitive Level
1	Demonstration of sampling gears, CTD, grabs, Secchi disk	2	CO2 K2, K3
2	Estimation of seawater salinity and pH	6	CO1, CO2, CO3, CO4 K1, K2, K3, K4
3	Determination of dissolved oxygen of seawater using Winkler's method	4	CO1, CO2, CO3, CO4 K1, K2, K3, K4
4	Determination of phosphate by the spectrophotometric method	6	CO1, CO2, CO3, CO4 K1, K2, K3, K4
5	Determination of nitrate/nitrite by the spectrophotometric method	6	CO1, CO2, CO3, CO4 K1, K2, K3, K4
6	Determination of chlorophyll <i>a</i> by the spectrophotometric method	6	CO1, CO2, CO3, CO4 K1, K2, K3, K4
Pedagogy:	Experiments in the laboratory, Field visits		
References/ Readings:	<ol style="list-style-type: none"> 1. Grasshoff, K., Ehrhardt, M. and Kremling, K. (1999). Methods of seawater analysis. Verlag Chemie, Weinheim. 2. Parsons, T.R., Maita, Y. and Lalli, C.M. (1984). A manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford. 		

[\[Back to Index\]](#)

Title of the Course	Microbial Biochemistry
Course Code	MMI-5002
Number of Credits	3
Theory/Practical	T
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

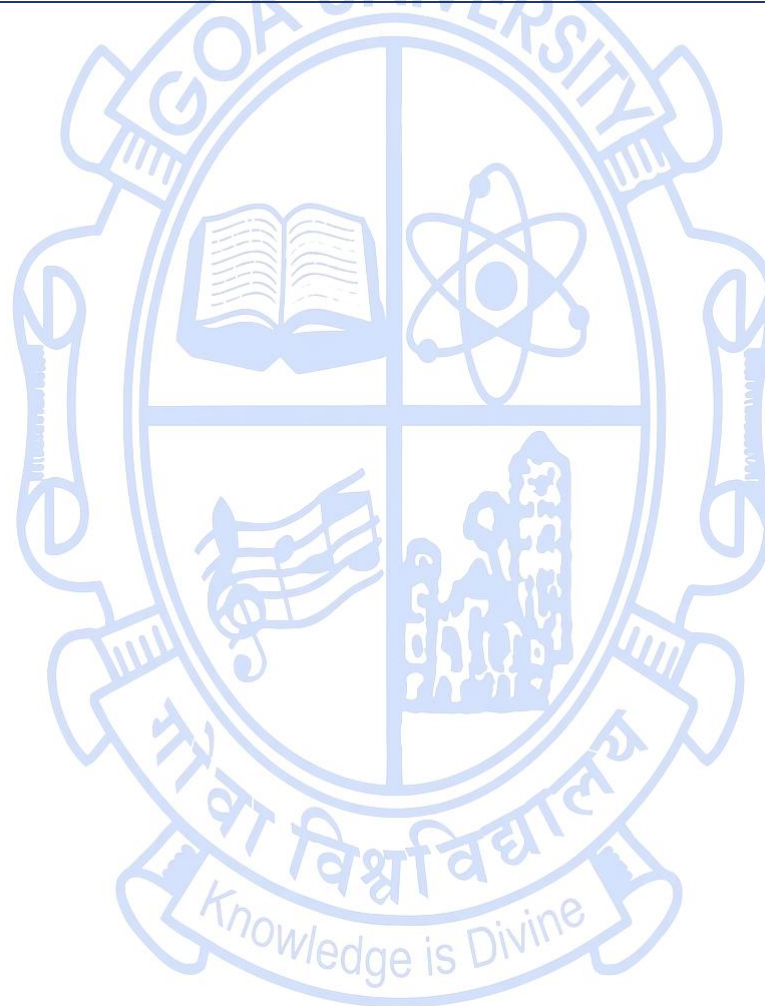
Pre-requisites for the Course:	Nil	
Course Objectives:	To provide in depth knowledge about characteristics, properties and biological significance of the biomolecules of life and energetics and regulation of different metabolic processes in microorganisms.	
Course Outcomes:		Mapped to PSO
	CO 1. Identify various biomolecules and their importance in microbial physiology.	PSO 1
	CO 2. Differentiate various metabolic pathways and study their bioenergetics.	PSO 1, PSO 2
	CO 3. Analyze the regulation of the biochemical pathways.	PSO 2, PSO 4
	CO 4. Discuss various carbon fixation pathways in marine microbes.	PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Biological Molecules: Proteins - Amino acids: features and properties. Protein structure, principles of separation and purification, molecular weight determination; sequencing and synthesis. Carbohydrates- monosaccharides, disaccharides, polysaccharides: types, characteristics, properties. Lipids - Fatty acids: saturated and unsaturated, structure and properties. Cellular composition and significance of biological molecules in microbes.	15	CO1, CO2	K1, K2
Module 2:	Metabolic pathways: Carbohydrate metabolism - Central pathways of metabolism – regulatory mechanisms, bioenergetics and significance – EMP, TCA cycle (glucose aerobic and anaerobic metabolism, malate metabolism), Glyoxylate cycle. Gluconeogenesis from TCA intermediates / amino acids / acetyl-CoA; biosynthesis of polysaccharides and sugar interconversions. Lipid Metabolism - Anabolism: Biosynthesis of fatty acids: saturated and unsaturated, triglycerides, phospholipids. Biosynthesis of nitrogenous biomolecules – Nitrogen cycle, Amino Acid and Nucleotide Biosynthetic pathway and their regulation. Deoxyribonucleotides: biosynthesis and regulation. Biosynthesis of nucleotide coenzymes.	15	CO2, CO3, CO 4	K3, K4
Module 3:	Electron Transport Chain. Mechanisms involved in Photosynthesis and Chemosynthesis: Photosynthetic Metabolism - Organisms and photosynthetic pigments, fundamental processes in Photosynthesis. Photosynthetic electron transport and photophosphorylation. Alternative pathways for carbon fixation in autotrophs: Calvin Benson cycle, Reverse TCA, Hydroxypropionate pathway. Chemosynthesis - Organisms, substrates, bioenergetics of metabolism. Osmoregulation: Salt-in cytoplasm mechanism, Organic-Osmolyte mechanism, Osmolyte transporters, Osmosensing.	15	CO3, CO4	K3, K4
Pedagogy:	Lectures/ assignments			
References/ Readings:	<ol style="list-style-type: none"> 1. Cox M.C., Freeman W.H., & Nelson D.L. (2004). Lehninger Principles of Biochemistry (4th edn), W. H. Freeman & Co. New York. 2. Foster J.W., & Spector M.P. (2002). Microbial Physiology (4th edn), A. John Wiley & Sons Inc. Publication. New York. 3. Kunte H.J. (2006). Osmoregulation in Bacteria: Compatible Solute Accumulation and Osmosensing. Environ. 			

Chem. 3: 94–99. doi:10.1071/EN06016

4. Murray R.K., Bender D.A., Botham K.M., Kennelly P.J., Rodwell V.W. & Weil P.A. (2018). Harper's Illustrated Biochemistry (31st edn), The McGraw- Hill Companies, Inc. New York.
5. Voet D., Voet J.G. & Pratt C.W. (2012). Principles of Biochemistry (4th edn), John Wiley and Sons Inc. New York.

[\[Back to Index\]](#)

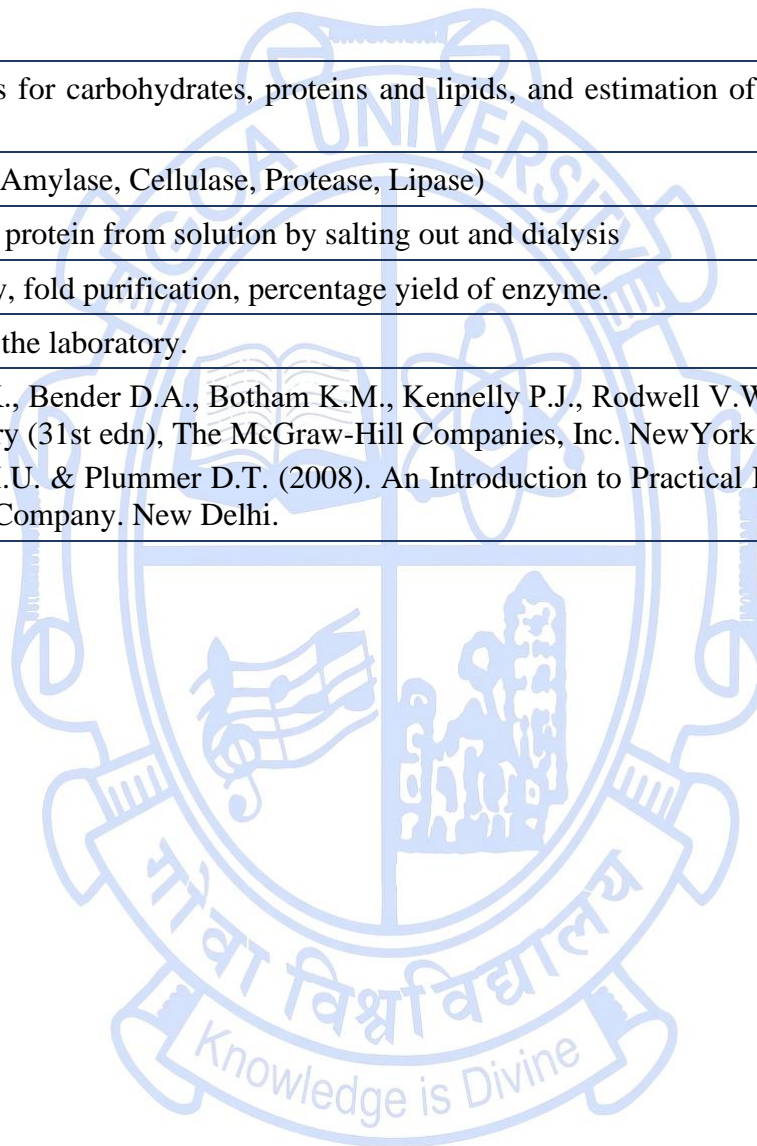


Title of the Course	Practical in Microbial Biochemistry
Course Code	MMI-5003
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course provides opportunities for hands-on experience with microbiological and biochemical concepts in laboratory setup.	
Course Outcomes:		Mapped to PSO
	CO 1. Estimate the concentration of various biomolecules.	PSO 1, PSO2
	CO 2. Analyse enzyme activity, specific activity and fold change.	PSO 2
	CO 3. Assess the efficiency of protein purification by salting out and dialysis method.	PSO 3, PSO 4
	CO 4. Design and perform experimental work on extracellular enzymes.	PSO 3, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
1	Standard curves for carbohydrates, proteins and lipids, and estimation of unknown biomolecules.	10	CO1	K4, K5
2	Enzyme assay (Amylase, Cellulase, Protease, Lipase)	8	CO1, CO2	K2, K3, K4
3	Precipitation of protein from solution by salting out and dialysis	8	CO3	K1, K2, K3
4	Specific activity, fold purification, percentage yield of enzyme.	4	CO4	K4, K5
Pedagogy:	Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. Murray R.K., Bender D.A., Botham K.M., Kennelly P.J., Rodwell V.W. & Weil P.A. (2018). Harper's Illustrated Biochemistry (31st edn), The McGraw-Hill Companies, Inc. New York. 2. Plummer M.U. & Plummer D.T. (2008). An Introduction to Practical Biochemistry (3rd edn), Tata McGraw Hill Publishing Company. New Delhi. 			

[\[Back to Index\]](#)



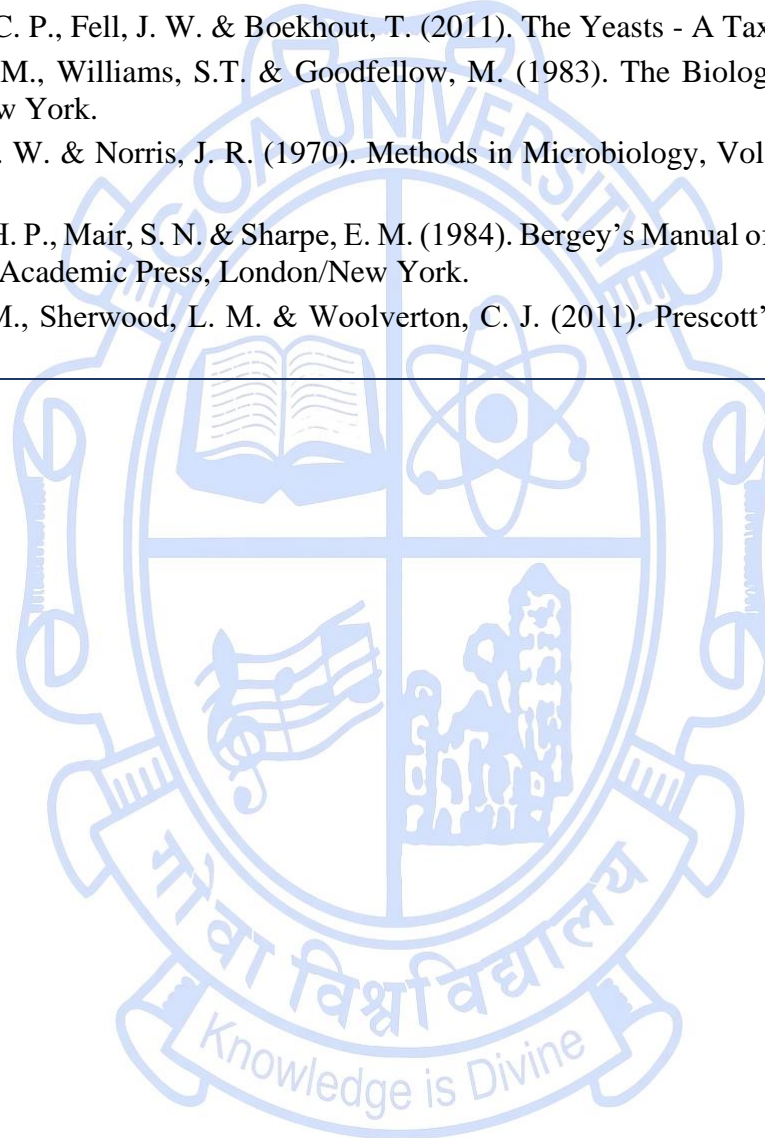
Title of the Course	Microbial Taxonomy and Systematics
Course Code	MMI-5004
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the development of taxonomy and systematics, the various characters used for this purpose, the rules governing the different taxonomy and classification systems and the salient features of the different microbial groups. It also focuses on the rapidly evolving nature of taxonomy and systematics.	
Course Outcomes:		Mapped to PSO
	CO 1. Recognize the dynamic and developing nature of the field of microbial taxonomy and systematics.	PSO 1
	CO 2. Apply knowledge of the standard rules of classification systems to categorize microorganisms.	PSO 1, PSO 2
	CO 3. Describe the recent advances in the fields of taxonomy and classification of microorganisms.	PSO 1, PSO 5

	CO 4. Evaluate the phenotypic, chemotaxonomic and genotypic analysis used in classification of different microbial groups.		PSO 1, PSO 5
	CO 5. Describe the concept of taxonomic hierarchy in different microbial groups.		PSO 1, POS 5
	CO 6. Compare the taxonomic characteristics across different microbial groups.		PSO 2, PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Concepts of taxonomy (characterization, classification and nomenclature), systematics, species, numerical taxonomy and polyphasic taxonomy. Classification of microorganisms, development of classification systems starting from two kingdom to three domain, six-kingdom and 8-kingdom systems; endosymbiotic theory for the origin of eukaryotic organelles. Traditional characters used in classification systems; phenotypic characters - Morphology, Biochemical characterization using Bergey's Manual, Bacteriophage typing, Serotyping.	15	CO1, CO2 K1, K2, K3
Module 2:	Nucleic acid-based techniques and chemotaxonomic markers used in classification systems. Nucleic acid-based techniques: PCRs, Restriction Fragment Length Polymorphisms (RFLPs); G+C content (T _m and HPLC); pyrosequencing; 16S rRNA, 18S rRNA and ITS gene sequencing; phylogenetic analysis; DNA-DNA hybridization. Chemotaxonomic markers: Cell wall components, lipid composition, cellular fatty acid (FAME analysis), isoprenoid quinones, activity-based protein profiling and MALDI-ToF analysis.	15	CO3, CO4 K2, K3
Module 3:	Salient features of phylum, class and orders with representative examples of the following: Archaea, Eubacteria - Bacteria, Cyanobacteria, Actinomycetes; Mycota; Protista - Algae, Protozoa, Diatoms; and viruses.	15	CO5, CO6 K1, K2
Pedagogy:	Lectures/ assignments/ videos.		
References/ Readings:	<ol style="list-style-type: none"> 1. Barlow, A. (ed.) (1992). The Prokaryotes: A Handbook on the Biology of Bacteria: Ecophysiology, Isolation, Identification, Applications, Vol. 1, Springer-Verlag, Germany. 2. Goodfellow, M. & Minnikin, D. E. (1985). Chemical Methods in Bacterial Systematics, The Society for Applied Bacteriology. Technical Series No. 20, Academic Press, London/New York. 		

3. Jean-Michel, C. (2005). Bioinformatics: a beginner's guide. India: Wiley Dreamtech.
4. Kurtzman, C. P., Fell, J. W. & Boekhout, T. (2011). The Yeasts - A Taxonomic Study, Elsevier, Amsterdam.
5. Mordarski, M., Williams, S.T. & Goodfellow, M. (1983). The Biology of the Actinomycetes. Academic Press, London/New York.
6. Ribbons, D. W. & Norris, J. R. (1970). Methods in Microbiology, Vols. 18 & 19, Academic Press, London/New York.
7. Sneath, A. H. P., Mair, S. N. & Sharpe, E. M. (1984). Bergey's Manual of Systematic Bacteriology, Vol. 2, Williams & Wilkins, Academic Press, London/New York.
8. Willey, J. M., Sherwood, L. M. & Woolverton, C. J. (2011). Prescott's Microbiology (10th edn), McGraw Hill, New York.

[\[Back to Index\]](#)



Title of the Course	Practicals in Microbial Taxonomy and Systematics
Course Code	MMI-5005
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course provides opportunities for hands-on experience with the microbiological and biochemical techniques used for characterization of different microbial groups.	
Course Outcomes:		Mapped to PSO
	CO 1. Develop skills in identification and characterization of different groups of microorganisms.	PSO 2
	CO 2. Use microscopic techniques to identify and classify different groups of microorganisms.	PSO 2
	CO 3. Identify protists using morphological features outlined in standard taxonomic keys.	PSO 2, PSO 4
	CO 4. Identify marine bacterial isolates based on Bergey's Manual of Determinative Bacteriology and 16S rRNA gene sequencing.	PSO 2, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
1	Identification of Gram-positive and Gram-negative bacterial isolates by morphological and biochemical tests using standard keys.	15	CO1, CO2, CO4	K3, K4
2	Identification of bacteria using 16S rDNA PCR, agarose gel electrophoresis, and sequence analysis.	5		
2	Microscopic observation of cyanobacteria.	2	CO1, CO2	K3, K4
3	Monochrome staining for visualization of actinomycetes (<i>Streptomyces</i> sp.).	2	CO1, CO2	K3, K4
4	Wet mount and slide culture technique for yeast (<i>Saccharomyces cerevisiae</i> / <i>Schizosaccharomyces pombe</i>).	2	CO1, CO2	K3, K4
5	Morphological characterization of filamentous fungi.	2	CO1, CO2	K3, K4
6	Microscopic observation of protists from marine samples.	2	CO1, CO2, CO3	K3, K4
Pedagogy:	Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> Alexopoulos, C. J., Mims, C. W. & Blackwell, M. (2017). Introductory Mycology. John Wiley & Sons, New Delhi. Barlow, A. (ed.) (1992). The Prokaryotes: A Handbook on the Biology of Bacteria: Ecophysiology, Isolation, Identification, Applications, Vol. 1, Springer-Verlag, Germany. Jean-Michel, C. (2005). Bioinformatics: a beginner's guide. India: Wiley Dreamtech. Kurtzman, C. P., Fell, J. W. & Boekhout, T. (2011). The Yeasts - A Taxonomic Study, Elsevier, Amsterdam. Mordarski, M., Williams, S.T. & Goodfellow, M. (1983). The Biology of the Actinomycetes. Academic Press, London/New York. Simpson, A.G.B., Slamovits, C.H. & Archibald, J.M. (2017). Handbook of the Protists. Springer International Publishing, Germany. Sneath, A. H. P., Mair, S. N. & Sharpe, E. M. (1984). Bergey's Manual of Systematic Bacteriology, Vol. 2, Williams & Wilkins, Academic Press, London/New York. 			

[\[Back to Index\]](#)

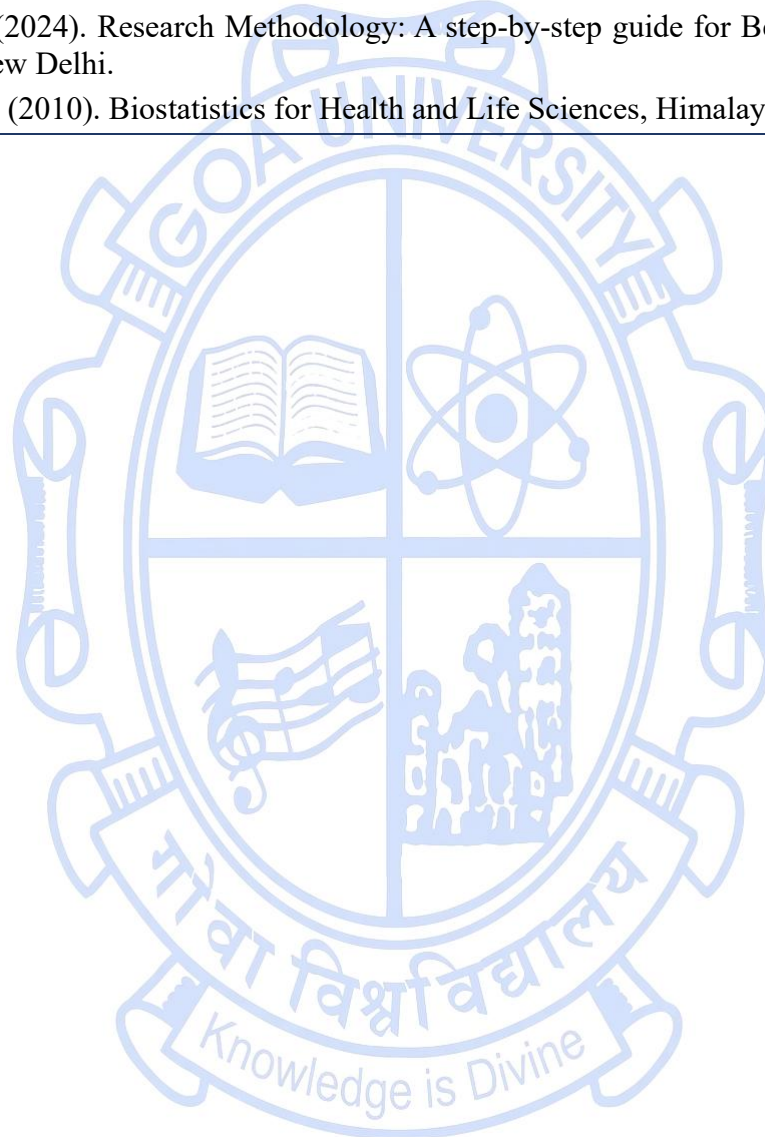
Title of the Course	Biostatistics
Course Code	MMI-5006
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The paper develops concepts about the formulation of experiments, types of data observed in biological experiments, and various statistical operations for handling and processing the data. It covers many mathematical techniques that are useful in understanding and predicting the behaviour of biological systems.	
Course Outcomes:		Mapped to PSO
	CO 1. Devise the process for designing a research study.	PSO 2, PSO 3
	CO 2. Acquire skills in data collection, management and quality assurance.	PSO 2, PSO 3
	CO 3. Integrate appropriate statistical procedures to analyse the research data.	PSO 2, PSO 3, PSO 5
	CO 4. Interpret statistical results and communicate the findings effectively.	PSO 2, PSO 3, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Fitting linear models to data, The Basic linear least squares method, Fitting the exponential model by linear least squares; Bacterial growth, steps towards building a mathematical model, Basic models of population growth: exponential and logistic; Nutrient uptake the Michaelis-Menten model and Monod model for growth and external nutrient supply; Analysis of population dynamics – aquatic ecosystem in estuary and ocean viz. Lotka-Volterra Model. Different steps in Research Process. Principles of Experimental Design. Types of sampling designs (Probability and Non-probability). Sampling and Non-sampling error. Validity and reliability of research. Data handling: Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations.	15	CO1, CO2	K3
Module 2:	Qualitative and Quantitative data. Types of variables and measurement scales (nominal, ordinal, interval, ratio). Errors in measurement. Tabulation and frequency distribution (relative and cumulative). Descriptive statistics (Measures of central tendency, Measures of dispersion, Skewness, Kurtosis, Correlation analysis – Karl Pearson’s Correlation Coefficient, Spearman’s Rank Correlation Coefficient, Regression analysis – Linear, Non-linear).	15	CO1, CO2, CO3	K5
Module 3:	Theoretical Distribution: Binomial, Poisson, Normal Distributions; Statistical Inference: Hypothesis Testing – parameter and statistics, degree of freedom, confidence limits, testing of hypothesis, test of significance, Type I and Type II error; Large sample tests, Students’ T-test, Chi-square test, F-test and ANOVA; Non-parametric tests: Wilcoxon Signed Rank test, Mann-Whitney ‘U’ test, Kruskal-Wallis ‘H’ test. Multi-dimensional scaling. Factor Analysis (Principal Component Analysis).	15	CO1, CO2, CO3, CO4	K6
Pedagogy:	Lectures/ tutorials/ assignments/ Videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Arora, P.N. and Malhan, P.K. (2012). Biostatistics, Himalaya Publishing House, New Delhi. 2. Danilina, N.I. (1988). Computational Mathematics, Mir Publishers, Russia. 3. Edelman-Keshet, L. (2017). Differential Calculus for the Life Sciences, The University of British Columbia, Vancouver, Open Book. 			

- | | |
|--|---|
| | <ol style="list-style-type: none">4. Kothari, C.R. (2013). Quantitative Techniques, Vikas Publishing House, Noida.5. Kumar, R. (2024). Research Methodology: A step-by-step guide for Beginners. SAGE Publications Pvt. Ltd., 4th Edition., New Delhi.6. Surya, R.K. (2010). Biostatistics for Health and Life Sciences, Himalaya Publishing House, New Delhi. |
|--|---|

[\[Back to Index\]](#)



Title of the Course	Practicals in Biostatistics
Course Code	MMI-5007
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Handling and processing of biological data for statistical analysis.	
Course Outcomes:		Mapped to PSO
	CO 1. Process and analyse data using different statistical tools for its application in microbiology-related experiments.	PSO 2, PSO 4, PSO 5
	CO 2. Use simple regression analysis for examining data related to standard graphs.	PSO 2, PSO 5
	CO 3. Apply normal distribution analysis to appropriate scientific problems.	PSO 2, PSO 5
	CO 4. Analyse biological problems statistically by examining their hypotheses using appropriate tests.	PSO 2, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
1	Statistical analysis and its applications and introduction to various statistical software – Primer, Statistica, Excel	9	CO1	K5
2	Linear Regression analysis	6	CO2	K5
3	Normal distribution	6	CO3	K5
4	Hypothesis testing	9	CO4	K5
Pedagogy:	Research papers/Experiments			
References/ Readings:	<ol style="list-style-type: none"> 1. Arora, P. N. and Malhan, P. K. (2012). Biostatistics, Himalaya Publishing House, New Delhi. 2. Kothari, C. R. (2013). Quantitative Techniques, Vikas Publishing House, Noida. 3. Surya, R. K. (2010). Biostatistics for Health and Life Sciences, Himalaya Publishing House, New Delhi. 4. Hammer, Ø., Harper, D. A. T., and Ryan, P. D. (2001). Past: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica, 4(1), 1- 9. 			
Web Resources:	<ol style="list-style-type: none"> 1. Basic Tasks in Excel https://support.microsoft.com/en-us/office/basic-tasks-in-excel-dc775dd1-fa52-430f-9c3c-d998d1735fca 2. Grapher User's Guide, 2020 – Golden Software, LLC USA, www.GoldenSoftware.com 3. Surfer 12 Full User's Guide, 2014 - Golden Software, LLC USA, www.GoldenSoftware.com 4. PRIMER: User Manual/Tutorial. PRIMER-E. Plymouth. 5. PAST: https://past.en.lo4d.com/windows#google_vignette 			

[\[Back to Index\]](#)

Discipline Specific Elective (DSE) Courses

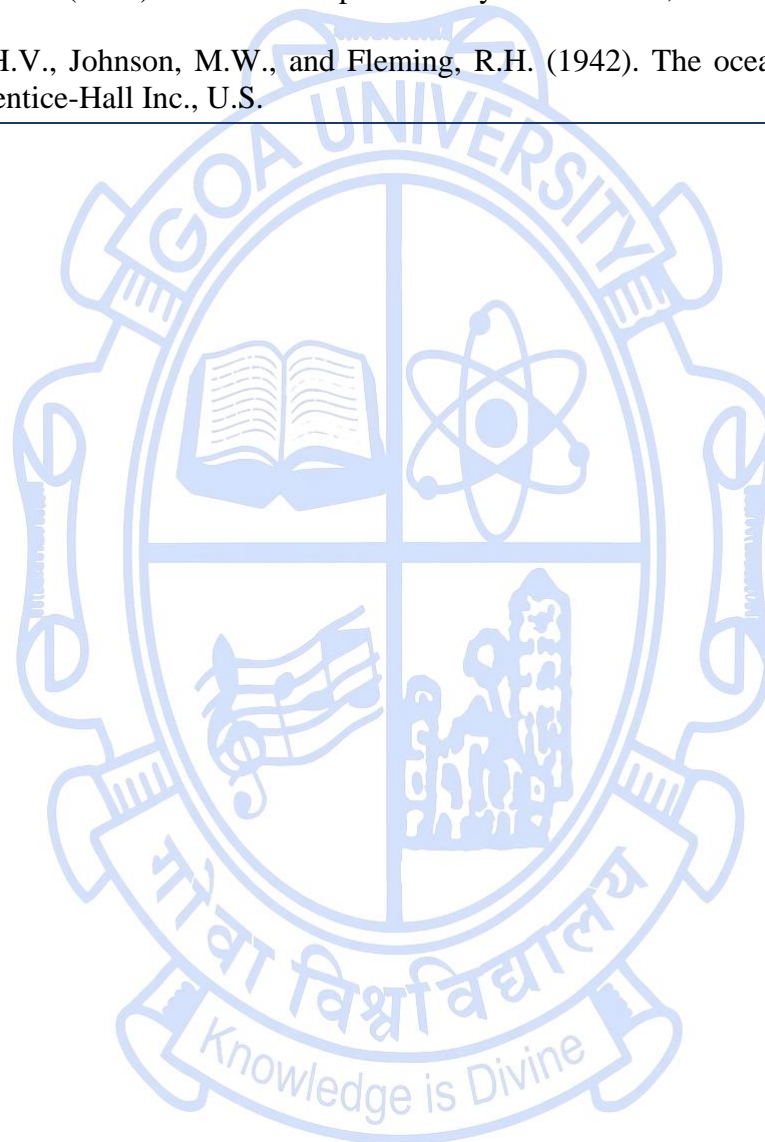
Title of the Course	Estuarine Ecosystems and Microbes
Course Code	MMI-5201
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course explores the estuarine ecosystem understanding the abiotic and biotic factors playing role in balancing the dynamic system.	
Course Outcomes:		Mapped to PSO
	CO 1. Explains the types of estuaries and their physico-chemical characteristics	PSO 1
	CO 2. Analyses the biodiversity of marine organisms and their distribution patterns	PSO 1, PSO 2
	CO 3. Explains the composition of Microflora of estuarine ecosystem, elaborate on the factors affecting and evaluate their interaction with other biota.	PSO 1, PSO 2
	CO 4. Defines Primary productivity and explain food webs in estuarine ecosystem.	PSO 1, PSO 4

	CO 5. Enlists the types of mangroves and describe their role in the estuarine ecosystem		PSO 1, PSO 5
	CO 6. Compiles the anthropogenic activities affecting estuaries and list the importance of conservation of estuaries		PSO 1, PSO 4
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Estuaries: Definition - Characteristics of estuaries - Origin of estuaries - Structure of an estuary - functions of estuary - Types of estuaries - Some typical estuarine habitats of India (Mandovi, Zuari, Godavari, Krishna, Cauvery) - Estuarine geomorphology - patterns of environmental variability - Physical environmental factors (temperature, light, currents, tides and waves) - Chemical environmental factors (oxygen, carbon dioxide and carbonates, salinity, pH, nutrients) - Classification of marine organisms and their characteristic features - variety and spatial patterns of diversity.	15	CO1, CO2 K2, K4
Module 2:	Estuarine microbial ecology – Microorganisms in estuarine water and sediments – Factors influencing estuarine microorganisms - Factors influencing estuarine microorganisms and their adaptations, Interactions with associated biota - Estuarine food webs - Factors affecting primary productivity - Trophic transfer, cascade effects and role of bacterial protoplasm, Biomagnification.	15	CO3, CO4, CO5 K1, K2, K3
Module 3:	Role of mangroves, salt marshes and deltas in estuarine ecosystem functioning. Threats to estuarine ecosystems - Natural threats - Anthropogenic threats – Trace metal pollution and bioaccumulation, effluents and introduction of pathogenic bacteria, Conservation of estuaries -Effects on estuarine ecosystem.	15	CO6 K3
Pedagogy:	Lectures/assignments/ visit to estuary		
References/ Readings:	<ol style="list-style-type: none"> Balakrishna Nair. N. and Thampy D.M. (1980). A text book of marine ecology. Macmillan, Delhi. Broecker, W.S. (1974). Chemical oceanography. Harcourt, Brace, Jovanivich Inc., New York. Day, J.W., Crump B.C., Kemp W.M., Yanez-Arancibia A. (2013). Estuarine ecology. Wiley-Blackwell Inc., Oxford. Friedrich, H. (1969). Marine Biology. Sidgewick & Jackson, London. Mitra A. and Zaman S. (2016) Basics of marine and estuarine ecology. Springer, India. 		

- | | |
|--|---|
| | <ol style="list-style-type: none">6. Raymont, J.E.C. (1980). Plankton and productivity in the oceans, Volume 1. Phytoplankton. 2nd Edition. Pergamon, U.K.7. Sverdrup, H.V., Johnson, M.W., and Fleming, R.H. (1942). The oceans - their physics, chemistry and general biology. Prentice-Hall Inc., U.S. |
|--|---|

[\[Back to Index\]](#)

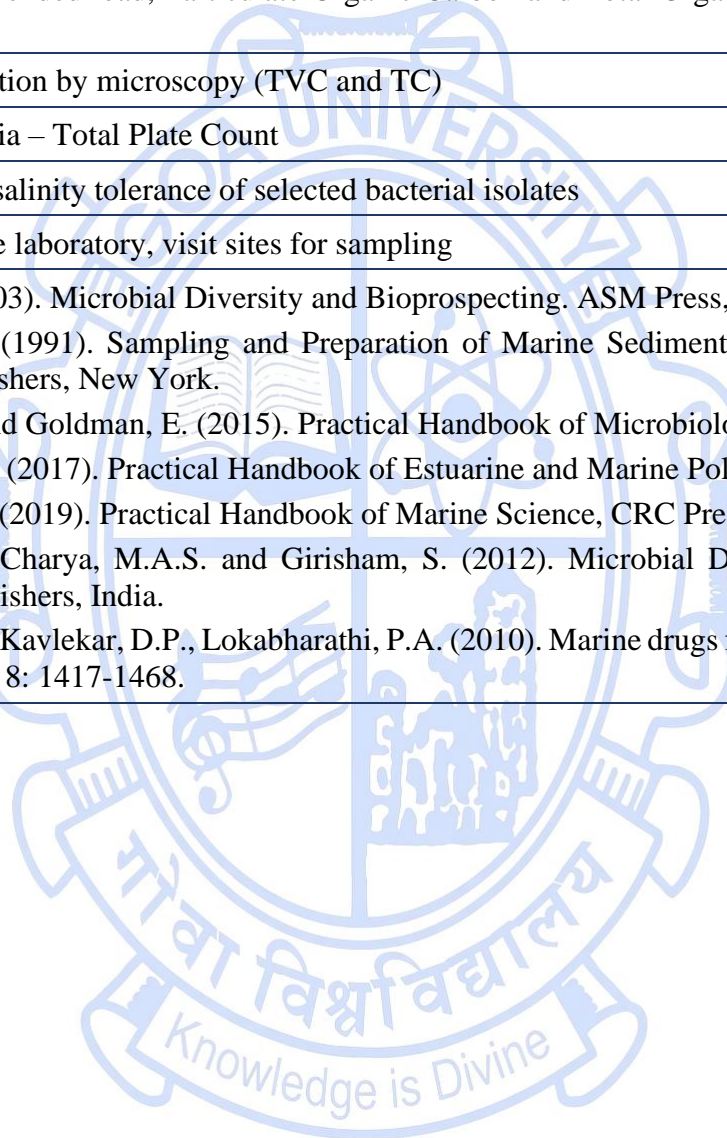


Title of the Course	Practicals in Estuarine Ecosystems & Microbes
Course Code	MMI-5202
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	The course develops the techniques involved in estuarine sample processing and analysis.			
Course Outcomes:		Mapped to PSO		
	CO1. Estimate BOD, POC, TOC of estuarine water and sediment samples	PSO 2, PSO 3		
	CO2. Analysis of water samples for bacterial enumeration by microscopy.	PSO 1, PSO 2		
	CO3. Microbial analysis of water and sediment samples	PSO 2, PSO 3		
	CO4. Determine the salinity tolerance of estuarine bacterial isolates.	PSO 1, PSO 2		
Content:		No of hours	Mapped to CO	Cognitive Level
1	Chemical characteristics of estuarine water sample – BOD, COD	8	CO1	K4, K5

2	Estimation of suspended load, Particulate Organic Carbon and Total Organic Carbon of estuarine water	8	CO1	K4, K5
3	Bacterial enumeration by microscopy (TVC and TC)	6	CO2	
4	Isolation of bacteria – Total Plate Count	4	CO3	K3, K4, K5
5	Determination of salinity tolerance of selected bacterial isolates	4	CO4	K4, K5
Pedagogy:	Experiments in the laboratory, visit sites for sampling			
References/ Readings:	<ol style="list-style-type: none"> 1. Bull, A.T. (2003). Microbial Diversity and Bioprospecting. ASM Press, Washington, U.S. 2. Chaney, R.C. (1991). Sampling and Preparation of Marine Sediments, In, Foundation Engineering Handbook, Springer Publishers, New York. 3. Green, L.H. and Goldman, E. (2015). Practical Handbook of Microbiology, 3rd Edition. CRC Press, Florida. 4. Kennish, M. J. (2017). Practical Handbook of Estuarine and Marine Pollution, CRC Press, Florida. 5. Kennish, M.J. (2019). Practical Handbook of Marine Science, CRC Press, Florida. 6. Reddy, S.M., Charya, M.A.S. and Girisham, S. (2012). Microbial Diversity: Exploration and Bioprospecting, Scientific Publishers, India. 7. Thomas, T.R., Kavlekar, D.P., Lokabharathi, P.A. (2010). Marine drugs from sponge-microbe association: a review. Marine Drugs, 8: 1417-1468. 			

[\[Back to Index\]](#)



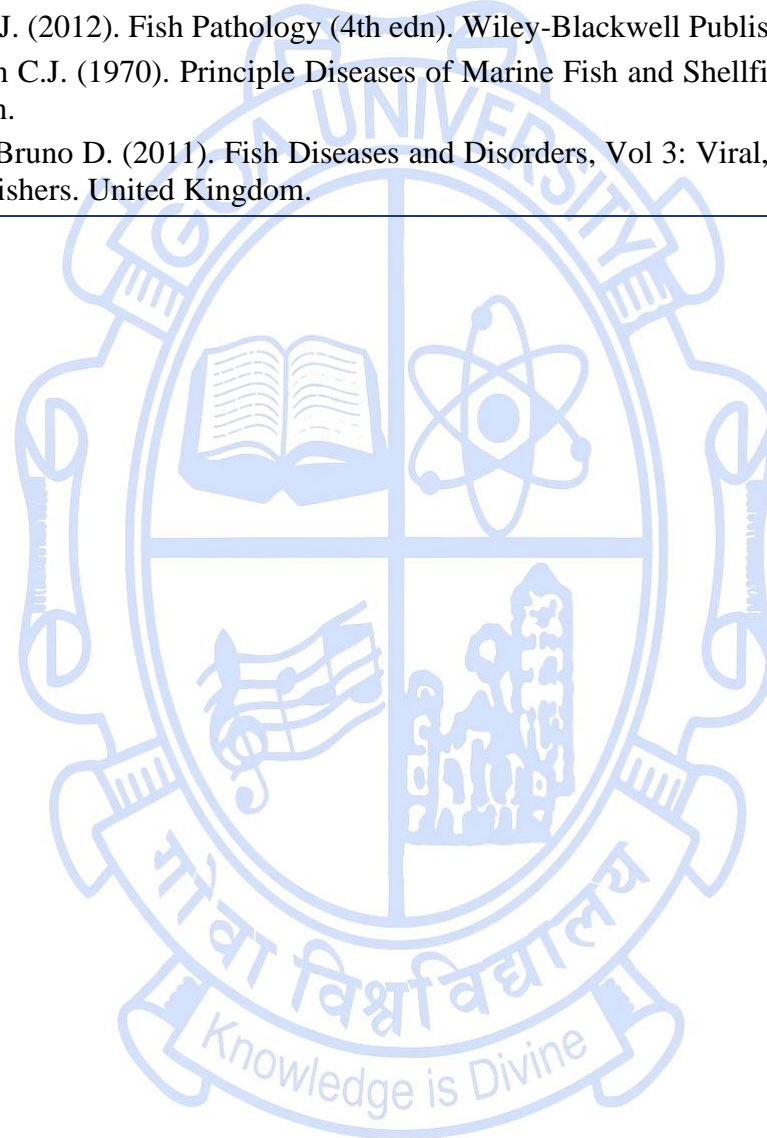
Title of the Course	Microbial Pathogens of Fish and Shellfish
Course Code	MMI-5203
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Develop the knowledge of fishes, fisheries, aquaculture in India. Develop the concepts of various infectious diseases present in fishes and spread through fishes.	
Course Outcomes:		Mapped to PSO
	CO 1. Garner knowledge of wide diversity of fisheries in marine and coastal ecosystems.	PSO 1, PSO 2
	CO 2. Analyse fish microbiome, pathogens and their associated antibiotic resistance.	PSO 3, PSO 4
	CO 3. Compare various microbial infections in fishery resources and their implications.	PSO 3
	CO 4. Assess the influence of zoonotic infections and marine toxins on fish and human health.	PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	History of microbial diseases associated with fishes and shellfishes. Role of beneficial vs harmful microbes in fish farms and natural habitats. Microbiome associated with fishes and shellfishes. Symbionts, commensals and parasites. Stress associated shifts in microbiome. Influence of gut microbiome on immunity and growth. Biofilm production and its implications in hatcheries.	15	CO1, CO2	K1, K2
Module 2:	Classification of diseases; Detailed study of bacteria pathogenic to finfish and shellfish with emphasis on morphology, epidemiology, pathogenesis, treatment and control: <i>Flavobacterium</i> , <i>Edwardsiella</i> , <i>Vibrio</i> , <i>Aeromonas</i> , <i>Renibacterium</i> , <i>Yersinia</i> , <i>Mycobacterium</i> . Viral infections: White Spot Syndrome Virus (WSSV), Monodon Baculo Virus (MBV), Yellow Head virus (YHV), Hepatopancreatic Parvo Virus (HPV), Infectious Hypodermal and Hematopoeitic Necrosis Virus (IHHNV). Ecto and endoparasitic infections. Antibiotic resistance in aquaculture systems. Responsible use of antibiotics and policies. Permissible limits for export. Methods of disease prevention and control: Use of Prebiotics, Probiotics and Phage therapy. Use of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) species.	15	CO2, CO3	K3, K4
Module 3:	Marine toxins: <i>Paralytic Shellfish Poisoning (PSP) Toxins</i> , <i>Amnesic Shellfish Poisoning (ASP) Toxins</i> , <i>Diarrhetic Poisoning Toxins</i> , <i>Lipophilic Shellfish Toxins (LST)</i> , <i>Neurotoxin Shellfish Poisoning (NSP) Toxins</i> , <i>Venerupin shellfish poisoning</i> , <i>Ciguatera toxins</i> , <i>tetradotoxins</i> , <i>Azaspiracids</i> , <i>Cyclic Imines and their origin</i> .	15	CO4	K1, K2, K3
Pedagogy:	Lectures/ assignments/ presentations			
References/ Readings:	<ol style="list-style-type: none"> 1. Hoole D., Buck D., Burgess P., & Welby I. (2011). Diseases of Carps and Other Cyprinid Fishes, Wiley-Blackwell Publishers. New 2. Jersey.Fernandes R. (2009). Microbiology Handbook: Fish and Seafood. RSC Publishing. London. 3. Leatherland J. F. & Wook P. K. T. (2006). Fish Diseases and Disorders (2nd edn) CABI Publishers. United Kingdom. 			

4. Noga E. C. (2010). Fish Disease: Diagnosis and Treatment (2nd edn). Wiley-Blackwell Publishers. New Jersey.
5. Roberts R. J. (2012). Fish Pathology (4th edn). Wiley-Blackwell Publishers. New Jersey.
6. Sindermann C.J. (1970). Principle Diseases of Marine Fish and Shellfish (1st edn). Academic Press of New York and London.
7. Woo P. & Bruno D. (2011). Fish Diseases and Disorders, Vol 3: Viral, Bacterial and Fungal Infections (2nd edn) CABI Publishers. United Kingdom.

[\[Back to Index\]](#)



Title of the Course	Practical in Microbial Pathogens of Fish and Shellfish
Course Code	MMI-5204
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Provides hands-on experience in the fish anatomy and its associated microbial flora, including human pathogens.	
Course Outcomes:		Mapped to PSO
	CO 1. Apply the tools and techniques of microbiology for isolation of fish microbiota.	PSO2, PSO3
	CO 2. Assess the microbiological quality of fishes in terms of associated disease or as carrier for human pathogens.	PSO2, PSO3, PSO4
	CO 3. Analyze the symptoms in diseased moribund fish for the prediction of disease type.	PSO1, PSO2
	CO 4. Evaluate the antibiotic sensitivity of fish pathogens.	PSO5

Content:		No of hours	Mapped to CO	Cognitive Level
1	Methods for examining moribund fish from aquaculture/aquarium for diagnosis of disease condition, techniques for diseased tissue collection and processing, and identification of causative agent.	10	CO1, CO2	K2, K3
2	One bacterial and viral pathogen identification using PCR and diagnostic kit.	10	CO2, CO3	K3, K4
3	Evaluation of Antibiotic sensitivity and MAR index of fish pathogens.	10	CO4	K5
Pedagogy:	Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. Bauer, A. W., Kirby, W. M. M., Sherris, J. C., & Turck, M. (1966). Antibiotic susceptibility testing by a standardized single disk method. <i>American Journal of Clinical Pathology</i>, 45(4), 493–496. [PMID: 5325707] 2. Krumperman, P. H. (1983). Multiple antibiotic resistance indexing of <i>Escherichia coli</i> to identify high-risk sources of fecal contamination of foods. <i>Applied and Environmental Microbiology</i>, 46(1), 165–170. 3. Leatherland J. F. & Wook P. K. T. (2006) <i>Fish Diseases and Disorders</i> (2nd edn) CABI Publishers. United Kingdom. 4. Noga E. C. (2010). <i>Fish Disease: Diagnosis and Treatment</i> (2nd edn). Wiley-Blackwell Publishers. New Jersey. 5. Woo P. & Bruno D. (2011). <i>Fish Diseases and Disorders, Vol 3: Viral, Bacterial and Fungal Infections</i> (2nd edn) CABI Publishers. United Kingdom. 			

[\[Back to Index\]](#)

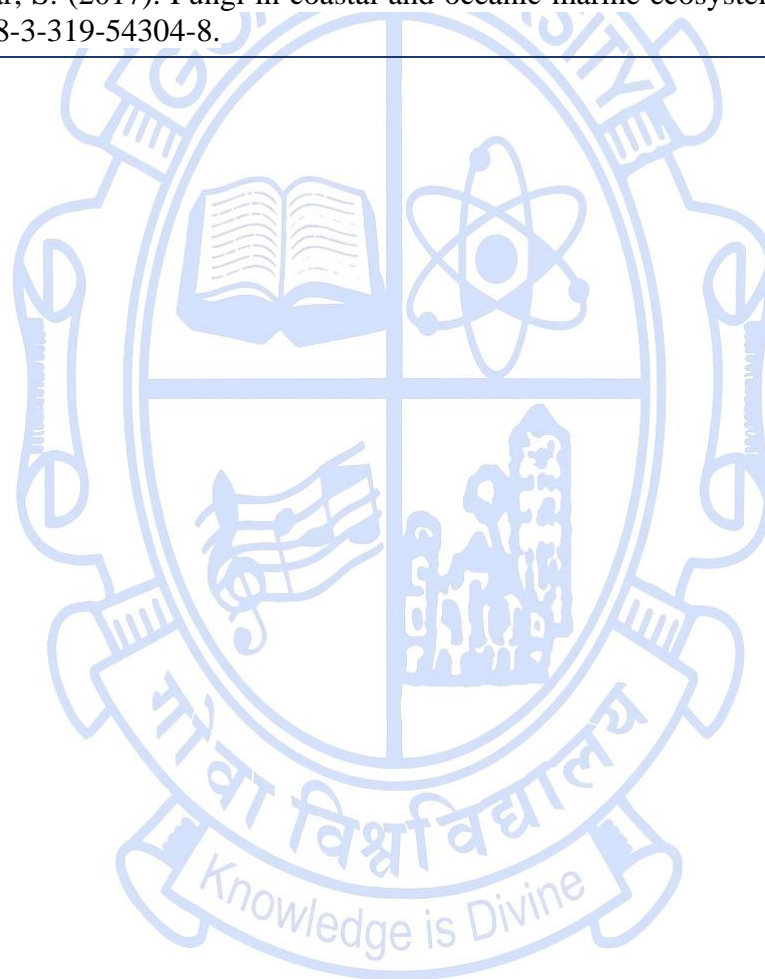
Title of the Course	Marine Mycology
Course Code	MMI-5205
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course deals with classification and identification of fungi, their ecology in marine and extreme habitats, and their applications.			
Course Outcomes:		Mapped to PSO		
	CO 1. Discuss the distribution of fungi in the marine environment.	PSO 1, PSO 4		
	CO 2. Demonstrate fungal growth and development.	PSO 1, PSO 4		
	CO 3. Integrate new technologies in studying physiology, genetics and applications of marine fungi.	PSO 1, PSO 2, PSO 4		
	CO 4. Analyse various biotechnological applications of marine fungi.	PSO 4, PSO 5		
Content:		No of hours	Mapped to CO	Cognitive Level

Module 1:	Fungal diversity and distribution: Phylogeny and detailed classification of fungi. Ecotones of marine fungi – polyhaline coastal environments (salt marshes, mangroves, estuaries); hypersaline environment (solar salterns, Salt Lake, Dead Sea); oceans and hydrothermal vents. Extremophilic fungi – halophiles, xerophiles, oligotrophs, barophiles, psychrophiles, thermophiles. Techniques to study marine and extremophilic fungi – sample collection and isolation procedures, identification – morphotyping, secondary metabolites, molecular fingerprinting, FAME, karyotyping, gene sequencing.	15	CO 1, CO 2, CO 3	K2
Module 2:	Physiology and genetics: Growth cycle and development. Fungal hormones (attractants), morphogenesis and differentiation. Secondary metabolites – pigments, mycotoxins. Cross over and tetrad analysis. Mating type switching. Deuteromycotina – parasexuality, cytoplasmic inheritance. Fungal associations – symbionts, saprophytes and parasites on higher forms of marine life.	15	CO 2, CO 3	K3
Module 3:	Threats and applications: Mycoses – diseases of fish, bivalves and corals. Bioprospecting and bioremediation – industrially important enzymes, secondary metabolites, nutraceuticals, antimicrobials, antitumour agents, pigments. Biodegradation and bioremediation.	15	CO 3, CO 4	K4
Pedagogy:	Lectures/assignments/presentations/videos/self-study			
References/ Readings:	<ol style="list-style-type: none"> Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2017). <i>Introductory mycology</i>. (Fourth Edition), New Delhi: John Wiley & Sons. Borkovich, K. A., & Ebbole, D. J., (2010). <i>Cellular and molecular biology of filamentous fungi</i>. Washington DC: ASM Press. Borse, B. D., Bhat, J. D., Borse, K. N., Tuwar, N. S., & Pawar, N. S. (2012). <i>Marine fungi of India (Monograph)</i>, Panaji: Broadway Publishing House. Deacon, J. W. (1984). <i>Introduction to modern mycology</i>. Oxford Blackwell Scientific Publications. Domsch, K. H., Gams, W., & Anderson, T-H., (2007). <i>Compendium of soil fungi</i>. (Second Edition), Eching, IHW-Verlag. Mehrotra, R. S., & Aneja K. R., (1990). <i>An Introduction to Mycology</i>. New Delhi: Wiley Eastern Limited. Moore, D. (2011). <i>21st Century guidebook to fungi</i>. New York: Cambridge University Press. 			

8. Moore, D., & Frazer, L. A. N. (2002). Essential fungal genetics. New York: Springer Publishers.
9. Onions, A. H. S., Allsop, D., & Eggins H. O. W., (1981). Smith's introduction to industrial mycology. London: Edward Arnold Publishers.
10. Raghukumar, C. (2012). Biology of marine fungi. Springer Publishers, Berlin Heidelberg.
11. Raghukumar, S. (2017). Fungi in coastal and oceanic marine ecosystems. Switzerland : Springer Publishers. doi: 10.1007/978-3-319-54304-8.

[\[Back to Index\]](#)



Title of the Course	Practicals in Marine Mycology
Course Code	MMI-5206
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course deals with the isolation and identification of fungi, handling fungal cultures and designing experiments with sporulating and non-sporulating fungi.	
Course Outcomes:		Mapped to PSO
	CO 1. Compare various morphological features of fungal cultures for identification to genus level.	PSO 1
	CO 2. Analyse and apply techniques necessary for isolation of fungi from different marine samples.	PSO 2
	CO 3. Design experimental work with fungal cultures on plate as well as in broth.	PSO 2
	CO 4. Assess handling of sporulating and non-sporulating fungal cultures during laboratory studies.	PSO 4, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
1	Study of fungal cultures: colony and morphological characteristics.	6	CO2, CO4	K4, K5
2	Isolation and identification of fungi from marine ecosystem.	10	CO1, CO2, CO4	K4, K5
3	Dye decolourization experiment using marine fungal isolate.	6	CO 3, CO 4	K4, K5
4	Biosorption of heavy metals using live and dead biomass	8	CO 3, CO 4	K4, K5
Pedagogy:	Laboratory experiments/ tutorials			
References/ Readings:	<ol style="list-style-type: none"> Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2017). <i>Introductory mycology</i>. (Fourth Edition), New Delhi: John Wiley & Sons. Borse, B. D., Bhat, J. D., Borse, K. N., Tuwar, N. S., & Pawar, N. S. (2012). <i>Marine fungi of India (Monograph)</i>, Panaji: Broadway Publishing House. Dusengemungu, L., Kasali, G., Gwanama, C., & Ouma, K. O. (2020). Recent advances in biosorption of copper and cobalt by filamentous fungi, <i>Frontiers in Microbiology</i>, 11, 582016. Lotlikar, N. P., Damare, S. R., Meena, R. M., Linsy, P., & Mascarenhas, B. (2018). Potential of marine-derived fungi to remove hexavalent chromium pollutant from culture broth. <i>Indian Journal of Microbiology</i>, 58(2), 182-192. Mehrotra, R. S., & Aneja K. R., (1990). <i>An Introduction to Mycology</i>. New Delhi: Wiley Eastern Limited. 			

[\[Back to Index\]](#)

SEMESTER II

Discipline Specific Core (DSC) Courses

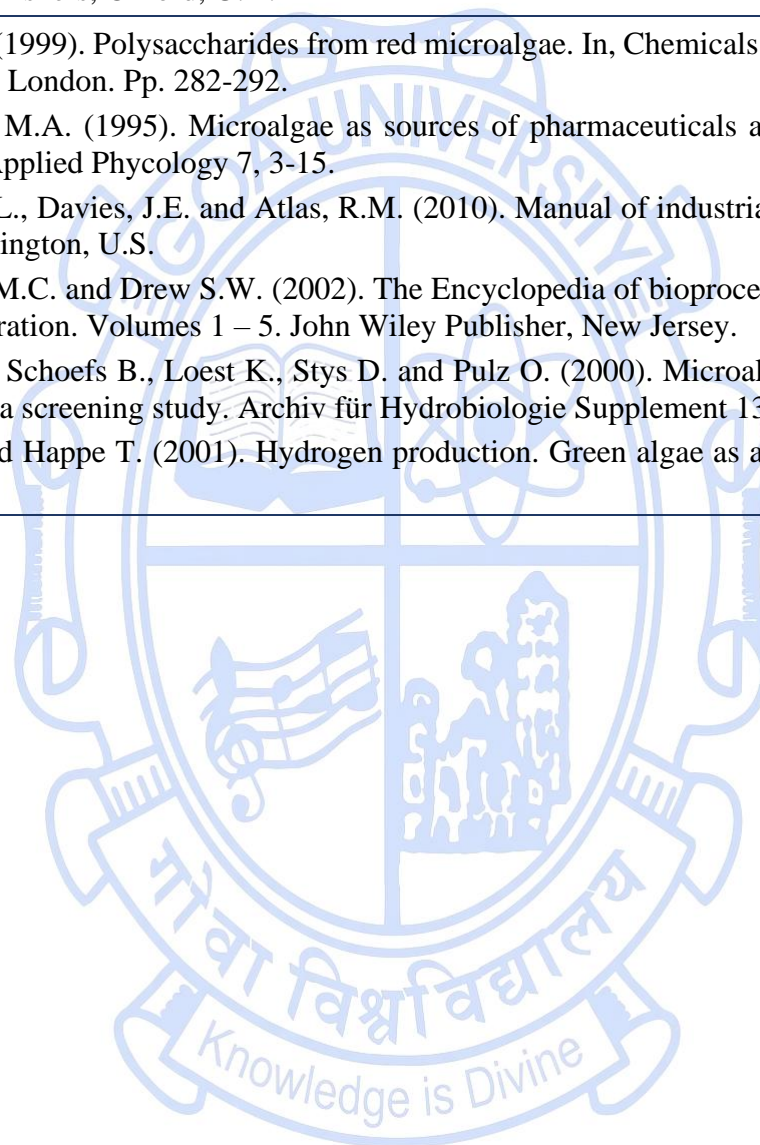
Title of the Course	Industrial Microbiology
Course Code	MMI-5008
Number of Credits	3
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Understanding of concepts in the fermentation processes employed in the industries to produce the products from marine microorganisms.	
Course Outcomes:		Mapped to PSO
	CO 1. Define fermentation, differentiate between different types of fermentations.	PSO1
	CO 2. Elaborate on the methods for strain improvement and mutant selection.	PSO1, PSO2, PSO3
	CO 3. Discuss role of rheology, sterilisation parameters for media and types of media.	PSO1

	CO 4. Explain the fermentation monitoring methods and their controls.		PSO1, PSO2, PSO3
	CO 5. Compare and contrast the different methods for downstream processing of fermentation products.		PSO1, PSO2, PSO3
	CO 6. Explain the production and application of marine microbial products.		PSO 1, PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Industrially important marine microorganisms, Fermentation media, Asepsis and sterilisation, growth kinetics – optimization of growth parameters - Bioreactor design and operation: Batch culture, Fed-batch culture and Continuous culture, classification of reactors; designing parameters for reactors (stirred tank reactor, airlift reactor, plug flow reactor) - rheology of fermentation broth - gas-liquid mass transfer, heat transfer, scale up - Solid substrate fermentation (SSF): Principles and application with examples (penicillin, amylase) - Immobilized enzymes and cell systems.	15	CO1, CO2, CO3 K1, K2, K3
Module 2:	Fermentation monitor and control: speed, temperature, gas, pH, Dissolved oxygen, foam, redox, air flow, weight, pressure, biomass - On-line and off-line analysis - Layout and components of fermentation process for extracellular and intracellular microbial products - Recovery of biomass (cells and solid particles), cell disruption for recovery of intracellular products, primary isolation (extraction, sorption), precipitation, industrial processes for chromatography and fixed bed adsorption, membrane separations - drying, crystallisation, whole broth processing (Penicillin production) - Formulation, packaging - QC/QA; IPR.	15	CO4, CO5 K1, K2, K3
Module 3:	Microbiological techniques in marine food industry, canning, freezing, drying - Industrial production and application – enzymes (proteases, lipases, amylase, pectinase, cellulase), carotenoids, EPS, bioplastics, biopolymers – xanthan, pigments, antibiotics-erythromycin, steroids, SCP, biofuels, introduction to synthetic biology using marine microbial strains – Entrepreneurship.	15	CO6 K1-K3
Pedagogy:	Lectures/ assignments/ posters		
Texts:	Stanbury, P.F., Whitaker, A. and Hall S.J. (2016). Principles of fermentation technology. 3 rd Edition. Butterworth-		

	Heinemann Publishers, Oxford, U.K.
References/ Readings:	<ol style="list-style-type: none"> 1. Arad, S.M. (1999). Polysaccharides from red microalgae. In, Chemicals from microalgae, Cohen, Z. (Ed.). Taylor and Francis, London. Pp. 282-292. 2. Borowitzka M.A. (1995). Microalgae as sources of pharmaceuticals and other biologically active compounds. Journal of Applied Phycology 7, 3-15. 3. Demain, A.L., Davies, J.E. and Atlas, R.M. (2010). Manual of industrial microbiology and biotechnology. ASM Press, Washington, U.S. 4. Flickinger, M.C. and Drew S.W. (2002). The Encyclopedia of bioprocess technology: Fermentation, biocatalysis and bioseparation. Volumes 1 – 5. John Wiley Publisher, New Jersey. 5. Kopecky J., Schoefs B., Loest K., Stys D. and Pulz O. (2000). Microalgae as a source for secondary carotenoid production: a screening study. Archiv für Hydrobiologie Supplement 133, 153-168. 6. Melis A. and Happe T. (2001). Hydrogen production. Green algae as a source of energy. Plant Physiology 127, 740-748.

[\[Back to Index\]](#)



Title of the Course	Practicals in Industrial Microbiology
Course Code	MMI-5009
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

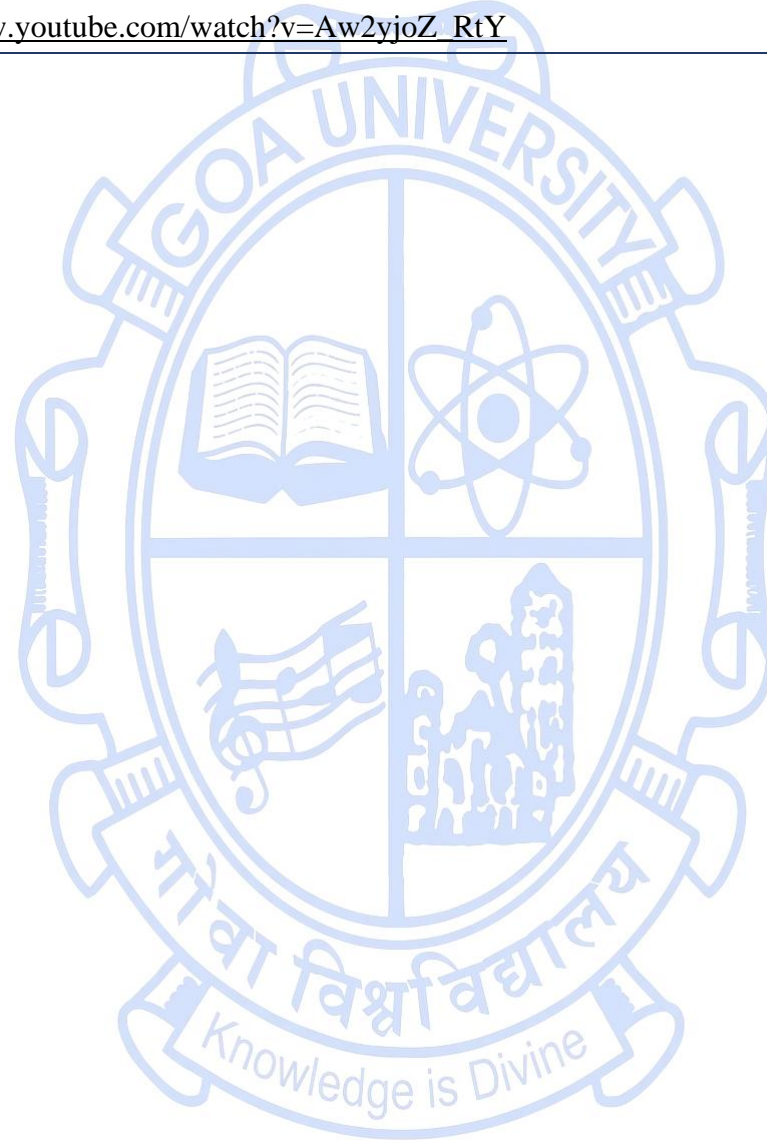
Pre-requisites for the Course:	Nil			
Course Objectives:	This course develops the skills for techniques and instrumentation in industrial microbiology.			
Course Outcomes:			Mapped to PSO	
	CO 1. Describe fermentor design, draw and label different parts of stirred tank reactor.		PSO 1, PSO 2	
	CO 2. Measure and calculate viscosity of substrate solutions using viscometer.		PSO 1 - PSO 3	
	CO 3. Extract and quantitate the exopolysaccharide produced using marine microbial isolate.		PSO 1 - PSO 4	
	CO 4. Isolation and screening of antibiotic producing marine bacteria.		PSO 1 - PSO 4	
Content:		No of hours	Mapped to CO	Cognitive Level
1	Batch cultivation of bacterial isolates for the production of protease/cellulase enzymes	6	CO 1	K1, K2

	using a stirred tank reactor.			
2	Rheology of culture medium using Ostwald's viscometer.	6	CO 2	K2-K4
3	Exopolysaccharide production using marine microbial isolate.	6	CO 3	K3, K4
4	Downstream processing for EPS.	6	CO 3	K3-K5
5	Screening for antibacterial activity of marine bacteria	6	CO 4	K2-K6
Pedagogy:	Experiments in the laboratory, data collection and processing.			
References/ Readings:	<ol style="list-style-type: none"> 1. Determination of viscosity with Ostwald's viscometer. Materials, Department of Physical Chemistry, Eotvos University, Budapest. 2. Flickinger, M.C. and Drew S.W. (2002). The Encyclopedia of bioprocess technology: fermentation, biocatalysis and bioseparation. Volumes 1 – 5. John Wiley Publisher, New Jersey. 3. Jyoti, K. M., Soni, K. & Chandra R. (2024) Optimization of the production of Exopolysaccharide (EPS) from biofilm-forming bacterial consortium using different parameters. The Microbe, 4: 100117. https://doi.org/10.1016/j.microb.2024.100117. 4. Temmerman, R., Goethals, K., Garmyn, A., Vanantwerpen, G., Vanrobaeys, M., Haesebrouck, F., Antonissen, G., & Devreese, M. (2020). Agreement of Quantitative and Qualitative Antimicrobial Susceptibility Testing Methodologies: The Case of Enrofloxacin and Avian Pathogenic <i>Escherichia coli</i>. <i>Frontiers in Microbiology</i>, 11, 570975. https://doi.org/10.3389/fmicb.2020.570975 5. Zaghoul, E. H., & Ibrahim, M. I. A. (2022). Production and characterization of exopolysaccharide from newly isolated marine probiotic <i>Lactiplantibacillus plantarum</i> EI6 with <i>in vitro</i> wound healing activity. <i>Frontiers in Microbiology</i>, 13, 903363. https://doi.org/10.3389/fmicb.2022.903363 			
Web Resources:	<ol style="list-style-type: none"> 1. https://acmeresearchlabs.in/2024/02/03/viscosity-using-ostwald-viscometer-a-detailed-guide 2. https://www.slideshare.net/slideshow/viscosity-measurement-using-ostwald-viscometer/54056547#8 3. https://www.youtube.com/watch?v=XApUZukvbmQ 4. https://www.youtube.com/watch?v=5eKdZ0dVCCo 5. https://www.youtube.com/watch?v=lgDYzUBGIIE 6. https://www.youtube.com/watch?v=slb508vD6l8 			

7. <https://www.youtube.com/watch?v=IN3lgusZe8U>

8. https://www.youtube.com/watch?v=Aw2yjoZ_RtY

[\[Back to Index\]](#)



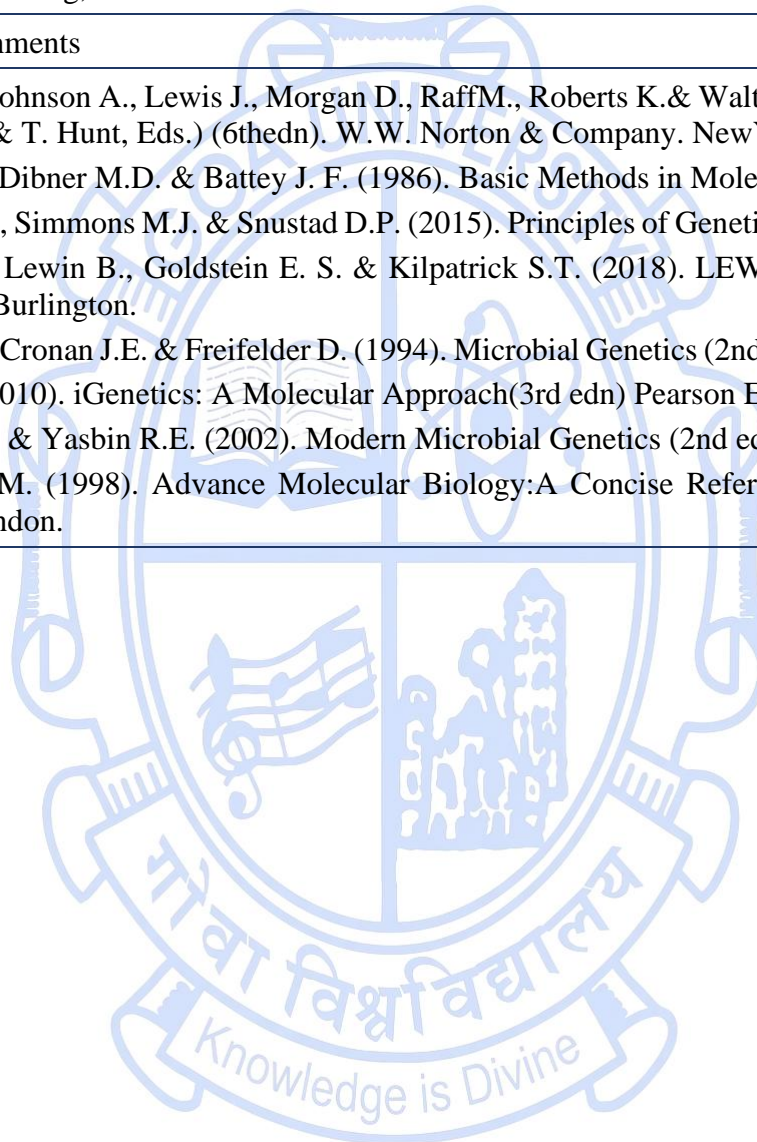
Title of the Course	Microbial Genetics
Course Code	MMI-5010
Number of Credits	3
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course develops concepts in molecular biology: DNA packaging, DNA damage and repair, gene structure, expression and regulation in both prokaryotes and eukaryotes	
Course Outcomes:		Mapped to PSO
	CO1. Understand gene structure and mutations in prokaryotes.	PSO 1
	CO2. Compare positive and negative gene expression and regulation systems.	PSO 3, PSO 4
	CO3. Differentiate various repair mechanisms of DNA damage.	PSO 4
	CO4. Discuss the significance of mutagenesis in molecular research and microbial evolution.	PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to microbial genetics. DNA structure and forms, its fundamental functions, Replication, Transcription, Translation, Genome organisation: Chromosome, structural features, functions, and packaging in the chromatin fibre. Satellite DNA, Repetitive DNA. Histone modifications. Microbial gene transfer (Conjugation, transformation, transduction). Structural and numerical chromosomal aberrations and their significance. Genomic islands. eDNA and metagenomics.	15	CO1, CO4	K1, K2
Module 2:	DNA Damage, DNA Repair and Recombination: Types of DNA damage (spontaneous and induced DNA damage). Mutagenesis: Somatic and germinal mutation, site specific using PCR/ cassette mutagenesis, and random mutagenesis. Types of mutation: silent, missense, nonsense, Read through, frameshift- insertion and deletion mutation, translocation, Inversion, suppressor mutation. Mutagenic chemicals and radiations and their mechanism of action: Base analogues (5-Bromouracil and 2-amino purines), EMS, acridines, NTG, Hydroxylamine; mutagenic radiations- UV, X-rays and gamma rays. Ames test; Auxotrophy. Mechanisms/pathways to remove damaged DNA: Excision repair, mismatch repair, recombination repair in <i>E. coli</i> and SOS Repair. Role of RecA in DNA damage repair, photoreactivation repair in <i>E. coli</i> involving photolyase. Mechanisms of Genetic Recombination: General and site-specific recombination. Heteroduplex DNA formation (Homologous recombination). Holliday junctions. Synaptonemal Complex, Bacterial RecBCD system and its stimulation of chi sequences.	15	CO3, CO4	K3
Module 3:	Genomic rearrangements, Gene structure and control of gene expression in Prokaryotes and Eukaryotes: Mechanism of General and programmed DNA rearrangements, Antigenic and phase variation in bacteria. Transposons: IS elements – Composite transposons (Tn3, Tn10), Ty and P type, Mechanism of transposition. Role of transposons in DNA rearrangements and microbial genome evolution. An overview of Gene expression control, DNA binding motifs in gene regulatory proteins, genetic switches and their role in control of gene expression. Lac operon, tryptophan operon, post-transcriptional controls-transcriptional attenuation, Riboswitches, Alternate	15	CO2	K3

	splicing, RNA editing, RNAi.			
Pedagogy:	Lectures/ assignments			
References/ Readings:	<ol style="list-style-type: none"> 1. Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K. & Walter, P. (2015). Molecular Biology of the Cell (J. Wilson, & T. Hunt, Eds.) (6th edn). W.W. Norton & Company. New York. 2. Davis L.G., Dibner M.D. & Battey J. F. (1986). Basic Methods in Molecular Biology, Elsevier. Netherlands 3. Gardner E.J., Simmons M.J. & Snustad D.P. (2015). Principles of Genetics (7th edn) John Wiley & Sons. New York. 4. Krebs J. E., Lewin B., Goldstein E. S. & Kilpatrick S.T. (2018). LEWIS Genes XII (1st edn) Jones and Bartlett Publishers. Burlington. 5. Maloy S.R., Cronan J.E. & Freifelder D. (1994). Microbial Genetics (2nd edn) Jones and Bartlett Publishers. Boston. 6. Peter J.R. (2010). iGenetics: A Molecular Approach (3rd edn) Pearson Education. San Francisco. 7. Streips U.N. & Yasbin R.E. (2002). Modern Microbial Genetics (2nd edn). John Wiley & Sons. New York. 8. Twyman R.M. (1998). Advance Molecular Biology: A Concise Reference (W. Wisden, Ed.) (1st ed.). Garland Science. London. 			

[\[Back to Index\]](#)



Title of the Course	Practical in Microbial Genetics
Course Code	MMI-5011
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course provides hands-on experience with DNA extraction, purification and electrophoretic techniques.			
Course Outcomes:			Mapped to PSO	
	CO 1. Perform genomic/total DNA extraction and PCR amplification in molecular research.		PSO 2, PSO 4	
	CO 2. Compare various DNA extraction protocols and interpret the importance of each step.		PSO 1, PSO 5	
	CO 3. Determine of amplicon size.		PSO 2	
	CO 4. Plan and perform mutagenesis to study induced genetic manipulation.		PSO 2, PSO 3	
Content:		No of hours	Mapped to CO	Cognitive Level
1	Isolation of genomic DNA of bacterial cells, estimation of quantity and purity of DNA	10	CO 1, CO 2,	K2, K3,

	by spectrophotometry, and agarose gel electrophoresis.		CO 3	K4
2	Isolation of metagenomic DNA from environmental sample (sediment/ water).	4	CO 1, CO 2	K2, K3, K4
3	Isolation of RNA, estimation of quality and quantity and purity of RNA by spectrophotometry, and agarose gel electrophoresis	6	CO 1, CO 2	K2, K3, K4
4	PCR amplification of a specific gene and agarose gel analysis of PCR product to determine amplicon size.	4	CO 1, CO 3	K5
5	Random mutagenesis using UV and plotting of UV survival curve for pigmented and non-pigmented bacterial strains.	6	CO 4	K2, K5
Pedagogy	Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. Davis L.G., Dibner M.D. & Battey J. F. (1986). Basic Methods in Molecular Biology, Elsevier. Netherlands. 2. Kamlage B. (1996). Methods for General and Molecular Bacteriology. Edited by P. Gerhardt, R. G. E. Murray, W. A. Wood and N. R. Krieg. American Society for Microbiology, Washington, D.C. 3. Miller, J. H. (1992). Experiments in Molecular Genetics (11. print). Cold Spring Harbor Laboratory. 			

[\[Back to Index\]](#)



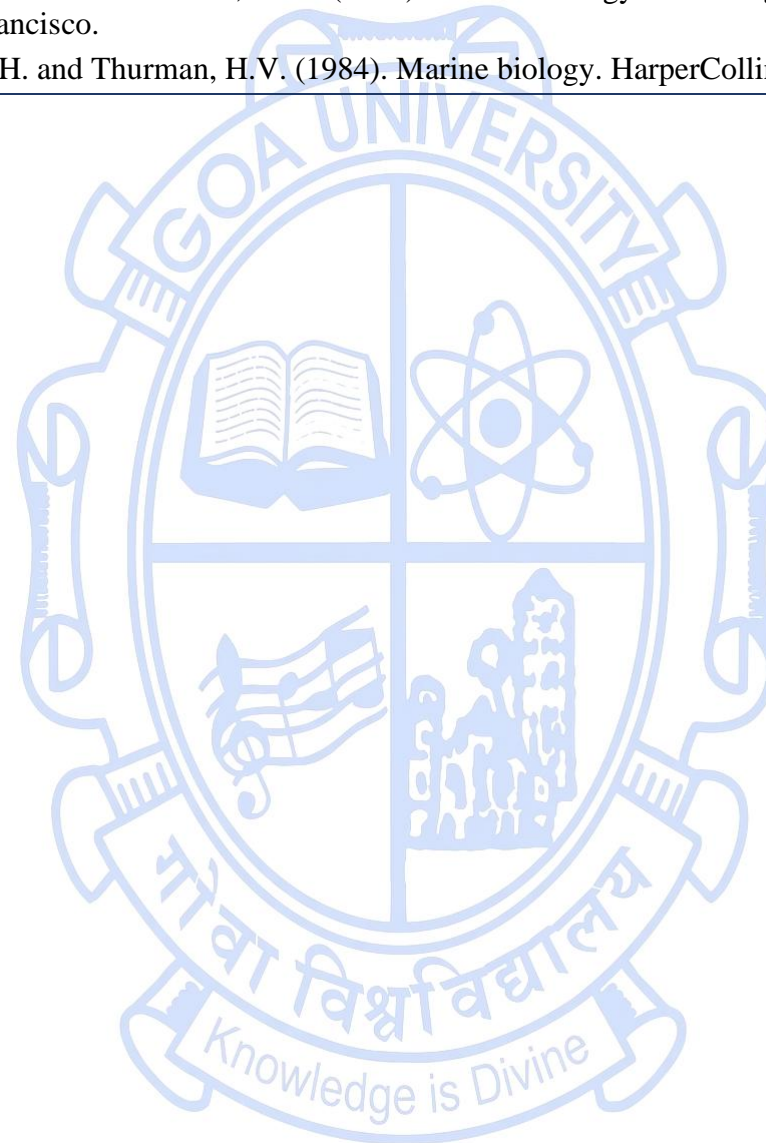
Title of the Course	Microbial Ecology
Course Code	MMI-5012
Number of Credits	3
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide an in-depth understanding of marine microbial ecology, focusing on microbial diversity and interactions with environmental factors, their role in biogeochemical cycles, and their responses to climate change and dissolved organic matter dynamics in the ocean.	
Course Outcomes:		Mapped to PSO
	CO 1. Identify the major groups of marine microorganisms and describe their ecological roles in marine ecosystems.	PSO 1, PSO 2
	CO 2. Evaluate the influence of microbial activity on the cycling of carbon, nitrogen, and other key elements in the ocean.	PSO 1, PSO 2
	CO 3. Explain how marine microbes interact with dissolved organic matter and play a role in biogeochemical cycles.	PSO 1, PSO 2

	CO 4. Analyze the impact of climate change on microbial diversity, distribution, and ecosystem processes in marine environments.		PSO 1, PSO 2
	CO 5. Synthesize the role of marine microorganisms in nutrient cycling and their potential responses to climate change.		PSO 1, PSO 2
	CO 6. Identify the major groups of marine microorganisms and describe their ecological roles in marine ecosystems.		PSO 1, PSO 2
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Marine microbiome: ecology and function, microbial interaction: mutualism, commensalism, parasitism, microbial symbiosis - microbiomes from plankton, fish, coral, sponge, deep-sea invertebrates, and animals. Biogeochemical cycles: carbon, nitrogen, phosphorus, sulphur, and iron. Anaerobic microbial metabolism: Biogeochemical cycles in the anoxic environment with special reference to OMZs in the world oceans	15	CO1, CO2 K1, K3
Module 2:	Trophic interactions - microbial loop, food web dynamics, sources and composition of DOM, reactivity class of DOM, transformations and fate of dissolved organic matter (DOM) - chromophoric dissolved organic matter (CDOM), DOM release and microbial food webs - extracellular enzymes – and influence of climate change	15	CO2, CO3 K2, K3
Module 3:	Factors affecting microbial ecology and diversity in specialized ecosystems – anthropogenic impacts - greenhouse gases - global warming, ocean acidification, deoxygenation - implications on biogeochemical processes. Mitigation measures. Analytical techniques in microbial ecology – productivity, biomass.	15	CO4, CO5 K2, K3
Pedagogy:	Lectures/assignments/field trip		
References/ Readings:	<ol style="list-style-type: none"> 1. Dipper, F. and Tait, R.V. (1998). Elements of marine ecology, Butterworth-Heinemann, Oxford, U.K. 2. Gasol, J.M. and Kirchman, D.L. (2018). Microbial ecology of the oceans. Wiley- Blackwell Publishers, Oxford. 3. Munn, C.B. (2019). Marine microbiology: ecology and applications. CRC Press, Florida. 4. Nair, N.B. and Thampy, D.M. (1980). A textbook of marine ecology. Macmillan, Delhi. 		

- | | |
|--|---|
| | <p>5. Nybakken, J.W. and Bertness, M.D. (2004). Marine biology: an ecological approach. Benjamin- Cummings Pub Co., San Francisco.</p> <p>6. Webber, H.H. and Thurman, H.V. (1984). Marine biology. HarperCollins Publishers, New York.</p> |
|--|---|

[\[Back to Index\]](#)



Title of the Course	Practical in Microbial Ecology
Course Code	MMI-5013
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide hands-on training in microbial and biochemical techniques for assessing the abundance, productivity, and organic matter dynamics in marine environments.	
Course Outcomes:		Mapped to PSO
	CO 1. Recall standard methods for estimating microbial biomass, productivity.	PSO1, PSO2
	CO 2. Describe the ecological significance of microbial activity and organic matter in marine biogeochemical processes.	PSO1, PSO2
	CO 3. Perform laboratory techniques to enumerate the effect of various physicochemical parameters on the growth and survival of microbes in seawater samples.	PSO1, PSO2
	CO 4. Assess variations in microbial and biochemical parameters to infer environmental conditions or ecosystem productivity.	PSO1, PSO2

Content:		No of hours	Mapped to CO	Cognitive Level
1	Estimation of bacterial biomass	6	CO 1	K2. K3, K4
2	Estimation of productivity using light and dark bottle technique	8	CO 1	K2. K3, K4
3	Experiments on the effect of various physicochemical parameters (salinity, pH, alkalinity, varying DOC concentration) on the growth and survival of selected marine bacterial isolates.	16	CO1, CO2, CO3, CO4	K2. K3, K4
Pedagogy:	Laboratory experiments and field studies			
References/ Readings:	<ol style="list-style-type: none"> 1. Bratbak G. (1985). Bacterial biovolume and biomass estimations. <i>Appl Environ Microbiol.</i>, 49(6):1488-93. 2. Cappuccino, J. G., & Sherman, N. (1998). <i>Microbiology: A laboratory manual</i>. California: Benjamin/Cummings Science Publishing. 3. Krishna M.S., Prasad V.R., Sarma V.V.S.S., Reddy N.P.C., Hemalatha K.P.J., and Y.V. (2015). Fluxes of dissolved organic carbon and nitrogen to the northern Indian Ocean from the Indian monsoonal rivers. <i>Journal of Geophysical Research: Biogeosciences</i>, 120:2067–2080. 4. Selvaraj, G. S. D. (2005). Estimation of primary productivity (modified light and dark bottle oxygen method). In: <i>Mangrove ecosystems: A manual for the assessment of biodiversity</i>. 83, CMFRI Special Publication 			

[\[Back to Index\]](#)

Title of the Course	Analytical Techniques in Marine Microbiology
Course Code	MMI-5014
Number of Credits	3
Theory/Practical	Theory
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

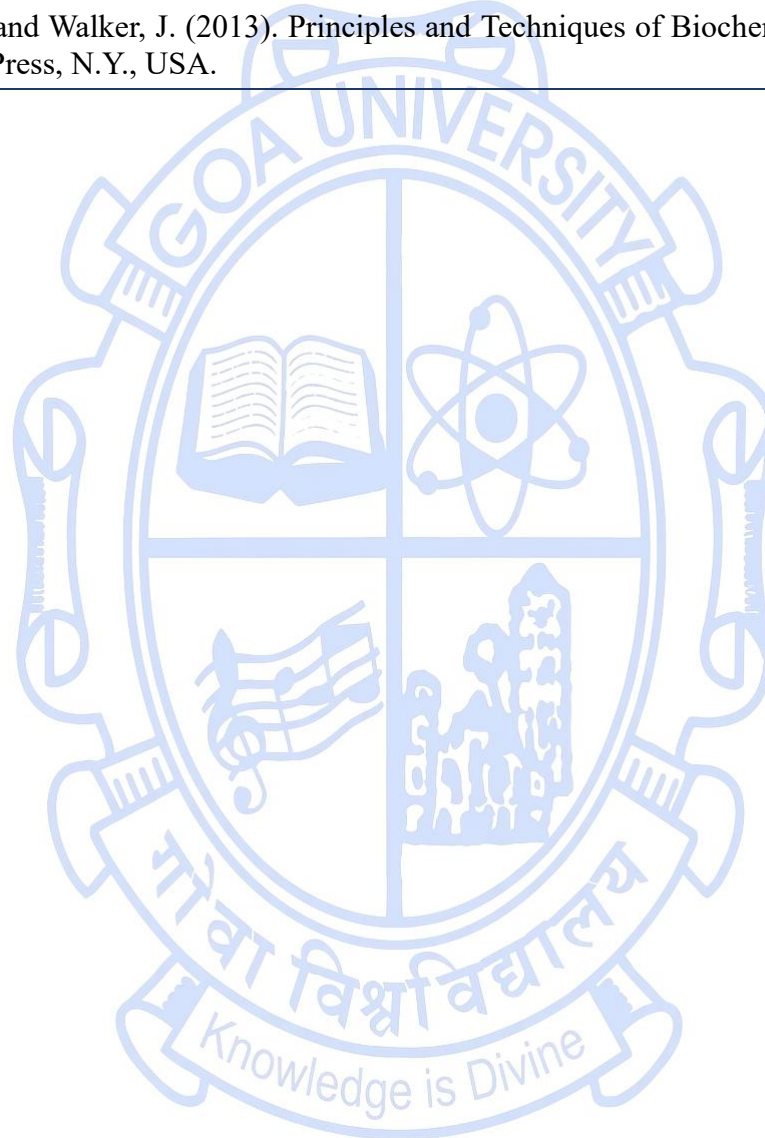
Pre-requisites for the Course:	Nil	
Course Objectives:	This course develops the concepts of methodology involved in studying the different aspects in microbiology and various techniques and instruments involved in metabolite analysis.	
Course Outcomes:		Mapped to PSO
	CO 1. Describe the principle, working and applications of various techniques/instruments.	PSO1, PSO4
	CO 2. Identify the proper Biosafety levels of the work proposed.	PSO1, PSO3, PSO4
	CO 3. Apply the knowledge to utilise the appropriate technique/instrument for any analysis.	PSO1, PSO4
	CO 4. Interpret the technique/instrument necessary for metabolite analysis.	PSO1, PSO4

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Chromatographic techniques: GC, HPLC, column/s matrix- Ion-exchange, affinity and molecular exclusion (using examples for separation of microbial lipids, pigments, nucleic acids and proteins/enzymes); Centrifugation: Principles, methodology, application; Density gradient centrifugation; Ultracentrifugation (Separation of ribosomal subunits of bacteria); Spectrophotometry: Atomic Absorption Spectrophotometry (AAS), UV-Visible, fluorimetry, Fourier transformation infra-red spectroscopy (FTIR), NMR, IRMS, ICP-MS, MALDI-TOF.	15	CO1, CO3, CO4	K3
Module 2:	Biohazards and Biosafety cabinet. Microscopy: Epifluorescence filter technique (DEFT), Electron microscopy, Phase contrast microscopy, Confocal microscopy; Radio-isotope and tracer techniques: Isotope and types of isotopes, Radio-activity counters, Autoradiography, Radiorespirometry; Cell and tissue culture techniques: Primary and secondary/established cell lines, Monolayer and suspension cultures, Fluorescence activated cell sorting (FACS).	15	CO1, CO2, CO3, CO4	K3
Module 3:	Electrophoretic techniques: PAGE, IEF, PFGE, DGGE, TGGE, Capillary electrophoresis, Single stranded conformation polymorphism (SSCP), Electroporator, Micro-array technique; Isolation of cell organelles: Different methods of cell lysis/ breakage and isolation and purification of various cell components - Cell surface structures, cell envelopes, plasma membranes, peptidoglycan, Outer membrane, ribosomes, protoplasts, spheroplast, DNA, RNA; X-ray diffraction, Oxygen analyser.	15	CO1, CO3, CO4	K3
Pedagogy:	Lectures/ assignments/ presentations/ research papers/ videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Colowick, S. P. and Kaplan, N. O. (1963). Methods in Enzymology, Vol. VI, Academic Press, N.Y. 2. Cooper, T. G. (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd., Noida. 3. Goswami, C., Paintal, A. and Narain, R. (2011). Handbook of Bioinstrumentation, Wisdom Press, New Delhi. 4. Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi. 5. Norris, J. R. and Ribbons, D. W. (1971). Methods in Microbiology, Volume 5, Part B, Academic Press, N.Y. 6. Parakhia, M. V., Tomar, R. S., Patel, S. and Golakiya, B. A. (2010). Molecular Biology and Biotechnology: 			

Microbial Methods, NIPA New Delhi, Pitampura.

7. Wilson, K. and Walker, J. (2013). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, N.Y., USA.

[\[Back to Index\]](#)



Title of the Course	Practical on Analytical Techniques in Marine Microbiology
Course Code	MMI-5015
Number of Credits	1
Theory/Practical	Practical
Level	500
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course develops the skills for techniques and instrumentation in microbiology.	
Course Outcomes:		Mapped to PSO
	CO 1. Demonstrate microbial cells under the microscope.	PSO1, PSO2
	CO 2. Analyse separation of microbes based on their cell densities.	PSO1, PSO2
	CO 3. Employ cell disruption technique and UV-visible spectrophotometry for intracellular pigment profiling.	PSO1, PSO2
	CO 4. Analyze proteins using polyacrylamide gel electrophoresis.	PSO1, PSO2
	CO 5. Learn separation of biomolecules using molecular exclusion chromatography.	PSO1, PSO2

Content:		No of hours	Mapped to CO	Cognitive Level
1	Microscopy – compound, phase contrast – of bacterial, fungal cells.	6	CO 1	K5
2	Density gradient separation of mixed bacterial and/or yeast cells.	6	CO 2	K5
3	Cell disruption of pigmented bacteria/yeast by sonicator, efficacy of sonication and pigment profiling using UV-visible spectrophotometer.	6	CO 3	K5
4	Polyacrylamide gel electrophoresis (PAGE).	6	CO 4	K5
5	Molecular exclusion chromatography.	6	CO 5	K5
Pedagogy:	Experiments in the laboratory			
References/ Readings:	<ol style="list-style-type: none"> Cooper, T. G. (2011). The Tools of Biochemistry, Wiley India Pvt. Ltd., Noida. Goswami, C., Paintal, A. and Narain, R. (2011). Handbook of Bioinstrumentation, Wisdom Press, New Delhi. Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International Publishers, New Delhi. Parakhia, M. V., Tomar, R. S., Patel, S. and Golakiya, B. A. (2010). Molecular Biology and Biotechnology: Microbial Methods, NIPA New Delhi, Pitampura. Wilson, K. and Walker, J. (2013). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, N.Y., USA. 			

[\[Back to Index\]](#)

Discipline Specific Elective (DSE) Courses

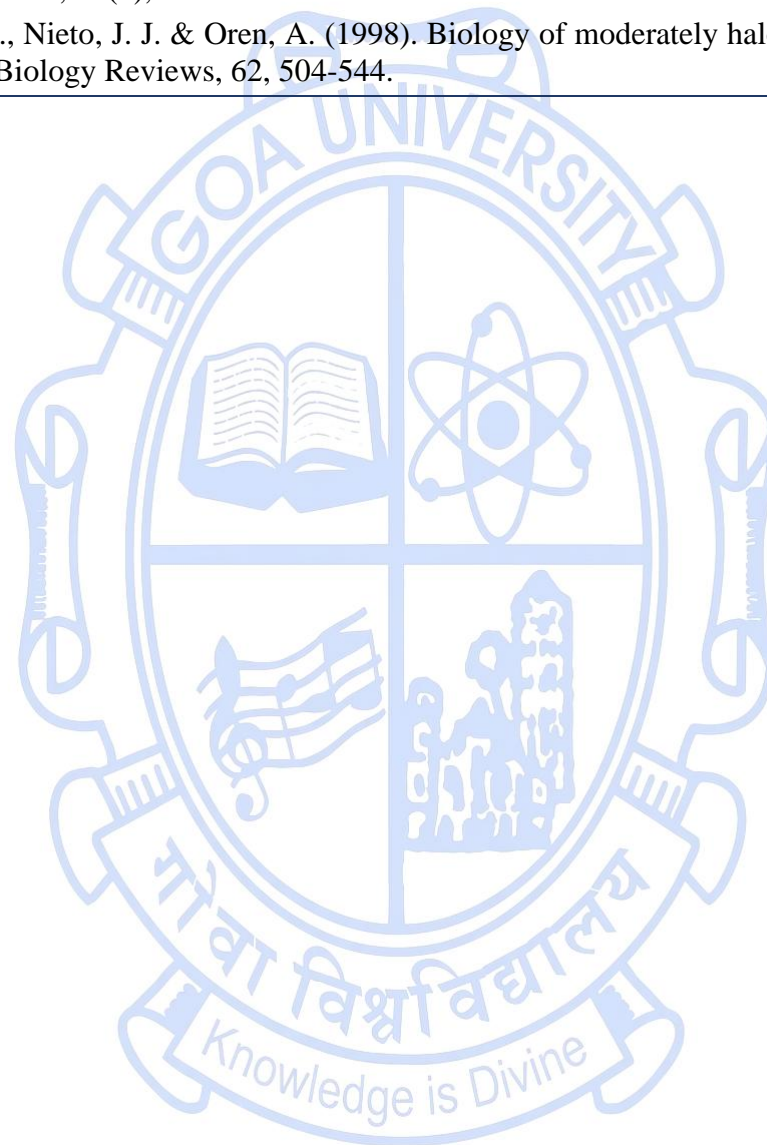
Title of the Course	Marine Extremophilic Microorganisms	
Course Code	MMI-5207	
Number of Credits	3	
Theory/Practical	Theory	
Level	400	
Effective from AY	2025-26	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	This course develops concepts relating to the ability of organisms to thrive in extreme marine ecosystems, their adaptations and biotechnological potential.	
Course Outcomes:		Mapped to PSO
	CO 1. Identify and describe diverse types of extreme niches in the marine environment.	PSO 1, PSO 2, PSO 5
	CO 2. Describe different types of extremophiles.	PSO 1, PSO 2, PSO 5
	CO 3. Critically evaluate the biotechnological potential of marine extremophilic microorganisms.	PSO 2, PSO 3
	CO 4. Describe the ecological significance of extremophilic microorganisms from the marine	PSO 1, PSO 2, PSO 5

	environment.			
	CO 5. Compare the adaptation strategies of different groups of extremophilic microorganisms from the marine environment.		PSO 1, PSO 2, PSO 5	
	CO 6. Discuss the application of extremophiles in astrobiology research and bioremediation.		PSO 1, PSO 2, PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Concept of extremophiles. Extreme marine ecomiche and their characteristics: marine trenches and ridges, submarine vents, cold seeps, deep sea basins and polar sea ice, glaciers, cryoconite holes, lakes, polynyas. Types of extremophiles (anaerobes, barophiles/piezophiles, cryophiles/psychrophiles, thermophiles and hyperthermophiles. oligotrophs, osmophiles, halophiles, xerophiles, alkaliphiles, acidophiles, radiophiles, metallophiles and xenobiotic utilizers).	15	CO1, CO2, CO3	K1, K2
Module 2:	Adaptation strategies, physiological features of anaerobes, barophiles/ piezophiles, cryophiles/psychrophiles, thermophiles and hyperthermophiles. oligotrophs, osmophiles, halophiles, xerophiles, alkaliphiles, acidophiles, radiophiles, metallophiles and xenobiotic utilizers.	15	CO4, CO5, CO6	K2, K3
Module 3:	Techniques used for isolation and characterization of diverse extremophilic groups: specialized equipment, media constituents, incubation conditions. application of selected extremophiles (thermophiles, psychrophiles, radiophiles, halophilic archaea) in astrobiology research. Biotechnological potential of extremophiles including in food, textile, and pharmaceutical industries. Application of extremophiles in bioremediation.	15	CO4, CO5, CO6	K2, K3
Pedagogy:	Lectures/ assignments/ videos.			
References/ Readings:	<ol style="list-style-type: none"> 1. Brock, T. D. (2012). Thermophilic Microorganisms and Life at High Temperatures, Springer, New York. 2. Morita, R. Y. (1999). Extremophiles: Microbial life in extreme environments, Bioscience, 49(3), 245-248. 3. Rainey, F. A. & Oren, A. (2006). Extremophile microorganisms and the methods to handle them. Methods in Microbiology, 35, 1-25. 4. Satyanarayana, T., Raghukumar, C. & Shivaji, S. (2005). Extremophilic microbes: diversity and perspectives. 			

Current Science, 89(1), 78-90.

5. Ventosa, A., Nieto, J. J. & Oren, A. (1998). Biology of moderately halophilic aerobic bacteria. *Microbiology and Molecular Biology Reviews*, 62, 504-544.

[\[Back to Index\]](#)



Title of the Course	Practicals on Marine Extremophilic Microorganisms
Course Code	MMI-5208
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to widen the students' understanding of the techniques involved in sampling extreme marine environments and processing and characterization procedures, for different categories of extremophiles.	
Course Outcomes:		Mapped to PSO
	CO 1. Understand the differences in culturing techniques for different groups of extremophiles.	PSO 1
	CO 2. Develop skills in isolation of different groups of extremophiles.	PSO 2
	CO 3. Design experiments to characterize different groups of extremophiles.	PSO 2, PSO 5
	CO 4. Evaluate the growth characteristics of microorganisms with respect to varying salt and nutrient concentrations.	PSO 2, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
1	Isolation of anaerobes (deep culture tubes/candle jar method/anaerobic jars).	8	CO1	K2, K3, K5
2	Techniques for isolation of xenobiotic-degraders and organic solvent-tolerant bacteria.	7	CO1, CO2	K2, K3, K5
3	Effect of varying salt concentrations on growth of halophiles/halotolerant microbes.	8	CO3, CO4	K2, K4, K5
4	Growth of bacterial isolates at varying nutrient concentrations (nitrate and phosphate).	7	CO3, CO4	K2, K4, K5
Pedagogy:	Experiments in the laboratory			
References/ Readings:	<ol style="list-style-type: none"> 1. Kéki, Z., Grébnér, K., Bohus, V., Márialigeti, K., & Tóth, E. (2013). Application of special oligotrophic media for cultivation of bacterial communities originated from ultrapure water. <i>Acta Microbiologica et Immunologica Hungarica</i>, 60(3), 345-357. 2. Rainey, F. A. & Oren, A. (2006). Extremophile microorganisms and the methods to handle them. <i>Methods in Microbiology</i>, 35, 1-25. 3. Russell, N. J. (2006). Antarctic micro-organisms: coming in from the cold. <i>Culture</i>, 27(2), e989. 4. Sardesai, Y. & Bhosle, S. (2002). Tolerance of bacteria to organic solvents. <i>Research in Microbiology</i>, 153, 263-268. 5. Uchino, Y. & Ken-Ichiro, S. (2011). A simple preparation of liquid media for the cultivation of strict anaerobes. <i>Petroleum and Environmental Biotechnology</i>, S3:001. doi:10.4172/2157-7463.S3-001. 6. Ventosa, A., Nieto, J. J. & Oren, A. (1998). Biology of moderately halophilic aerobic bacteria. <i>Microbiology and Molecular Biology Reviews</i>, 62, 504-544. 			

[\[Back to Index\]](#)

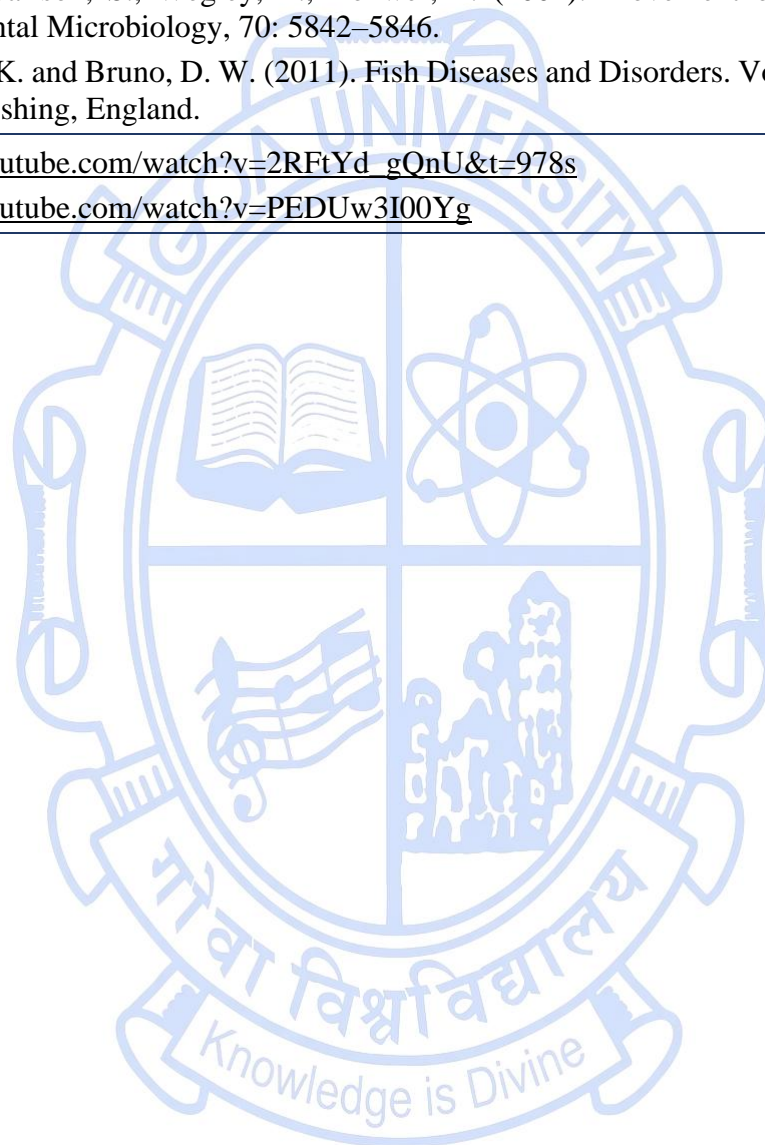
Title of the Course	Marine Virology
Course Code	MMI-5209
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	This course introduces the fundamental concepts of viruses in the marine environment. It covers diverse approaches used to study marine viruses, highlights their ecological roles and significance in marine ecosystems, and provides insights into select viral diseases affecting fish, shrimp, and shellfish.	
Course Outcomes:		Mapped to PSO
	CO 1. Compare viruses from the marine environment infecting different hosts.	PSO 1, PSO 5
	CO 2. Understand and apply various instruments and techniques for characterizing marine bacteriophages and directly enumerating viruses in natural samples.	PSO 1, PSO 2
	CO 3. Evaluate the significance of viruses to the marine environment and global climate change.	PSO 1, PSO 5
	CO 4. Predict the effect of viral infection on different fish species.	PSO 1, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Virus Structure, Diversity and Assay: Marine Viruses – Introduction, nature, structure and classification (ICTV and Baltimore), New system of classification; Marine phages and their host: Archaea, bacteria and cyanobacteria, phytoplankton, algae; Marine viruses and their hosts: fish and shrimp; Giant marine virus	15	CO1	K4
Module 2:	Significance of viruses in marine ecosystem: Viral shunt, Role in biogeochemical cycles, Movement of viruses between biomes; Effect of viruses on ecology of the marine ecosystem; Marine viruses and global climate change; Viral pathogens of fish and shellfish.	15	CO2	K2, K4
Module 3:	Techniques in marine virology: Multiplication and Assay of Phages and Viruses: Bacteriophage life cycles - lysogenic (latent) and lytic (virulent); Viral multiplication; One step growth profile; Assay: plaque assay (PA); most-probable number (MPN); epifluorescence microscopy, flow cytometry, transmission electron microscopy, Viral productivity, Metagenomic approaches to study the diversity of marine viruses	15	CO3, CO4	K3, K4
Pedagogy:	Lectures/ assignments/ Videos.			
References/ Readings:	<ol style="list-style-type: none"> 1. Bosch, A., Le Guyader, S.F. (2010). Viruses in Shellfish and Food, <i>Environmental Virology</i> 2: 115-116. 2. Breitbart, M., Thompson, L. R., Suttle, C. A., Sullivan, M. B. (2007). Exploring the Vast Diversity of Marine Viruses. <i>Oceanography</i>, 20: 135-139. 3. Coutinho, F.H., Gregoracci, G.B., Walter, J.M., Thompson, C.C., and Thompson, F.L. (2018). Metagenomics sheds light on the ecology of marine microbes and their viruses, <i>Trends in Microbiology</i>, 26: 955-965. 4. Crane, M., Hyatt, A. (2011). Viruses of Fish: An Overview of Significant Pathogens. <i>Viruses</i>, 3: 2025–2046. 5. Danovaro, R., Corinaldesi, C., Dell’Anno, A., Fuhrman, J.A., Middelburg, J.J., Noble, R.T., Suttle, C.A. (2011). Marine viruses and global climate change. <i>FEMS Microbiology Reviews</i>, 35: 993–1034. 6. Davis, B. D., Dulbecco, R., Eisen, H. N. and Ginsberg, H. S. (1982). <i>Microbiology</i>, Harper and Row Publishers, N.Y. 7. Rohwer, F., Thurber, R. V. (2009). Viruses manipulate the marine environment. <i>Nature</i>, 459: 207-212. 			

	<p>8. Sano, E., Carlson, S., Wegley, L., Rohwer, F. (2004). Movement of Viruses between Biomes. Applied and Environmental Microbiology, 70: 5842–5846.</p> <p>9. Woo, P. T. K. and Bruno, D. W. (2011). Fish Diseases and Disorders. Vol 3: Viral, Bacterial and Fungal Infections. CABI Publishing, England.</p>
Web Resources:	<p>https://www.youtube.com/watch?v=2RFtYd_gQnU&t=978s</p> <p>https://www.youtube.com/watch?v=PEDUw3I00Yg</p>

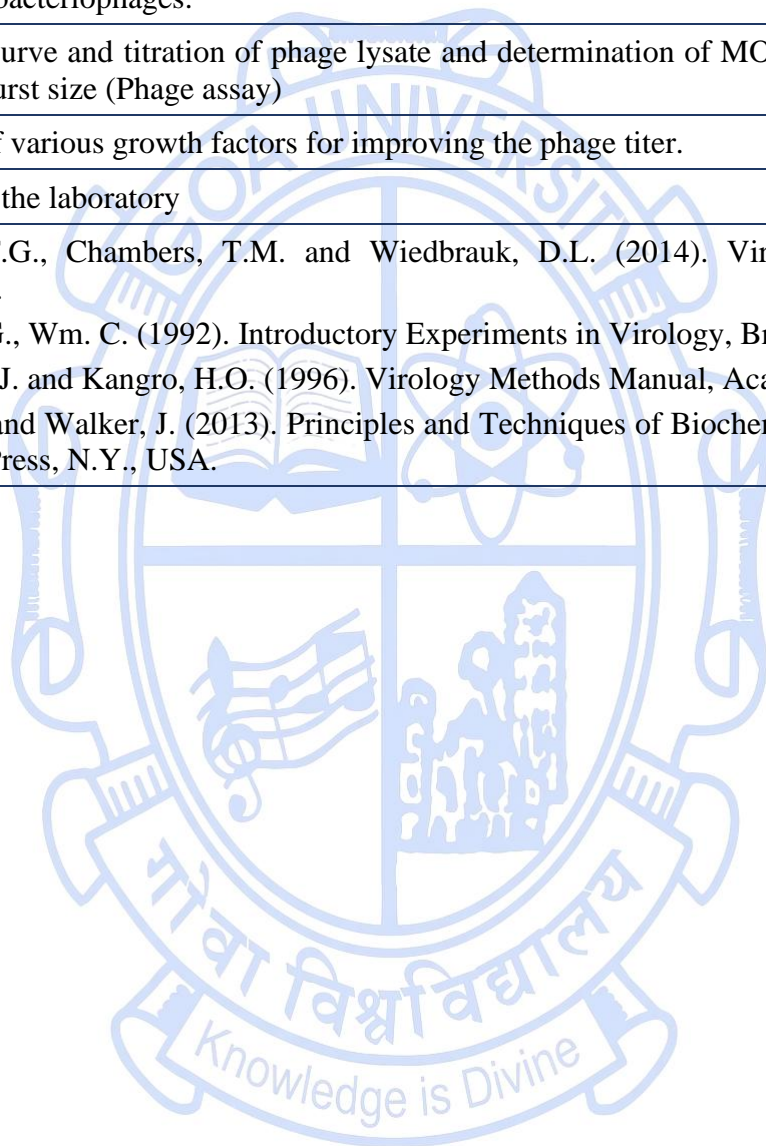
[\[Back to Index\]](#)



Title of the Course	Practical in Marine Virology
Course Code	MMI-5210
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil			
Course Objectives:	This course develops the skills for handling bacterial viruses.			
Course Outcomes:		Mapped to PSO		
	CO 1. Demonstrate working with marine samples for the isolation of bacteriophages.	PSO 2		
	CO 2. Discuss various techniques for bacteriophage characterization.	PSO 2		
	CO 3. Identify the phases of the phage growth curve.	PSO 2		
	CO 4. Design the work plan for bacteriophage work from an environmental sample.	PSO 2, PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level
1	Isolation of marine bacteriophages by double agar layer method.	3	CO1, CO4	K5, K6

2	Purification of bacteriophages.	3	CO2, CO4	K5, K6
3	Phage growth curve and titration of phage lysate and determination of MOI, latent period, burst size (Phage assay)	12	CO3, CO4	K3, K4, K5, K6
4	Optimization of various growth factors for improving the phage titer.	12	CO3, CO4	K3, K4, K5, K6
Pedagogy:	Experiments in the laboratory			
References/ Readings:	<ol style="list-style-type: none"> 1. Burleson, F.G., Chambers, T.M. and Wiedbrauk, D.L. (2014). Virology: A Laboratory Manual, Elsevier, Netherlands. 2. Goldstein, G., Wm. C. (1992). Introductory Experiments in Virology, Brown & Benchmark Publishers, Ohio. 3. Mahy, B.W.J. and Kangro, H.O. (1996). Virology Methods Manual, Academic Press, N.Y. 4. Wilson, K. and Walker, J. (2013). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, N.Y., USA. 			



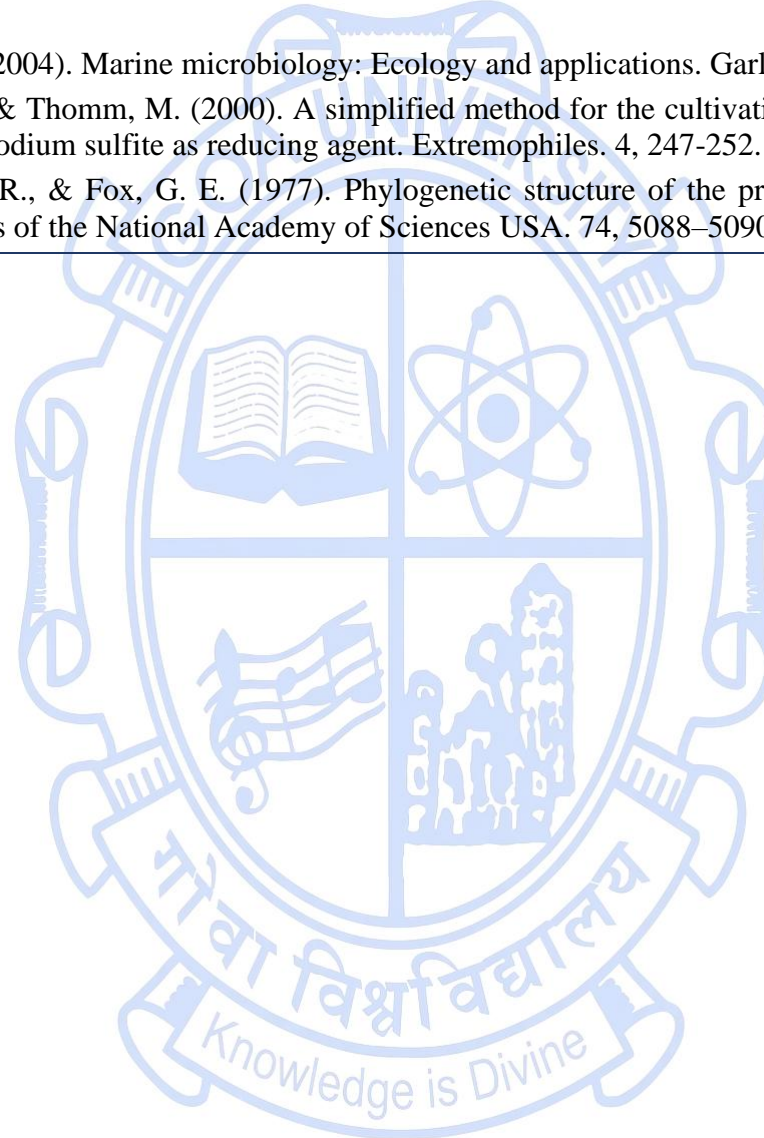
Title of the Course	Archaea
Course Code	MMI-5211
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course develops concept of three domains of life, ecology, physiology, diversity, cell structure, metabolism, energetics and genetics of archaea.			
Course Outcomes:		Mapped to PSO		
	CO 1. Classify and summarize the types of archaea.	PSO1		
	CO 2. Describe the ecological niches and culturability	PSO1		
	CO 3. Draw the biochemical pathways and calculate its energetics	PSO1, PSO2		
	CO 4. Understand the genetic makeup of archaea and emphasize its uniqueness	PSO1		
CO 5. Explain the gene organisation and compare the operons in archaea	PSO1, PSO2			
Content:		No of	Mapped	Cognitive

		hours	to CO	Level
Module 1:	Carl Woese's three domain classification of life, classification of archaea. Cellular organization of archaea. Ecology, physiology and diversity of Archaea. Nutrition, growth and growth kinetics and physiological versatility. Stress response of methanogenic, halophilic, thermophilic, thermoacidophilic, barophilic, alkaliphilic and psychrophilic archaea. Methanotrophs, methylotrophs. Global niches: deep sea, hydrothermal vents, Dead Sea, solar salterns, geothermal vents, solfataras, Antarctica, soda lake. Study of archaeal diversity. Unculturable archaeal studies by metagenomics. Archaeal culture retrieval methods. Novel samplers. Preservation and maintenance of archaeal cultures. Significance of Archaea: biogeochemical cycling, biotechnology.	15	CO1, CO2	K1, K2
Module 2:	Metabolism and energetics of Archaea: modified anabolic pathways of carbohydrates and lipids, methanogenesis and acetoclastic reactions. Modified central metabolic pathways – EMP, ED, incomplete TCA, reverse Krebs cycle, carbon dioxide reduction pathways – reductive acetyl-CoA pathway, 3-hydroxypropionate pathway. Chemolithoautotrophy. Bioenergetics – ATP synthesis (i) respiration-driven; (ii) light-driven, involving bacteriorhodopsin; and (iii) chloride-driven, involving halorhodopsin.	15	CO3	K1-K3
Module 3:	Genome of Archaea: size of genome, G + C content, associated proteins, archaeal histones and nucleosomes, introns in archaea. Archaeal RNA polymerases, reverse DNA gyrase. Plasmids, transposons -IS elements. Modifications in tRNA and rRNA structure. Novel 7S rRNA. DNA replication, transcription and translation in archaea. Gene organization in Archaea: (i) <i>his</i> operon; (ii) <i>bob</i> operon; and (iii) <i>mcr</i> operon.	15	CO4, CO5	K1-K3
Pedagogy:	Lectures/assignments.			
References/ Readings:	<ol style="list-style-type: none"> Boone, D. R., & Castenholz, R. W. (1984). <i>Bergey's manual of systematic bacteriology</i>. Vol. I, The Archaea and the deeply branching and phototrophic bacteria. Springer. Cavicchioli, R. (2007). <i>Archaea: Molecular and cellular biology</i>. ASM Press. Corcelli, A., & Lobasso, S. (2006). Characterization of Lipids of Halophilic Archaea. <i>Methods in Microbiology</i>. 35, 585-613. 			

4. Garrett, R. A., & Hans-Peter, K. (2007). Archaea: Evolution, physiology and molecular biology. John Wiley and Sons.
5. Munn, C. (2004). Marine microbiology: Ecology and applications. Garland Science, Taylor and Francis Group.
6. Rothe, O., & Thomm, M. (2000). A simplified method for the cultivation of extreme anaerobic archaea based on the use of sodium sulfite as reducing agent. *Extremophiles*. 4, 247-252.
7. Woese, C. R., & Fox, G. E. (1977). Phylogenetic structure of the prokaryotic domain: the primary kingdoms. *Proceedings of the National Academy of Sciences USA*. 74, 5088–5090.

[\[Back to Index\]](#)

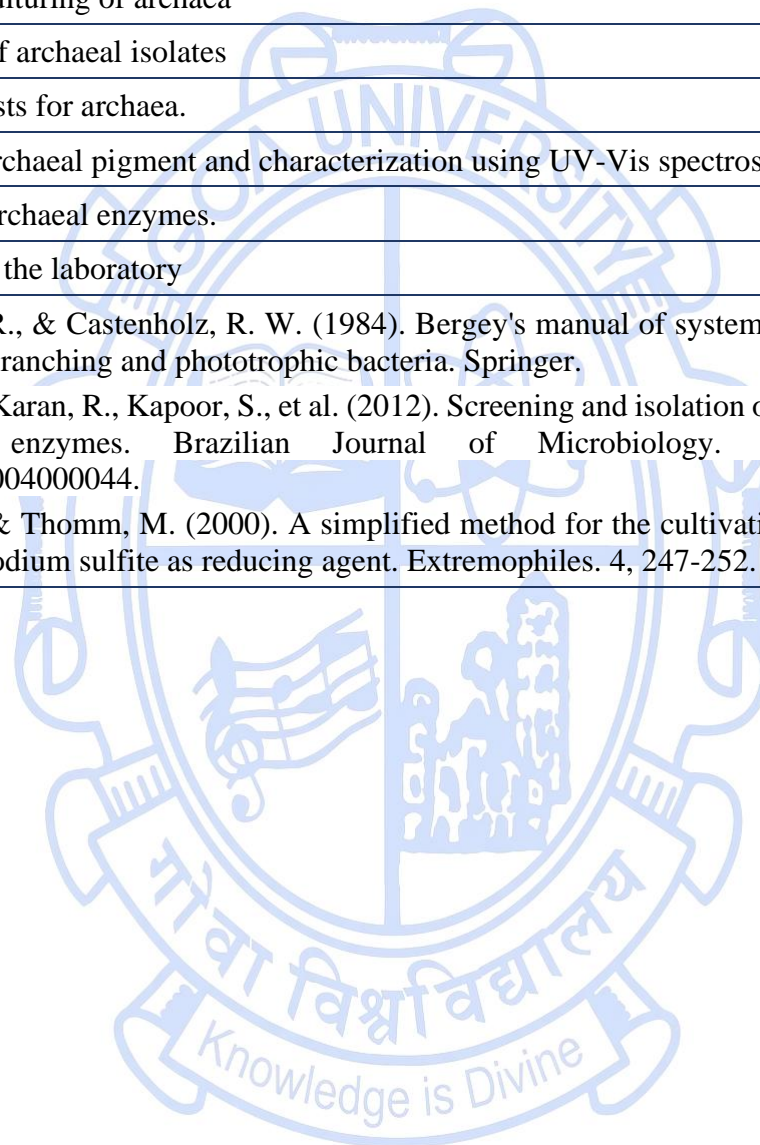


Title of the Course	Practical on Archaea
Course Code	MMI-5212
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course focuses on sampling, isolation and identification techniques of archaea from different niches and the study of archaeal pigments.			
Course Outcomes:		Mapped to PSO		
	CO 1. Analyse samples from different niches for archaea	PSO 1, PSO 2		
	CO 2. Perform isolation, culturing and identification of archaea.	PSO 1, PSO 2		
	CO 3. Carry out bioprospecting of bioactive molecules from archaea.	PSO 4		
	CO 4. Assess the archeal isolates for industrially important enzymes	PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level

1	Isolation and culturing of archaea	6	CO 1	K4, K5
2	Identification of archaeal isolates	6	CO 2	K3-K6
3	Biochemical tests for archaea.	6	CO 2	K4, K5
4	Extraction of archaeal pigment and characterization using UV-Vis spectroscopy.	6	CO 3	K4, K5
5	Screening for archaeal enzymes.	6	CO3, CO4	K4, K5
Pedagogy:	Experiments in the laboratory			
References/ Readings:	<ol style="list-style-type: none"> Boone, D. R., & Castenholz, R. W. (1984). <i>Bergey's manual of systematic bacteriology</i>. Vol. I, The Archaea and the deeply branching and phototrophic bacteria. Springer. Kumar, S., Karan, R., Kapoor, S., et al. (2012). Screening and isolation of halophilic bacteria producing industrially important enzymes. <i>Brazilian Journal of Microbiology</i>. 43(4),1595-603. doi: 10.1590/S1517-838220120004000044. Rothe, O., & Thomm, M. (2000). A simplified method for the cultivation of extreme anaerobic archaea based on the use of sodium sulfite as reducing agent. <i>Extremophiles</i>. 4, 247-252. 			

[\[Back to Index\]](#)

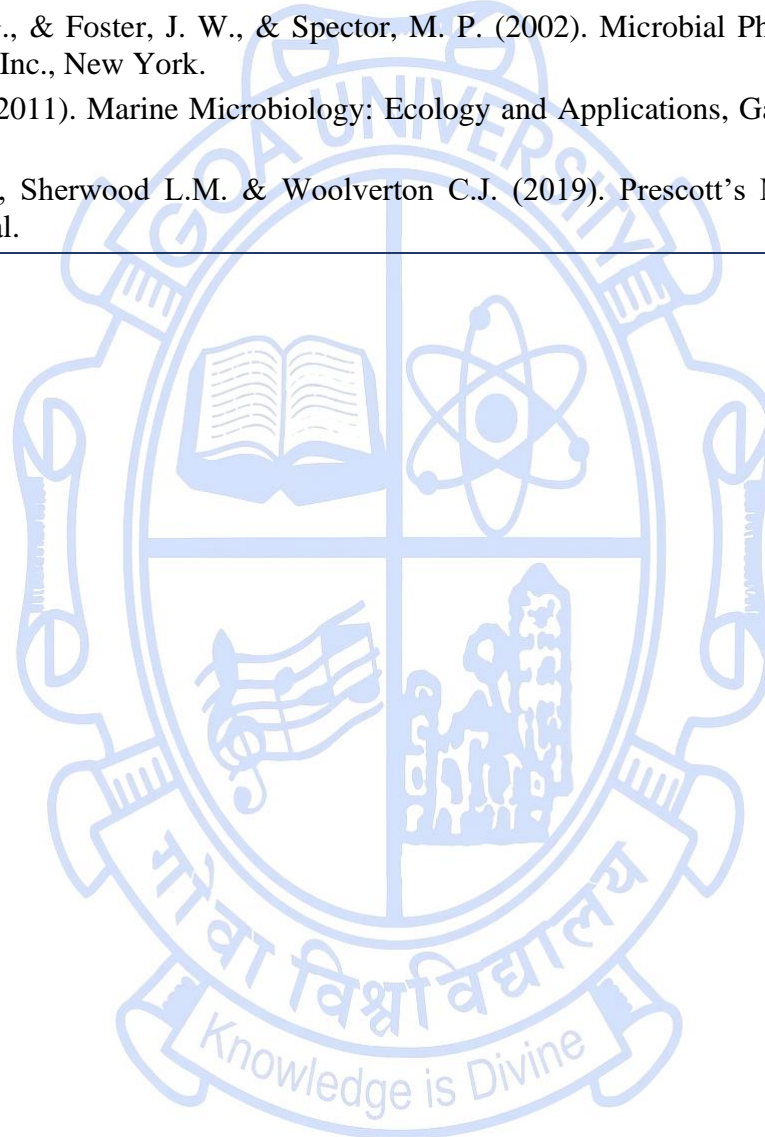


Title of the Course	Microbial Physiology and Interactions		
Course Code	MMI-5213		
Number of Credits	3		
Theory/Practical	Theory		
Level	400		
Effective from AY	2025-26		
New Course	Yes		
Bridge Course/ Value added Course	No		
Course for advanced learners	No		
Pre-requisites for the Course:	Nil		
Course Objectives:	This course aims to deepen students' understanding of the diverse protist groups in the marine environment, and focuses on the diverse physiological and nutritional strategies of microorganisms, and their interactions within and across trophic levels.		
Course Outcomes:		Mapped to PSO	
	CO 1. Describe the diverse protists and their features in the marine environment.	PSO 1, PSO 5	
	CO 2. Describe the physiological and nutritional characteristics of marine microorganisms.	PSO 1, PSO 5	
	CO 3. Summarize the interactions of marine microorganisms within and across trophic levels.	PSO 2, PSO 5	
	CO 4. Analyze the role and significance of quorum sensing in communication within and across trophic levels.	PSO 2, PSO 5	
Content:		No of	Mapped Cognitive

		hours	to CO	Level
Module 1:	Characteristics of protists: eukaryotic cell surfaces and organelles, organs of locomotion (cilia and flagella), chemotaxis; diverse protists in the marine environment: euglenids, bicosoecids, choanoflagellates, dinoflagellates, ciliates, haptophytes, diatoms, raphidophytes, stramenopiles, thraustochytrids, labrinthulids, amoebzoa, radiolarians, foraminifera; multiple marine protistan lineages in seven supergroups of the eukaryotic tree of life.	15	CO 1	K1, K2
Module 2:	Physiology and nutrition of marine microorganisms. Structure and organization of membranes: bilayer model, Danielli-Davson's trilaminar sandwich model, Robertson's unit membrane model, Singer and Nicholson's fluid mosaic model; protein diffusion, osmosis, fluidity and permeability of membranes; transport and translocation of metabolites and proteins across membranes: facilitated diffusion; active transport (primary active transport, ABC Transporters; and secondary active transport, chemiosmotic-driven transport); vesicular transport (endocytosis and exocytosis); mechanosensitive channels, ATP-linked ion motive pumps; siderophores and iron transport; osmotic stress and osmoregulation; osmotic control of gene regulation. Metabolic diversity: Phototrophy, chemotrophy, thiotrophy, autotrophy, mixotrophy, heterotrophy; acquired phototrophy; photosynthesis, anaerobic anoxygenic photosynthesis, aerobic anoxygenic phototrophy.	15	CO 2	K1, K2
Module 3:	Microbial interactions. The paradox of the plankton; interactions within and across trophic levels (allelopathic interactions); chemical ecology; signalling molecules, quorum sensing, types of autoinducers (Acyl Homoserine Lactone molecules, peptides, pheromones); quorum sensing in biofilms; bioluminescence; quorum quenching; intra-species, inter-species and cross-kingdom interactions in marine ecosystems; host-symbiont interactions (microbe-sponge interactions); indirect chemical defence of microalgae (nitric oxide, lipids).	15	CO 3, CO 4	K2, K3, K4
Pedagogy:	Lectures/ assignments/ videos.			
References/	1. Bassler, B.L., & Winnans, S.C. (2008). Chemical Communication Among Bacteria. ASM Press, United Kingdom.			

Readings:	<ol style="list-style-type: none">2. Caldwell, D. R. (1995). Microbial Physiology & Metabolism. Wm. C. Brown, Germany.3. Moat, A. G., & Foster, J. W., & Spector, M. P. (2002). Microbial Physiology. Microbial Physiology, 4th Edn. Wiley-Liss Inc., New York.4. Munn, C. (2011). Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, New York.5. Wiley J.M., Sherwood L.M. & Woolverton C.J. (2019). Prescott's Microbiology. 11th Edition. McGraw Hill International.
------------------	--

[\[Back to Index\]](#)



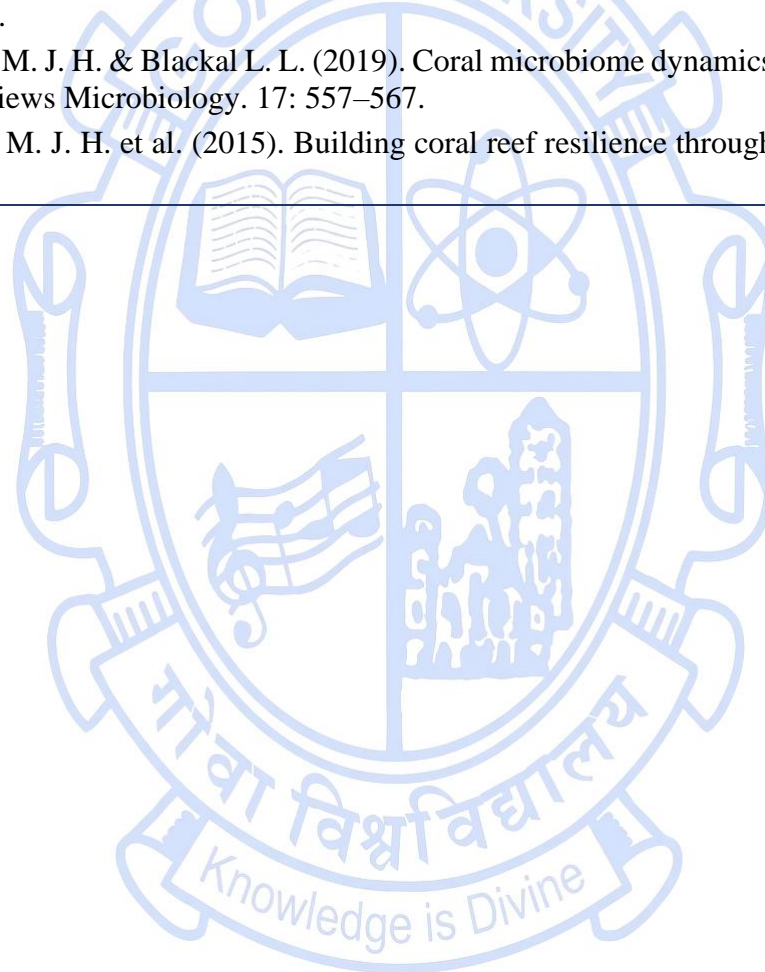
Title of the Course	Coral Ecosystem and Associated Microbiota
Course Code	MMI-5214
Number of Credits	3
Theory/Practical	Theory
Level	400
Effective from AY	2025-26
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course focuses on the various characteristics of coral ecosystems including the physico-chemical variables, evolution, survival strategies and associated microbial diversity.	
Course Outcomes:		Mapped to PSO
	CO 1. Understand the biodiversity of corals and their interactions.	PSO1
	CO 2. Describe coral ecosystem function and examine its economic implications.	PSO2, PSO3
	CO 3. Indicate the physico-chemical and biological factors influencing coral ecology.	PSO1
	CO 4. Create awareness of the impact of anthropogenic activities on coral health.	PSO5
	CO 5. Identify microbial infections in corals and understand their epidemiology.	PSO4
	CO 6. Survey the conservation and management strategies of damaged corals and their	PSO4, PSO5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	recovery. Introduction to Corals: Coral reef biology - Types of corals, composition, ecology, structure- anatomy and physiology. Types of coral reefs and their global distribution. Factors affecting coral reefs – Abiotic factors: pH, temperature, salinity, sedimentation, wave action, weather conditions, nutrient availability, pollution, aerial exposure, light. Biological factors: competitors, disease, predators, symbiotic relationships, nutrient flux. Natural and human disturbances to reefs and their impacts. Influence of microbes on coral health. Importance of coral reefs - Fisheries and marine products associated with coral reefs. Ecological importance of coral reefs. Cultivation and conservation of corals. Law and policy for conservation and management of corals in India, permissions for coral sample collection.	15	CO 1, CO 2	K1, K2
Module 2:	Microbial interaction with coral communities: Coral microbial communities and trophic structure. Microbes, Primary producers, consumers, food webs, productivity in coral reefs. Coral and microbiome dynamics – Coral holobiont. Rosenberg’s hologenome hypothesis, Adaptive bleaching hypothesis (ABH), Adaptive Dysbiosis hypothesis (ADH), Coral probiotic hypothesis, DDAMed Model, Influence of sponge loop on corals. Symbiotic associations: Algal-coral associations, bacterial symbiosis, Multi-partner symbiosis. Nutrient cycling.	15	CO 3, CO 4	K2, K3
Module 3:	Diagnosis and recovery of diseased/damaged corals: Microbial causative agents associated with coral diseases – Bacterial, fungal, viral and proteozoic infections disease spread assessment, treatment and recovery - Coral disease survey and monitoring protocols. Disease response plan. Outbreak management. Use of antibiotics and antioxidants for treating diseased corals. Phage therapy. Coral Restoration strategies carried out by national and international groups.	15	CO 5, CO 6	K5, K6
Pedagogy:	Lectures/ assignments/ videos.			
References/ Readings:	1. Chakravarti L. J., Van Oppen M. J. H. (2018). Experimental Evolution in Coral Photosymbionts as a Tool to Increase Thermal Tolerance. <i>Frontiers in Marine Science</i> . 5 :227.			

2. Contardi M. et al. (2020) Treatment of coral Wounds by combining an Antiseptic Bilayer film and an injectable Antioxidant Biopolymer. Scientific Reports.10: 988.
3. Munn C.B. (2019). Marine Microbiology: Ecology and Applications, CRC Press. Florida. 3. Jones O.A. & Endean R. (1973). Biology and Geology of coral reefs (1st edn). Academic Press. Cambridge.
4. Sheppard C., Davy S., Pilling G. & Graham N. (2018). The Biology of Coral Reefs (2nd edn). Oxford University Press. USA.
5. Van Oppen M. J. H. & Blackal L. L. (2019). Coral microbiome dynamics, functions and design in a changing world. Nature Reviews Microbiology. 17: 557–567.
6. Van Oppen M. J. H. et al. (2015). Building coral reef resilience through assisted evolution. PNAS. 112 (8): 2307-2313.

[\[Back to Index\]](#)

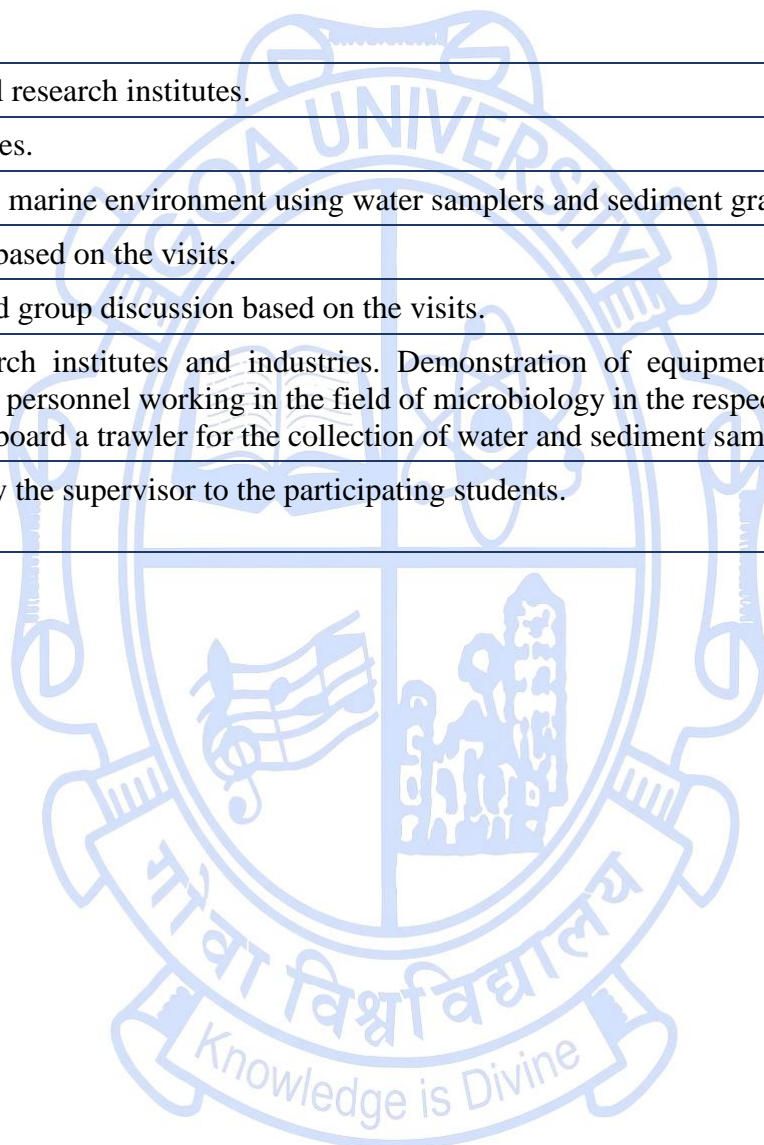


Title of the Course	Fieldtrip
Course Code	MMI-5215
Number of Credits	1
Theory/Practical	Practical
Level	400
Effective from AY	2025-26
New Course	No
Value added Course	Yes
Course for advanced learners	Yes

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide knowledge about the on-going research in various national research institutes, and the functioning of microbiology related industries and industrial processes. To provide hands-on experience in collection of water and sediment samples from the marine environment.	
Course Outcomes:		Mapped to PSO
	CO 1. Discover and examine the working of microbiology-related industries.	PSO1
	CO 2. Appraise on ongoing/recent research activities carried out in the fields of marine microbiology and oceanography.	PSO1, PSO2
	CO 3. Formulate work plans for the collection of water and sediment samples from the marine environment.	PSO2
	CO 4. Effectively communicate observations, findings, and analyses from the field trip through a well-organized report.	PSO4

Content:		No of hours	Mapped to CO	Cognitive Level
1	Visit to national research institutes.	30	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6
2	Visit to industries.			
3	Sampling in the marine environment using water samplers and sediment grabs.			
4	Report writing based on the visits.			
5	Presentation and group discussion based on the visits.			
Pedagogy:	Visits to research institutes and industries. Demonstration of equipment available with respective laboratories, interaction with personnel working in the field of microbiology in the respective institutes. Field trip visits to estuarine environments aboard a trawler for the collection of water and sediment samples.			
References/ Readings:	As suggested by the supervisor to the participating students.			

[\[Back to Index\]](#)



SEMESTER III

Research Specific Elective (RSE) Courses

Title of the Course	Phytoplankton Ecology and Genomics
Course Code	MMI-6000
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

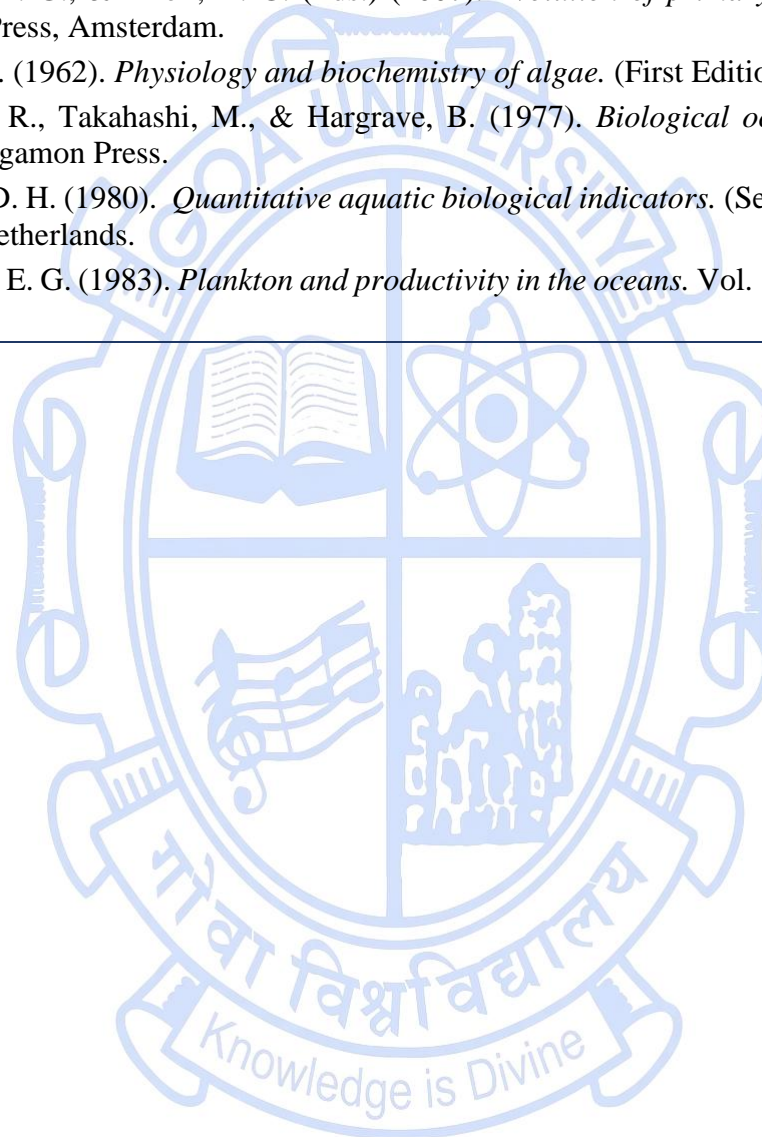
Pre-requisites for the Course:	Nil	
Course Objectives:	The students will learn the biology of marine photosynthetic phytoplankton, identifying and classifying phytoplankton from marine and estuarine habitats and recognizing its role in ocean biogeochemical cycles.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Understand the ecological importance of phytoplankton.	PSO 1
	CO 2. Describe characteristic features of marine phytoplankton	PSO 1
	CO 3. Identify and classify marine phytoplankton	PSO 1

	CO 4. Correlate the biological factors affecting plankton biomass and adaptations observed		PSO 1, PSO 2
	CO 5. Analyse the role of phytoplankton in DMS formation, CO ₂ sequestering and biogeochemical cycles		PSO 1, PSO 5
	CO 6. Indicate the harmful effects of blooms and red tides.		PSO 1, PSO 4
Content:		No of hours	Mapped to CO
Module 1:	Introduction to phytoplankton, evolution through geological time scale. Phytoplankton classification and diversity – major organelles and structural variations, morphological adaptations, division of phytoplankton based on size. Phytoplankton groups like diatoms, dinoflagellates, coccolithophores, microflagellates. Cyanobacteria, Chlorophytes, Heterokontophytes (emphasis on diatoms), Prymnesiophytes, Dinophytes, Cryptophytes, Raphidophytes, Rhodophytes. Phytoplankton distribution and its diversity indices; Phytoplankton biomass estimation, primary productivity; Phytoplankton enumeration techniques – Flow CAM and flow cytometry.	15	CO 1, CO 2 K1, K2, K3, K4
Module 2:	Biogeographic zones of distribution. Phytoplankton nutrition, nutrient requirements (N, P, Si), physiology and ecological significance; Photoautotrophic production, adaptations to physico-chemical and biological factors; Grazing defences (morphology, chemical defences, life cycle strategies, escape response); Marine food webs; Role in biogeochemical cycles. Biological pump, microbial loop; Phytoplankton and zooplankton interactions, phytoplankton-bacteria interactions.	15	CO 3, CO 4, CO 5 K1, K2, K3, K4, K5
Module 3:	Phytoplankton and environmental genomics; Genetic diversity and manipulation, barcoding and its applications; Applications of phytoplankton in CO ₂ sequestration, DMS production, biofuels and other commercial products, as live feed in aquaculture, secondary metabolites; Harmful algal blooms and toxin production, characterisation and causes of bloom formation, red tides, prevention and control. HNLC areas and iron fertilization.	15	CO 6 K1, K2, K3, K4, K5
Pedagogy:	Lectures/ assignments		

**References/
Readings:**

1. Falkowski, P. G., & Knoll, A. G. (Eds.) (2007). *Evolution of primary producers in the sea*. (1st Ed.), Elsevier Academic Press, Amsterdam.
2. Lewin, R.A. (1962). *Physiology and biochemistry of algae*. (First Edition), Academic Press, New York.
3. Parsons, T. R., Takahashi, M., & Hargrave, B. (1977). *Biological oceanography processes*. (Second Edition), Oxford: Pergamon Press.
4. Phillips, J. D. H. (1980). *Quantitative aquatic biological indicators*. (Second Edition), Applied Science Publishers, Springer, Netherlands.
5. Raymont, J. E. G. (1983). *Plankton and productivity in the oceans*. Vol. 1 and 2. (Second Edition). Pergamon Press, Toronto.

[\[Back to Index\]](#)



Title of the Course	Practicals in Phytoplankton Ecology
Course Code	MMI-6001
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To acquaint students about phytoplankton sampling and isolation. The course will enable the students to identify phytoplankton.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Perform sampling methods for phytoplankton.	PSO 1
	CO 2. Perform isolation and identification of phytoplankton.	PSO 1, PSO 2
	CO 3. Develop culturing methods and estimate biomass of phytoplankton.	PSO 1, PSO 2
	CO 4. Gain expertise in culturing of benthic diatoms using the extinction dilution method.	PSO 1, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	1. Sampling and collection of phytoplankton using a net and a Niskin sampler.	6	CO 1, CO 2	K1, K2, K3, K4
	1. Estimation of phytoplankton biomass.	6	CO 1, CO 2	K1, K2, K3, K4
	2. Microscopic Identification of phytoplankton.	6	CO 1, CO 2	K1, K2, K3, K4
	3. Culturing of diatoms and cyanobacteria (f/2, K medium).	6	CO 1, CO 2	K1, K2, K3, K4
	4. The extinction-dilution method for culturing of benthic diatoms.	6	CO 1, CO 2	K1, K2, K3, K4
Pedagogy:	On-site sampling and laboratory experiments.			
References/ Readings:	<ol style="list-style-type: none"> 1. Horner, R.A. (Ed.) (2002). A taxonomic guide to some common phytoplankton. Biopress, Bristol. 2. Thronsen, J. (1978). The dilution-culture method. In: Sournia, A. (Ed.). <i>UNESCO Monographs on oceanographic methodology</i>. Vol. 6, Phytoplankton manual. UNESCO Publishing, Paris. 3. Tomas, C.R. (1996). <i>Identifying marine diatoms and dinoflagellates</i>. Academic Press, US. 4. Tomas, C.R. (1997). <i>Identifying marine phytoplankton</i>. Academic Press, US. 			

[\[Back to Index\]](#)

Title of the Course	Marine Zooplankton Ecology and Microbial Interactions
Course Code	MMI-6002
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learner:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course will introduce students to the biology of marine zooplankton which are the free-floating microscopic animals in the sea. Students will gain a deeper insight into the role of zooplankton in marine ecology and ecosystem functioning. They will also learn about global programs related to ocean observations.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Discuss characteristics of zooplankton and associated microbes.	PSO 1, PSO 5
	CO 2. Describe new techniques for detection of zooplankton specimens.	PSO 2, PSO 3
	CO 3. Compare new techniques for zooplankton community analysis.	PSO 2, PSO 3
	CO 4. Discover on-going research at global scale through monitoring projects.	PSO 5
	CO 5. Evaluate the significance of zooplankton in marine environment with respect to food web dynamics (trophic interactions, nutrient cycling, vectors of toxins/microbes).	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	<p>Introduction to Zooplankton and Associated Microbial Communities: Classification based on size, ecology, as per depth distribution, length of planktonic life; Spatio-Temporal variation, Seasonal changes; Zooplankton transport in fronts and clines; microscale turbulence, vertical and ontogenic migration; Diversity and biomass: Feeding mechanism: Passive ambush feeding, Active ambush feeding, Feeding-current feeding, Cruise feeding;</p> <p>Calculation of feed rates, Intraguild predation; impact of zooplankton food selectivity on plankton dynamics and nutrient cycling; Zooplankton monitoring projects, Continuous plankton recorder surveys. Sampling constraints and instrumentation.</p>	15	CO 1, CO 4	K1, K2, K3, K4
Module 2:	<p>Systematics, Genomics and Molecular Detection: Systematics and morphology of the major groups such as copepods, rotifers, chaetognaths, euphausiids, mysids, ostracods, tintinnids, cnidarians; Growth, Reproduction and development lifecycles; Protists; Population genomics of marine zooplankton: Genomic resources, Mitogenomes, Transcriptomic resources, Genomic basis of adaptation, Metagenetics & metabarcoding, Molecular detection, Sandwich hybridization assay, Zooplankton diversity analysis through single-gene sequencing of community sample; Non-destructive genome skimming for aquatic copepods; Target Capture Sequencing for cross-species relevance; Single Cell Genomics approach for pico- and nano-sized protists.</p>	15	CO 2, CO 3	K1, K2, K3, K4
Module 3:	<p>Microbial interactions: Zooplankton associated microbial communities – prokaryotes, eukaryotes; aerobes, anaerobes; Ecological Significance of Zooplankton and Trophic Interactions: Zooplankton indicators of water quality; Zooplankton toxicity test methods for marine water quality evaluations; Effect of water quality on structure of zooplankton assemblages, anthropogenic pressure; Elemental stoichiometry of zooplankton, implications in nutrient cycling; microzooplankton stoichiometry plasticity; Association between Vibrios and zooplankton, Bacterial bioluminescence as a lure for marine zooplankton; Studies on the Interrelationships of Zooplankton and</p>	15	CO 5	K1, K2, K3, K4

	<p>Phytoplankton, Microcosm experiments for interactions between zooplankton, phytoplankton and microbial foodweb; Zooplankton impact on the trophic structure of phytoplankton, blooms, Zooplankton grazing; zooplankton as toxin vectors or toxin sink; Relevance of marine chemical ecology to zooplankton; zooplankton population dynamics influencing the recruitment success of pelagic fish stocks, Effect of microplastics and climate change on zooplankton.</p>			
Pedagogy:	Lectures/assignments/presentations/videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Omori, W. and Ikeda, T. (1984). <i>Methods in Marine Zooplankton Ecology</i>, John Wiley & sons, N.Y. 2. Harris, R., Wiebe, P., Lenz, J., Skjoldal, H.R., Huntley, M. (2000). <i>Zooplankton Methodology Manual</i>, ICES Academic Press, San Diego. 3. Dumont, H. (1984). <i>Tropical Zooplankton</i>, The Hogue Dr. W. Junk Publishers, USA. 4. Guglielmo, L. and Ianora, A. (1997). <i>Atlas of Marine Zooplankton Straits of Magellan: Amphipods, Euphausids, Mysids, Ostracods, and Chaetognaths</i>, Springer-Verlag, Berlin, Heidelberg. 5. Mitra, A. (2004). <i>Introduction to Marine Plankton</i>, Daya Publishing House, New Delhi. 6. Raymont, J.E.G., Burton, J.D., Dyer, K.R. (1980). <i>Plankton and Productivity in the Oceans: Zooplankton</i>, Pergamon Press, Oxford, UK. 7. Munn, C.B. (2011). <i>Marine Microbiology Ecology and Applications</i>, Garland Science, New York. 8. Ramaiah, N. (2004). <i>Marine Microbiology: Facets and Opportunities</i>, National Institute of Oceanography, Dona Paula, Goa. 			

[\[Back to Index\]](#)

Title of the Course	Practicals on Marine Zooplankton
Course Code	MMI-6003
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To get practical knowledge of handling the sampling, microscopy and grazing of zooplankton, and microorganisms associated with zooplankton.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Use the knowledge to conduct collection and preservation of zooplankton specimens.	PSO 1, PSO 2
	CO 2. Analyse microscopically different zooplankton groups based on morphology.	PSO 2, PSO 3
	CO 3. Analyse the zooplankton community based on grazing behaviour.	PSO 2, PSO 3
	CO 4. Apply the protocol for DNA isolation from zooplankton specimens that hold promise for future molecular identification and taxonomic analysis.	PSO 2, PSO 3

Content:		No of hours	Mapped to CO	Cognitive Level
1	Sampling of marine zooplankton	6	CO 1	K1, K2, K3
2	Identification of marine zooplankton up to different groups or order	6	CO 2	K1, K2, K3, K4
3	Grazing studies (dilution plot)	12	CO 3	K1, K2, K3, K4
4	DNA extraction from zooplankton specimens for PCR	6	CO 4	K1, K2, K3
Pedagogy:	Field work/ Laboratory experiments/ Tutorials			
References/ Readings:	<ol style="list-style-type: none"> 1. Fazhan, H., Waiho, K., and Shahreza, S. (2016). A simple and efficient total genomic DNA extraction method for individual zooplankton, <i>Springer Plus</i>, 5: 2049. 2. Guglielmo, L. and Ianora, A. (1997). <i>Atlas of Marine Zooplankton Straits of Magellan: Amphipods, Euphausiids, Mysids, Ostracods, and Chaetognaths</i>, Springer-Verlag, Berlin, Heidelberg. 3. Harris, R., Wiebe, P., Lenz, J., Skjoldal, H.R., Huntley, M. (2000). <i>Zooplankton Methodology Manual</i>, ICES Academic Press, San Diego. 4. Omori, W. and Ikeda, T. (1984). <i>Methods in Marine Zooplankton Ecology</i>, John Wiley & sons, N.Y. 			

[\[Back to Index\]](#)

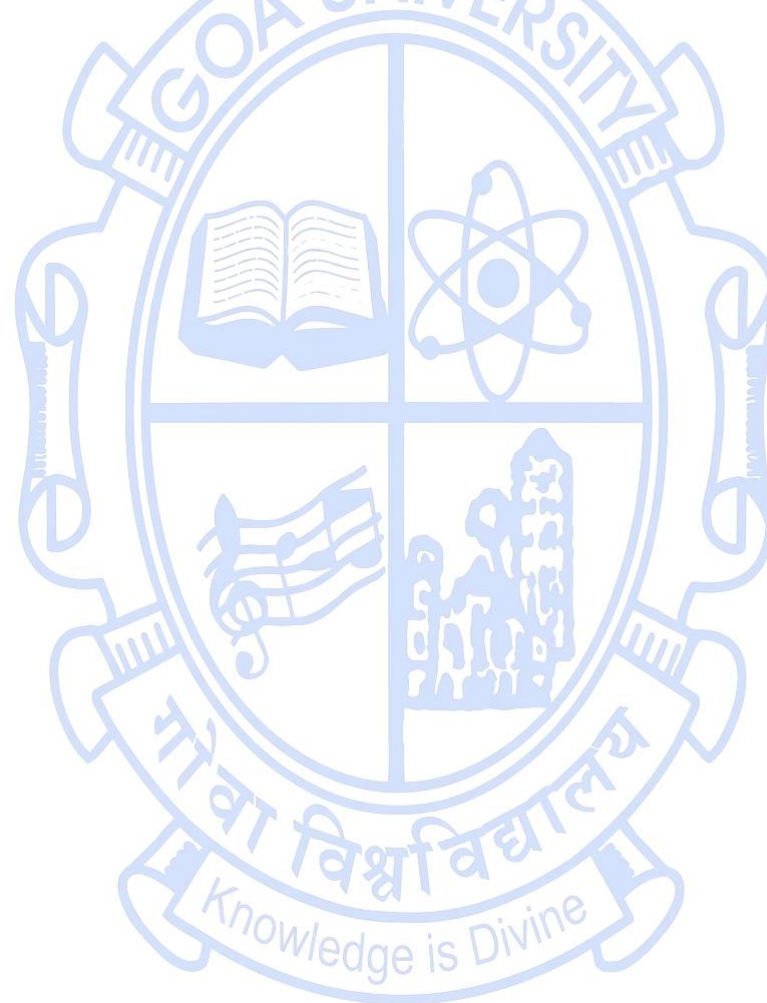
Title of the Course	Marine Microbial Prospecting and Technology
Course Code	MMI-6004
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course explores marine microbes as a potential source for isolation of novel compounds and the regulatory frameworks for their usage.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the concepts of bioprospecting and biopiracy.	PSO 1, PSO 4
	CO 2. Interpret and summarize the regulatory frameworks governing bioprospecting.	PSO 3, PSO 4
	CO 3. Understand the relevance of high throughput screening strategies in bioprospecting.	PSO 2, PSO 4
	CO 4. Identify and discuss analytical methods for detection of natural products from the marine environment.	PSO 2, PSO 4
	CO 5. Discuss the advantages of Geographical Indications (GI) tag.	PSO 1, PSO 4
	CO 6. Point out the commercial applications of natural products isolated from the marine	PSO 1, PSO 4

environment.				
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Bioprospecting: Concept of exploiting marine microbial resources; Microbes: free-living and associated with marine invertebrates, macroalgae, phytoplankton. Diversity of bio-active metabolites. Collection, sampling and analytical (chromatographic) techniques for natural product isolation; Sampling and search strategies for novel targets under: enzymes, therapeutics, antimicrobials and biofuels; Legal framework for collection and conservation of marine niches and microbes; Convention on Biological Diversity, Rio (1992/1994). Bioethics and Biosafety. Quarantine regulations. Biopiracy. Cartagena & Montreal Protocols, FAO International Treaty (2001-2004), Bonn Declaration on Access and Benefit-Sharing.	15	CO 1, CO 2	K1, K2, K3, K4
Module 2:	Conventional and high throughput screening strategy, Conventional: Plating, enrichment, advanced staining techniques using probes, extinction culturing, micro manipulations, optical tweezers, microautoradiography. Novel: Proteomics and metabolomics, genomics; Substrate-Induced Gene Expression Screens (SIGEX), catabolic gene expression screens, metagenomics, microarrays, combinatorial chemistry, combinatorial biosynthesis and biochemistry assays. Databases, natural product libraries.	15	CO 3, CO 4	K1, K2, K3, K4
Module 3:	Deposition of microbes and biomolecules. Culture collection/ repository, deposition of sequences of nucleic acids, proteins and structures of biomolecules. Geographical Indications (GI) tag. Commercial development of marine natural products like chitosan, algal products, SCPs, β -carotene and vitamins. Case studies on marine products and process development using microbes: archaea, cyanobacteria and proteobacteria.	15	CO 5, CO 6	K1, K2, K3, K4
Pedagogy:	Lectures/assignments/case-studies			
References/ Readings:	<ol style="list-style-type: none"> 1. Borkar, S. (2015). <i>Bioprospects of coastal Eubacteria</i>. Springer Publishers. 2. Bull, A. T. (2003). <i>Microbial diversity and bioprospecting</i>. ASM Press, Washington, D.C., US. 3. Goldman, E., & Green, L. H. (2019). <i>Practical handbook of microbiology</i>. (4th Ed), CRC Press, Boca Raton, Florida. 			

- | | |
|--|--|
| | <ol style="list-style-type: none">4. Kennish, M. J. (2019). <i>Practical handbook of estuarine and marine pollution</i>. CRC Press, Boca Raton, Florida.5. Kennish, M. J. (2022). <i>Practical Handbook of Marine Science</i>. (Fourth Edition), CRC Press, Boca Raton, Florida.6. Reddy, S. M., Charya, M. A. S., & Girisham, S. (2012). <i>Microbial diversity: Exploration and bioprospecting</i>. Scientific Publishers, Jodhpur, India. |
|--|--|

[\[Back to Index\]](#)

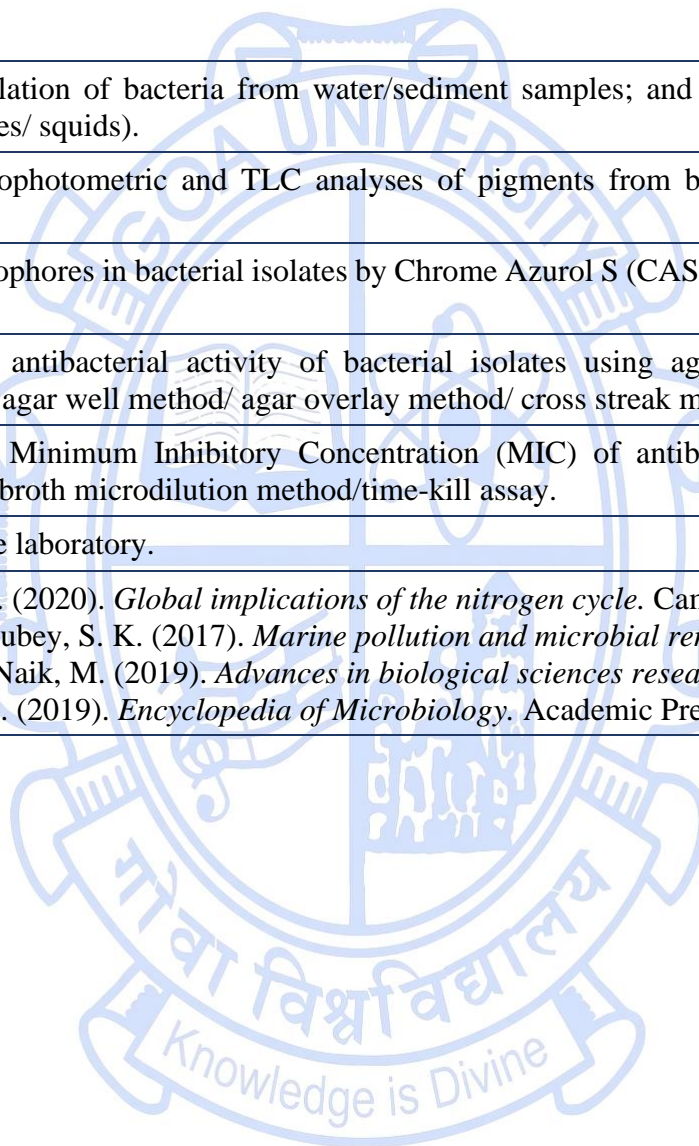


Title of the Course	Practicals in Marine Microbial Prospecting and Technology
Course Code	MMI-6005
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course develops skills for processing marine samples for bioprospecting.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Demonstrate skills in sampling and isolation of marine microorganisms for bioprospecting studies.	PSO 2, PSO 4
	CO 2. Discuss various techniques for screening of marine microorganisms for commercial products.	PSO 2, PSO 4
	CO 3. Select appropriate bioprospecting approaches for diverse commercial products.	PSO 2, PSO 4
	CO 4. Formulate a workplan for bioprospecting of microorganisms from the marine environment.	PSO 2, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
1	Sampling and isolation of bacteria from water/sediment samples; and marine organisms (bivalves/ squids).	6	CO 2, CO 4	K1, K2, K3, K4, K5, K6
2	Extraction, spectrophotometric and TLC analyses of pigments from bacterial isolates.	6	CO 2, CO 4	K1, K2, K3, K4, K5, K6
3	Detection of siderophores in bacterial isolates by Chrome Azurol S (CAS) assay.	6	CO 2, CO 4	K1, K2, K3, K4, K5, K6
4	Determination of antibacterial activity of bacterial isolates using agar disc diffusion method/ agar well method/ agar overlay method/ cross streak method.	6	CO 2, CO 4	K1, K2, K3, K4, K5, K6
5	Determination of Minimum Inhibitory Concentration (MIC) of antibacterial compounds using broth microdilution method/time-kill assay.	6	CO 2, CO 4	K1, K2, K3, K4, K5, K6
Pedagogy:	Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. De Sousa, T.S. (2020). <i>Global implications of the nitrogen cycle</i>. Cambridge Scholars Publishing, Newcastle, UK. 2. Naik, M., & Dubey, S. K. (2017). <i>Marine pollution and microbial remediation</i>, Springer Publications, Singapore. 3. Meena, S., & Naik, M. (2019). <i>Advances in biological sciences research</i>. Academic Press, London. 4. Schmidt, T. M. (2019). <i>Encyclopedia of Microbiology</i>. Academic Press, Cambridge, MA. 			

[\[Back to Index\]](#)



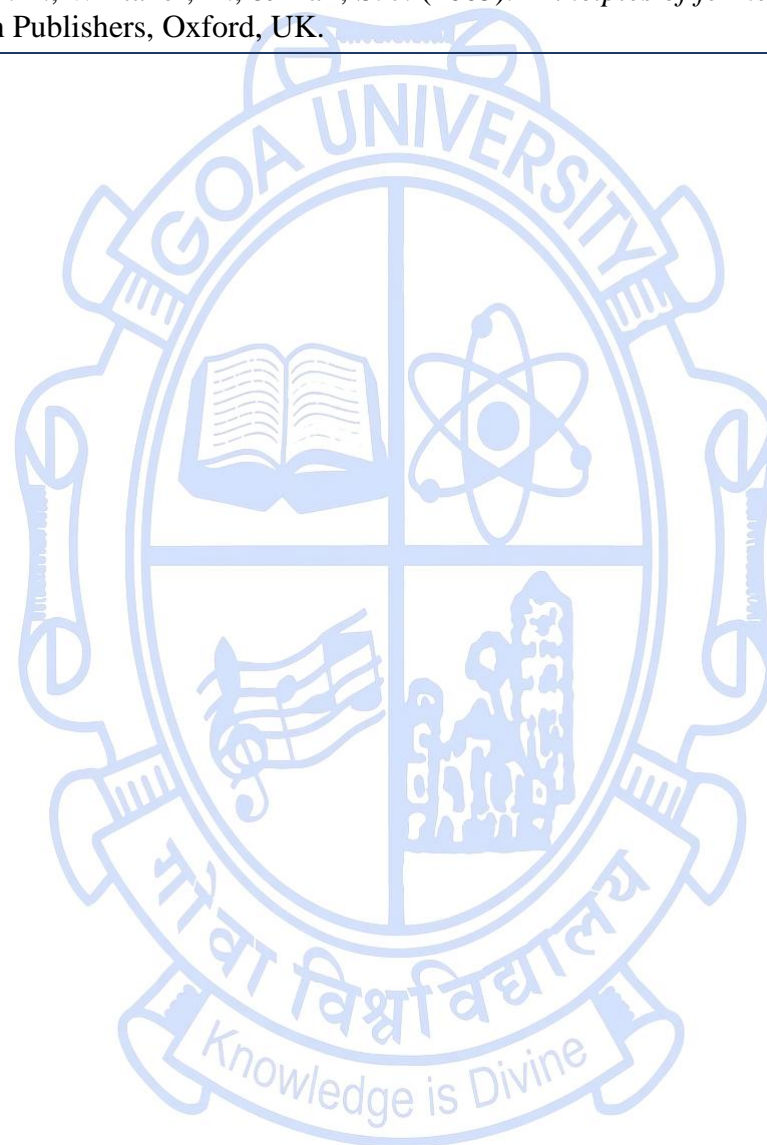
Title of the Course	Microbial Growth and Enzyme Kinetics
Course Code	MMI-6006
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course	Nil.			
Course Objectives:	Development of concepts in microbial enzymology and the microbial processes used in industries to produce microbial products.			
Course Outcomes:	Students will be able to	Mapped to PSO		
	CO 1. Differentiate microbial growth kinetics based on nutrient availability.	PSO 1, PSO 3		
	CO 2. Identify factors responsible for extra- cellular enzyme activity.	PSO 1, PSO 3		
	CO 3. Analyse regulation of enzymes under different cellular environments.	PSO 1, PSO 3		
	CO 4. Describe multienzyme systems in bacteria and protists.	PSO 1, PSO 3		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Microbial growth kinetics.	15	CO 1	K1, K2,

	Batch kinetics: Monod's model (single substrate), deviations from Monod's model, dual substrates, multiple substrates, substrate inhibition, product synthesis (primary and secondary metabolite), toxic inhibition, death constant; Fed-batch kinetics: fixed volume, variable volume and cyclic fed-batch, applications and examples; Continuous cultivation system: relationship between specific growth rate (μ) and dilution rate, comparison between various cultivation systems.			K3, K4
Module 2:	Enzyme kinetics: Michaelis - Menten Equation, Line-Weaver Burk plot for one substrate reactions, significance of V_{max} and K_m ; Enzyme turnover: K_s and K_d , its measurement and significance, mechanism of enzyme degradation and reversible and irreversible inhibition: competitive, uncompetitive and noncompetitive.	15	CO 2, CO 3	K1, K2, K3, K4
Module 3:	Enzyme catalysis mechanisms, identification of functional groups, factors affecting catalytic efficiency, proximity and orientation effects. Enzyme regulation: control of activity, availability of substrate and inhibitor or enhancer molecules, change in the covalent structure of enzyme; Regulatory enzymes: Allosteric (aspartate transcarbamylase) and covalently modulated enzymes (glycogen phosphorylase, glutamine synthetase); Mechanism of action and their significance in metabolism. Zymogens and isozymes; Multienzyme systems: disassociated system (catabolic enzymes), multienzyme complex (pyruvate dehydrogenase); membrane-bound system (electron carrying enzymes).	15	CO 2, CO 3, CO 4	K1, K2, K3, K4
Pedagogy:	Lectures/assignments/presentations/videos/performative (dramatization)			
References/ Readings:	<ol style="list-style-type: none"> Atkinson, B., & Mavituna, F. (1992). <i>Biochemical engineering and biotechnology handbook</i>. (2nd Ed), Stockton Press, New York. Dixon, M., & Webb, E. C. (2014). <i>Enzymes</i>. (2nd Ed) Elsevier, San Diego, CA. Flickinger, M. C., & Drew S. W. (2002). <i>The encyclopedia of bioprocess technology: Fermentation, biocatalysis and bioseparation</i>, Vols. 1 - 5, John Wiley Publishers, New Jersey, USA. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2008). <i>Principles of biochemistry</i>. (Fifth Edition), Worth Publishers, New York. Price N. C., & Stevens, L. (2009). <i>Fundamentals of enzymology</i>. (Third Edition), Oxford University Press, Oxford, UK. 			

- | | |
|--|---|
| | 6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2005). <i>Principles of fermentation technology</i> . (3 rd Ed.), Butterworth-Heinemann Publishers, Oxford, UK. |
|--|---|

[\[Back to Index\]](#)



Title of the Course	Practicals on Microbial Growth and Enzyme Kinetics
Course Code	MMI-6007
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil			
Course Objectives:	To understand microbial growth and enzyme kinetics.			
Course Outcomes:	Students will be able to	Mapped to PSO		
	CO 1. Estimate microbial growth in different nutrient conditions.	PSO 1		
	CO 2. Analyse various parameters of batch cultivation.	PSO 1, PSO 3		
	CO 3. Evaluate enzyme kinetics.	PSO 3, PSO 4		
	CO 4. Formulate experiment to calculate the growth rate and enzyme activity under any given condition.	PSO 3, PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level
1	Growth kinetics – bacterium/yeast and determination of μ_{max} , K_s , $Y_{x/s}$	15	CO 1,	K1, K2,

			CO 2	K3, K4
2	Enzyme purification and kinetics - Purification of enzyme: salting out, dialysis, gel filtration, assay of enzyme activity, rate of reaction, determination of specific activity, Km, Vmax	15	CO 3, CO 4	K1, K2, K3, K4
Pedagogy:	Laboratory experiments/ Tutorials			
References/ Readings:	<ol style="list-style-type: none"> 1. Dixon, M., & Webb, E. C. (2014). <i>Enzymes</i>. (Second Edition), Elsevier. 2. Flickinger, M. C., & Drew, S. W. (2002). <i>The encyclopedia of bioprocess technology: Fermentation, biocatalysis and bioseparation</i>. Vols. 1 - 5, New Jersey: John Wiley Publishers. 3. Hegyi, G., Kardos, J., Kovács, M., Málnási-Csizmadia, A., Nyitray, L., Pál, G., Radnai, L., Reményi, A., & Venekei, I. (2013). <i>Introduction to practical biochemistry</i>. E-book. www.renderx.com 4. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2008). <i>Principles of biochemistry</i>. (Fifth Edition), New York: Worth Publishers. 5. Plummer, M. U., & Plummer, D. T. (2008). <i>An introduction to practical biochemistry</i>. (Third Edition), New Delhi: Tata Mc Graw Hill Publishing Company. 6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2005). <i>Principles of fermentation technology</i>. (Third Edition). Butterworth-Heinemann Publishers. 			

[\[Back to Index\]](#)

Title of the Course	Marine Pollution and Monitoring
Course Code	MMI-6008
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course	Nil	
Course Objectives:	To equip students with knowledge and skills to understand, analyze, and manage marine pollution using ecological concepts, modern monitoring tools, and sustainable strategies	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the sources, types, and toxicity of marine pollutants	PSO 1, PSO2
	CO 2. Analyze the impacts of pollutants on different marine ecosystems and trophic levels	PSO 1, PSO2
	CO 3. Evaluate case studies of pollution impact on human health and the ecosystem	PSO 1, PSO2
	CO 4. Apply modern tools and remote sensing in pollution monitoring	PSO 1, PSO2
	CO 5. Evaluate integrated monitoring and management strategies	PSO 1, PSO2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Marine environment: pollutants, toxicity, point and non-point sources of pollution- oil spills, polyaromatic hydrocarbons, domestic sewage, agricultural waste, industrial discharge, thermal power plant discharge, pesticides, persistent organic pollutants, pharmaceuticals, personal care products, antibiotics, metals, metalloids, organometals, radioactive waste - deep-sea mining - marine debris: sources, constituents, derelict fishing gear, plastic/microplastic, garbage patches in the oceans	15	CO 1	K1, K2
Module 2:	Eutrophication, biofouling and bioinvasion, biocorrosion bioaccumulation and biomagnification, impact of pollutants on estuarine, mangroves, coastal and open ocean, coral reefs, phytoplankton, zooplankton, fish, shellfish, effect of marine pollutants on productivity and humans, harmful algal blooms, Minamata and Itai Itai disease	15	CO 2, CO 3	K1, K2, K3, K4, K5
Module 3:	Ocean health index, biomonitoring and bioremediation, biosensors, biotracers, genomics in marine monitoring, remote sensing in pollution monitoring, marine pollution monitoring programs, marine environmental impact assessment	15	CO 4, CO 5	K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments			
References/ Readings:	<ol style="list-style-type: none"> Judith, S.W. (2015). Marine pollution: What everyone needs to know. Oxford University Press, New York, USA. Kennish, M. J. (1997). Practical handbook of estuarine and marine pollution. CRC Press, Boca Raton, Florida. King, R. B., Sheldon, J. K., & Long, G. M. (2019). Practical environmental bioremediation: The field guide. CRC Press, Boca Raton, Florida. Naik, M., & Dubey, S. K. (2017). Marine pollution and microbial remediation. India: Springer Publications, Singapore. Prince, R. C., & Atlas, R. M. (2016). Bioremediation of Marine Oil Spills. In: Steffan, R. (Eds.). Consequences of microbial interactions with hydrocarbons, oils and lipids: biodegradation and bioremediation. Handbook of hydrocarbon and lipid microbiology, Springer, Cham, Switzerland. Satyanarayana, T., Johri, B., & Anil, T. (2012). <i>Microorganisms in environmental management</i>, Springer Dordrecht, Germany. 			

[\[Back to Index\]](#)

Title of the Course	Practicals in Marine Pollution and Monitoring
Course Code	MMI-6009
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To equip students with practical skills to assess pollutant impacts on marine microbes, analyze water quality, classify marine debris, and design approaches for effective pollution monitoring	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the effects of heavy metals and hydrocarbons on marine microbes	PSO 1, PSO2
	CO 2. Perform assays to assess microbial responses to pollutants	PSO 1, PSO2
	CO 3. Measure and analyze biological and chemical oxygen demand to assess water quality	PSO 1, PSO2
	CO 4. Classify marine debris/plastics by type and size	PSO 1, PSO2

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Determine the impact of lead/arsenic on marine microbes by the spread plate method.	6	CO 1, CO 2	K1, K2, K3, K4
Module 2:	Determine the impact of naphthalene/anthracene on marine microbes	6	CO 1, CO 2	K1, K2, K3, K4
Module 3:	Determination of biochemical oxygen demand	6	CO 3	K1, K2, K3, K4
Module 4:	Determination of chemical oxygen demand	6	CO 3	K1, K2, K3, K4
Module 5:	Size classification of marine debris/plastic using stereozoom microscope.	6	CO 4	K1, K2, K3, K4
Pedagogy:	Laboratory experiments/field trip			
References/ Readings:	<ol style="list-style-type: none"> 1. Cappuccino, J. G., & Sherman, N. (1998). <i>Microbiology: A laboratory manual</i>. Benjamin/Cummings Science Publishing, San Francisco, California. 2. Martin, D. F. (1972). <i>Marine chemistry</i> (01). London: Academic Press, London. 3. Metcalf & Eddy, Inc., Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2003). <i>Wastewater engineering: Treatment and reuse</i> (4th ed.). McGraw-Hill. 4. Rice, E. W., & Bridgewater, L. (2012). <i>Standard methods for the examination of water and wastewater analysis</i> (Second Edition), American Public Health Association, Washington DC. 			

[\[Back to Index\]](#)

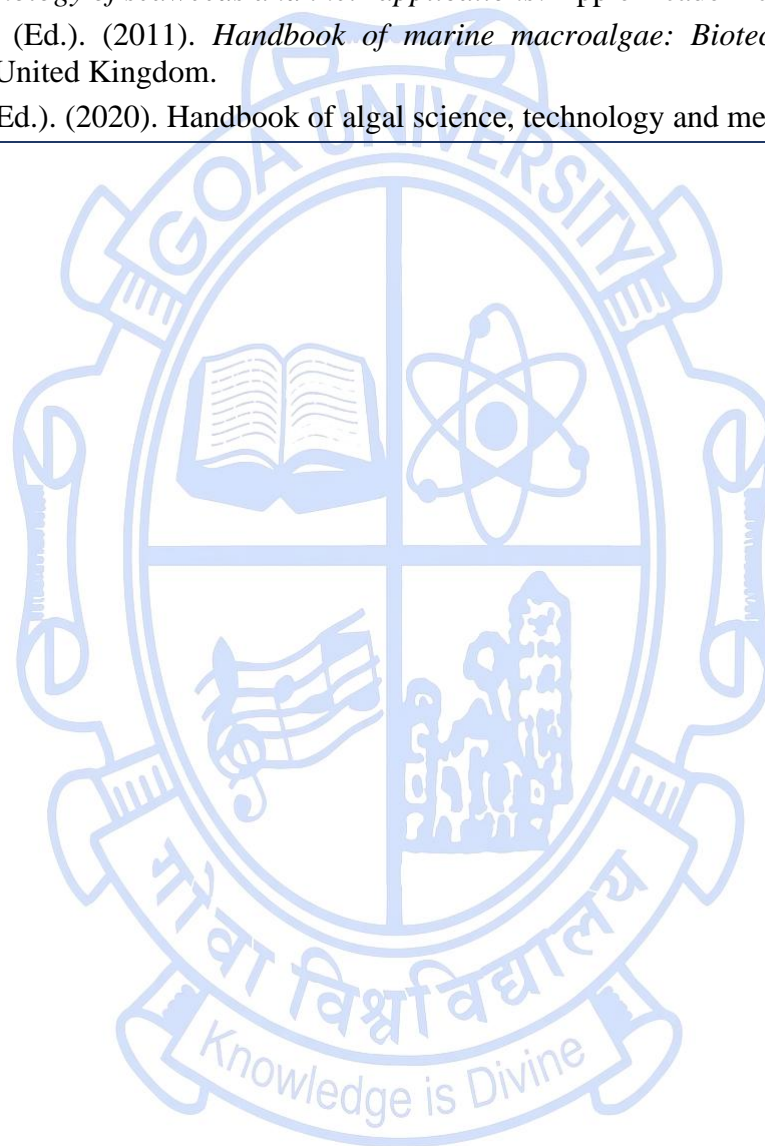
Title of the Course	Microbiology Associated with Seaweeds
Course Code	MMI-6010
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide students with an in-depth understanding of microbes associated with seaweeds, highlighting their interactions, holobiont nature, and environmental adaptations under climate change, along with their contemporary biotechnological potential.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the diversity and functional dynamics of epiphytic and endophytic microbial communities associated with seaweeds.	PSO 1, PSO2
	CO 2. Study molecular and microscopic tools for the characterization and analysis of seaweed-associated microbiomes.	PSO 1, PSO2
	CO 3. Assess the ecological and physiological interactions between seaweeds and associated microbes.	PSO 1, PSO2
	CO 4. Evaluate the biotechnological and commercial applications of seaweeds associated	PSO 1, PSO2, PSO

microbes in various industries.		4		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Diversity of epiphytic and endophytic microbial communities associated with seaweeds. culture-dependent and independent tools for studying seaweed microbiomes (metagenomics, 16S and ITS rRNA gene sequencing, etc). Factors affecting the composition and abundance of epiphytic bacteria: Host, Season, temperature, nutrients and surface-bound chemicals. Succession of seaweed-associated microbial communities during the life cycle of seaweed. Viral components of the seaweed holobiont: Diversity and ecology of seaweed-associated viruses, Bacteriophages in seaweed microbiomes.	15	CO 1, CO 2	K1, K2
Module 2:	Role of seaweed microbiome in: Carbon metabolism and Carbon sink, Nitrogen fixation, Induction of morphological switch and Effect on spore germination. Pathogenicity of epiphytic microbes. Symbiotic relationships with marine microorganisms; Chemical interactions between seaweeds and microbes. Quorum sensing and chemical signaling, Cross-domain signalling between bacterial AHLs and zoospores; bacterial EPS and seaweed growth. Seaweed holobionts under environmental stress and climate change.	15	CO 3	K1, K2, K3, K4, K5
Module 3	Industrial and biotechnological applications of seaweed-associated microbes: Enzymes from seaweed-associated microbes (Agarases, carrageenases, alginate lyases, cellulases, proteases, lipases, amylases, Marine Endo-1,4-β-Glucanase and polysaccharidase). Applications in food processing, textile, biofuel, and paper industries. Screening and characterisation of bioactive metabolites: antimicrobial, anticancer, antioxidant, antifouling, anti-inflammatory. Seaweed-associated microbes as biofertilizers and biocontrol agents. Seaweed-microbe consortia in bioremediation.	15	CO 4	K1, K2, K3, K4
Pedagogy:	Lectures/assignments/videos.			
References/ Readings:	<ol style="list-style-type: none"> 1. Ecology & Holobiont Concept Hurd, C. L., Harrison, P. J., Bischof, K., & Lobban, C. S. (2014). <i>Seaweed ecology and physiology</i> (2nd ed.). Cambridge University Press, United Kingdom. 2. Sangeetha, J., Thangadurai, D., Hospet, R., & Purushotham, P. (Eds.). (2022). <i>Seaweed biotechnology: Biodiversity</i> 			

- | | |
|--|---|
| | <p><i>and biotechnology of seaweeds and their applications</i>. Apple Academic Press, New York).</p> <ol style="list-style-type: none">3. Kim, S.-K. (Ed.). (2011). <i>Handbook of marine macroalgae: Biotechnology and applied phycology</i>. Wiley-Blackwell, United Kingdom.4. Konur, O. (Ed.). (2020). <i>Handbook of algal science, technology and medicine</i>. Academic Press United Kingdom. |
|--|---|

[\[Back to Index\]](#)



Title of the Course	Practicals in Microbiology Associated with Seaweeds
Course Code	MMI-6011
Number of Credits	01
Theory/Practical	Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide hands-on training in isolating and characterizing seaweed-associated microbes, and to develop skills in screening their functional traits for ecological and biotechnological applications.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Isolate and characterize epiphytic and endophytic bacteria associated with seaweeds.	PSO 2
	CO 2. Screen seaweed-associated bacteria for extracellular enzyme production.	PSO 3, PSO 4
	CO 3. Evaluate biofilm formation and EPS production by seaweed-associated bacteria.	PSO 3, PSO 4
	CO 4. Assess the antimicrobial activity of seaweed-associated bacteria against selected pathogens.	PSO 1, PSO 4
	CO 5. Detect plant growth-promoting traits of seaweed-associated microbial isolates.	PSO 1, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
1.	Isolation and tentative identification of select epiphytic and endophytic bacteria from collected seaweeds.	6	CO1	K1, K2, K3, K4, K5
2.	Screening of enzymes (cellulase, amylase, protease, agarase and Carrageenase) by seaweed-associated bacteria.	6	CO2	K1, K2, K3, K4, K5
3.	Detection of biofilm formation and EPS production by seaweed-associated bacteria.	6	CO3	K1, K2, K3, K4, K5
4.	Antagonistic activity of seaweed-associated bacteria against microbial pathogens.	6	CO4	K1, K2, K3, K4, K5
5.	Screening for phosphate-solubilising, nitrogen-fixing, siderophore and IAA-producing potential of seaweed-associated bacteria for plant growth promotion traits.	6	CO5	K1, K2, K3, K4, K5
Pedagogy:	Experiments, field visit.			
References/ Readings:	<ol style="list-style-type: none"> 1. Trivedi, N., Gupta, V., Reddy, C. R. K., & Jha, B. (2016). Marine microbes as a potential source of cellulolytic enzymes. In A. Trincone (Ed.), <i>Marine enzymes biotechnology: Production and industrial applications</i> (pp. 27–41). Academic Press. 2. Shukla, P. J., Vhora, S. B., Murnal, A. G., Yagnik, U. B., & Patadiya, M. (2023). Exopolysaccharide production from marine bacteria and its applications. In S.-K. Kim (Ed.), <i>Marine biochemistry: Isolations and techniques</i> (1st ed., Chapter 18). CRC Press. 3. Kurhekar, J. V. (2020). Antimicrobial lead compounds from marine plants. In C. Egbuna, S. Kumar, J. C. Ifemeje, S. M. Ezzat, & S. Kaliyaperumal (Eds.), <i>Phytochemicals as lead compounds for new drug discovery</i> (pp. 257–274). Elsevier. https://doi.org/10.1016/B978-0-12-817890-4.00017-2 			

[\[Back to Index\]](#)

Title of the Course	Research methodology in Marine Microbiology
Course Code	MMI-6012
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Students should have opted for Discipline-Specific Dissertation and undergone 400 level courses.			
Course Objectives:	To provide knowledge on basic and advanced methods to conduct research in the area of marine microbiology.			
Course Outcomes:	Students will be able to			Mapped to PSO
	CO 1. Demonstrate research methods in marine microbiology.			PSO 2,
	CO 2. Apply knowledge of instrumentation and good microbiological practices in research design.			PSO 2, PSO 5
	CO 3. Analyse experimental data sets using appropriate statistical analyses.			PSO 2
	CO 4. Integrate knowledge of biosafety practices in experimental design.			PSO 2, PSO 5
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Selection of research topic. Literature survey. Research methods in marine microbiology.	15	CO 1	K2, K3

	Procedures and protocols followed in collection of water, sediment and other types of samples for analysis. Pre-treatment and preservation methods. On-board/on-site measurement of parameters.			
Module 2:	Experimentation in the laboratory: Experimental design, Pilot studies, Good Microbiological Practices (GMP), Techniques for isolation and culturing of microorganisms; Knowledge of instruments used in marine microbiology, Errors in analytical measurements, accuracy, precision and validation of analytical data; Calibration of instruments, Reference standard materials; Documentation and record keeping.	15	CO 2	K3, K4
Module 3:	Statistical tools and softwares used in data processing. Tabular and graphical representation of data. Poster and power-point presentation and manuscript writing skills. Different types of manuscripts: short communication, research articles, review articles, Dissertation in thesis, research proposal; Citation of references. Reference managers like ENDNOTE and MENDELEY. Standard reference citation styles. Plagiarism check softwares.	15	CO 3	K3, K4, K5
Module 4:	Safety practices in the laboratory. Biosafety levels and practices. Handling of hazardous chemicals and gases. Disposal of chemical and biological waste. Fire safety protocols and first aid measures.	15	CO 4	K3, K4
Pedagogy:	Lectures/assignments/presentations/videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Grasshoff, K., Ehrhardt, M., & Kremling, K. (Eds.). (1983). <i>Methods of seawater analysis</i>. (2nd Ed.), Verlag Chemie, Weinheim, Germany. 2. Grinnel, F. (1992). <i>The scientific attitude</i>. The Guilford Press, New York. 3. Marsh, B. (2003). <i>The Chicago guide to communicating science</i>. University of Chicago Press, Chicago. 4. Morrison, D. F. (1990). <i>Multivariate statistical methods</i>. McGraw-Hill Education, Singapore. 5. Sokal, R. R., & Rohlf, F. J. (1981). <i>Biometry</i>. Freeman & Company, San Francisco. 			

[\[Back to Index\]](#)

Discipline Specific Vocational Elective (DSVE) Courses

Title of the Course	Seafood Processing and Technology
Course Code	MMI-6401
Number of Credits	2T+2P
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

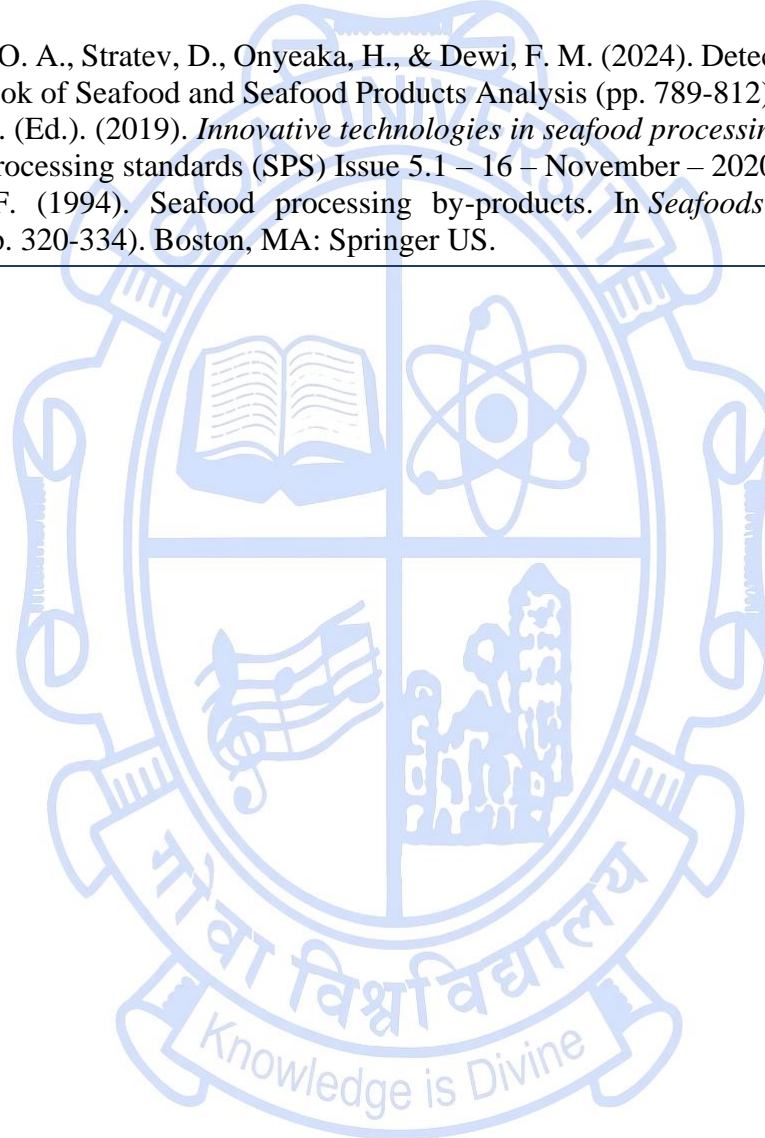
Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to deepen students' understanding of various technologies used in seafood processing and their impact on quality.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Understand the fundamental and advanced technologies involved in seafood processing.	PSO1, PSO2
	CO 2. Learn the principles of food safety management systems and their application in seafood processing for quality assurance.	PSO1, PSO2
	CO 3. To perform select techniques in seafood preservation.	PSO1

	CO 4. Demonstrate microbiological and molecular techniques for the isolation, identification, and detection of bacterial pathogens from processed/canned fish products.		PSO2	
	CO 5. Evaluate the microbiological safety and perform certification of the commercial sterility of processed/canned fish products through comprehensive testing protocols.		PSO2, PSO3, PSO4	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1	Overview of Global Seafood Industry: Market trends, consumption patterns, and economic significance, PHFL; Traditional Preservation Methods: Chilling and Freezing: Drying, Salting, Smoking and Curing, fermentation, biopreservation, thermal processing - principles, methods and their impact on microbial activity of fishes/molluscan /crustacean shellfish; Modern/Novel Processing Technologies: High-pressure processing (HPP), irradiation, pulsed electric field (PEF); Modified atmosphere packaging (MAP), vacuum packaging, Active packaging; Advanced Diagnostics and Detection Systems: Use of ELISA kits for pathogen determination, RT PCR for rapid pathogen identification and quantification.	15	CO 1	K1, K2, K3
Module 2	Microbiology of Processed Seafood: specific spoilage organisms (SSOs) and mechanisms; Adverse effects of microbial spoilage in the seafood processing industry; Artificial intelligence in monitoring seafood safety (Blockchain applications in the seafood supply chain, IoT sensors for real-time monitoring, and digital traceability systems); New challenges in seafood microbial quality and safety; Quality Assurance Fundamentals: Good Manufacturing Practices (GMPs), HACCP System Design and Implementation: principles, implementation, and monitoring in seafood processing; Standards and Regulatory Framework: National (FDA, BIS) and International standards (ISO 22000, Codex) for fish products; Audit procedures and certification processes; Waste management in the seafood industry.	15	CO 3, CO 4	K1, K2, K3
Module 3	1. Isolation and Detection of Bacterial Pathogens from Canned/Processed Fish Products. a) Isolation and Detection of Bacterial Pathogens from Canned/Processed Fish Products.	30	CO3, CO4, CO5	K1, K2, K3, K4.

	<ul style="list-style-type: none"> b) Visual inspection and Sterility testing of canned products for can integrity and spoilage indicators. c) Microscopic examination for bacterial spores and vegetative cells. d) Thermophilic spore-formers using the differential heating technique. e) Anaerobic culture techniques for <i>Clostridium botulinum</i> and <i>Clostridium perfringens</i> detection. f) <i>Salmonella</i>, <i>Listeria monocytogenes</i> and <i>Staphylococcus aureus</i>. g) DNA extraction and PCR identification of select bacterial pathogens. 			
Module 4	<ol style="list-style-type: none"> 1. Use of low temperature (refrigeration & freezing) and reduced water activity (salt curing and drying) approaches for sea food processing. 2. Certification of canned/processed fish products: <ul style="list-style-type: none"> a) Physical and Sensory Testing (Water Activity (aw) Determination, pH, Temperature, Seam Integrity Test, Visual Inspection and Organoleptic Testing). b) Microbial testing (Total Viable Count (TVC), Standard Commercial Sterility Tests, Indicator Organism Testing, Spoilage Bacteria Assessment, Biochemical and chemical testing (Moisture content, ash content, Protein analysis, Shelf-Life and Stability Testing). 	30	CO3, CO4, CO5	K1, K2, K3, K4.
Pedagogy:	Lectures/tutorials/assignments/videos/ Experiments in the laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. Bonnell, A. D. (2012). <i>Quality assurance in seafood processing: a practical guide</i>. Springer Science & Business Media. 2. Boziaris, I. S. (Ed.). (2014). <i>Seafood processing: Technology, quality and safety</i>. John Wiley & Sons. 3. Dillon, M., & McEachern, V. (1997). HACCP and quality assurance of seafood. In <i>Fish Processing Technology</i> (pp. 224-248). Boston, MA: Springer US. 4. FDA. (2025). Seafood HACCP Guidelines. U.S. Food and Drug Administration. 5. FSSAI Manual of Methods of Analysis of Foods – Fish and Fish Products - reg. 6. Hassoun, A., Siddiqui, S. A., Smaoui, S., Ucak, İ., Arshad, R. N., Garcia-Oliveira, P., ... & Bono, G. (2022). Seafood processing, preservation, and analytical techniques in the age of Industry 4.0. <i>Applied Sciences</i>, 12(3), 1703. https://fssai.gov.in/upload/uploadfiles/files/Manual%20of%20Methods%20of%20Analysis%20for%20Fish%20%26%20Fish%20Products.pdf 			

7. Kim, S. K., Perera, U. M. S. P., Rajapakse, N., & Kim, S. (2016). Seafood processing by-products. *NY: Springer-Verlag*.
8. Odeyemi, O. A., Stratev, D., Onyeaka, H., & Dewi, F. M. (2024). Detection of Seafood Spoilage Microorganisms. In *Handbook of Seafood and Seafood Products Analysis* (pp. 789-812). CRC Press.
9. Ozogul, Y. (Ed.). (2019). *Innovative technologies in seafood processing*. CRC Press.
10. Seafood processing standards (SPS) Issue 5.1 – 16 – November – 2020.
11. Shahidi, F. (1994). Seafood processing by-products. In *Seafoods: chemistry, processing technology and quality* (pp. 320-334). Boston, MA: Springer US.

[\[Back to Index\]](#)



Title of the Course	Genetic Engineering
Course Code	MMI-6402
Number of Credits	2T + 2P
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course aims to introduce the tools and techniques in molecular cloning, DNA editing and protein expression in wide variety of hosts and their applications in genetic engineering	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Understand and analyze the techniques involved in gene manipulation and molecular cloning.	PSO 1
	CO 2. Recognize the applications of genetic engineering in agriculture, medicine, pharmaceuticals and allied areas.	PSO 1, PSO 2
	CO 3. Understand and apply the knowledge of genetic engineering in developing industrially important microbial products	PSO 1, PSO 2

	CO 4. Perform isolation of bacterial plasmid DNA by gel electrophoresis, purify DNA and Restriction mapping.	PSO 1		
	CO 5. Assess the DNA ligation activity using enzymes.	PSO 1, PSO 2		
	CO 6. Develop competent cells using heat shock/ electroporator.	PSO 1, PSO 2		
	CO 7. Perform and analyze the transformation of <i>E. coli</i> host using a plasmid; prepare clones	PSO 1, PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to genetic engineering. Tools and techniques involved in genetic manipulation – I: restriction endonucleases, exonucleases, DNA ligases, terminal DNA transferase, DNA polymerases, reverse transcriptase, T4 polynucleotide kinases, alkaline phosphatase, S-1 nuclease, mung bean nuclease, RNases. Gene cloning systems/Hosts: Gene cloning in <i>E. coli</i> and other organisms such as <i>Bacillus subtilis</i> , <i>Saccharomyces cerevisiae</i> .	15	CO 1, CO 2	K1, K2, K3, K4
Module 2:	Tools and techniques involved in genetic manipulation – II: Expression vectors – Prokaryotic (pET, pGEX-2T). Characteristics of expression vectors – strong bacterial and viral promoters (lac, trp, tac, SV 40, T7, T3) for induction of gene expression. Cloning vectors – plasmid (pUC19, pBR 322), λ phage-based vectors (M-13), cosmid vectors, phagemid vectors, shuttle vectors, high capacity cloning vectors (BAC and YACs), Ti plasmid. Construction of cDNA, cloning, its expression and techniques – transformation, electroporation, transfection, gene gun. Other recombinant DNA techniques – use of radioactive and non- radioactive nucleotides for DNA probe preparation and detection of hybrids, restriction mapping, RFLP, PCR, RT-PCR, Real time PCR. Microarray. DNA sequencing methods. Chromosome walking. CRISPR-Cas. Application of genetic engineering in diagnostics, agriculture, medicine, pharmaceuticals, industries and allied areas. Genetically modified foods/crops, recombinant drugs, vaccines, interferons and hormones. Recombinant proteins and drugs, enzymes, biomolecules and fermentation products, bioremediation and	15	CO 3, CO 4, CO 5	K1, K2, K3, K4, K5

	biomonitoring (biosensors) of toxic environmental pollutants. Ethics in genetic engineering.			
Module 3:	<ol style="list-style-type: none"> 1. Plasmid extraction – 3 methods (CTAB, alkaline lysis, Boil prep) 2. Restriction mapping of bacterial plasmid 3. Determination of molecular weight of DNA using molecular weight marker 	30	CO 4, CO 5, CO 6, CO 7	K1, K2, K3, K4
Module 4:	<ol style="list-style-type: none"> 1. Assessment of DNA ligation activity of T4 DNA ligase 2. Preparation of competent cells and transformation of <i>E. coli</i> host with plasmid DNA using heat shock method 3. Cloning – using kit 4. Blue-white Screening assay of positive transformants 	30	CO 4, CO 5, CO 6, CO 7	K1, K2, K3, K4
Pedagogy:	Lectures/assignments/Practicals in laboratory.			
References/ Readings:	<ol style="list-style-type: none"> 1. Brown, T. A. (2010). <i>Gene cloning & DNA analysis</i>. Wiley-Blackwell, Hoboken, NJ. 2. Davis, L. G., Dibner, M. D., & Battey, J. F. (1986). <i>Basic methods in molecular biology</i>. Elsevier, New York. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (1994). <i>Molecular biotechnology: Principles and applications of recombinant DNA</i>. ASM Press, Washington, D.C. 4. Glover, D. M. (1984). <i>Gene cloning: The mechanics of DNA manipulation</i>. Springer-Science+Business Media, Dordrecht, Netherlands. 5. Green, M. R., & Sambrook, J. (2001). <i>Molecular cloning: A laboratory manual</i>. Cold Spring Harbor Laboratory, New York. 6. Old, R. W., & Primrose, S. B. (1980). <i>Principles of gene manipulation: An introduction to genetic engineering</i>. University of California Press, Berkeley, CA. 			

[\[Back to Index\]](#)

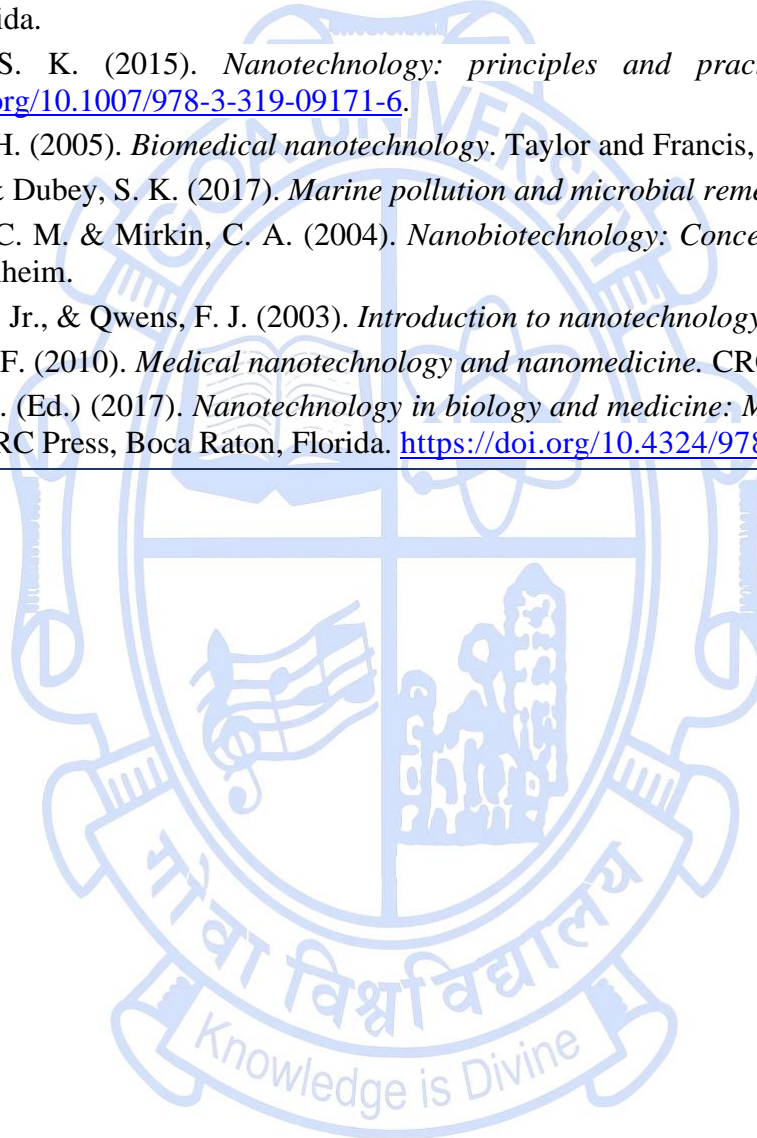
Title of the Course	Bionanotechnology
Course Code	MMI-6403
Number of Credits	2T + 2P
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To impart the knowledge of nanotechnology and the synthesis of nanoparticles from marine microorganisms	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Define nanoparticles and explain its types.	PSO 1
	CO 2. Discuss the properties and applications of nanoparticles	PSO 1, PSO 2
	CO 3. Indicate methodologies for bionanoparticle synthesis	PSO 1, PSO 2
	CO 4. Explain underlying principles of toxicity studies and inhibitory levels of nanoparticles as bioactive compounds	PSO 1, PSO 2, PSO 5
	CO 5. Isolate metal-tolerant microorganisms and synthesize nanoparticles of different metals	PSO 1, PSO 2

	CO 6. Design and execute nanoparticle characterisation using spectroscopy.		PSO 1, PSO 2
	CO 7. Demonstrate antimicrobial and antibiofilm activity of nanoparticles		PSO 1, PSO 4
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Introduction to nanotechnology; overview of development of nanotechnology. Types of nanoparticles; natural and incidental nanoparticles. Cellular nanostructures: nanopores, biomolecular motors. Bio-inspired nanostructures: thin films, colloidal nanostructures, nanovesicles, nanospheres, nanocapsules. Properties and characterization. Nanomaterials in biotechnology – nanoparticles, quantum dots, nanotubes, nanowires. Applications of nanoparticles in drug delivery, bio-imaging and diagnosis. Concept: cantilevers as nano-biosensors for cancer screening.	15	CO1, CO2 K1, K2, K3, K4
Module 2:	Microbial synthesis of nanomaterials, methodology, mechanism and applications of nanomaterials synthesis mediated by bacteria, fungi and yeast. Advantages of microbial/biogenic nanomaterials synthesis methods. Antimicrobial activities/mechanisms of nanomaterials; concept of MIC, MBC. Toxicity studies	15	CO3, CO4 K1, K2, K3, K4, K5
Module 3:	1. Isolation and enrichment of metal-tolerant microorganisms. 2. Preparation of metal nanoparticles using marine bacteria/fungi/plankton.	30	CO 5, CO 6, CO 7 K1, K2, K3, K4
Module 4:	1. Characterisation of metal nanoparticles using SEM-EDX, FTIR, XRD. 2. Biological activity of nanoparticles: antimicrobial, antibiofilm assay.	30	CO 5, CO 6, CO 7 K1, K2, K3, K4
Pedagogy:	Lectures, assignments, Practicals in the laboratory.		
References/ Readings:	1. Bharat, B. (2007). <i>Springer handbook of nanotechnology</i> . Springer Verlag, US 2. Challa, S., Kumar, S. R., & Carola, J. H. (2006). <i>Nanofabrication towards biomedical application: Techniques, tools, application and impact</i> . John Wiley – VCH, Weinheim. 3. Ehad, G. (2007). <i>Plenty of room for biology at the bottom: An introduction to bionanotechnology</i> . Imperial College Press, UK.		

4. Greco, R. S., Prinz, F. B., & Smith, R. L. (2004). *Nanoscale technology in biological systems*. CRC Press, Boca Raton, Florida.
5. Kulkarni, S. K. (2015). *Nanotechnology: principles and practices*. (3rd Ed.), Springer, Switzerland. <https://doi.org/10.1007/978-3-319-09171-6>.
6. Malsch, N.H. (2005). *Biomedical nanotechnology*. Taylor and Francis, CRC Press, Boca Raton, Florida.
7. Naik, M., & Dubey, S. K. (2017). *Marine pollution and microbial remediation*. Springer Verlag, Singapore.
8. Niemeyer, C. M. & Mirkin, C. A. (2004). *Nanobiotechnology: Concepts, applications and perspectives*. Wiley-VCH, Weinheim.
9. Poole, C. P. Jr., & Qwens, F. J. (2003). *Introduction to nanotechnology*. Wiley- VCH, Weinheim.
10. Tibbals, H. F. (2010). *Medical nanotechnology and nanomedicine*. CRC Press, Boca Raton, Florida.
11. Vo-Dinh, T. (Ed.) (2017). *Nanotechnology in biology and medicine: Methods, devices and applications*. (Second Edition). CRC Press, Boca Raton, Florida. <https://doi.org/10.4324/9781315374581>

[\[Back to Index\]](#)



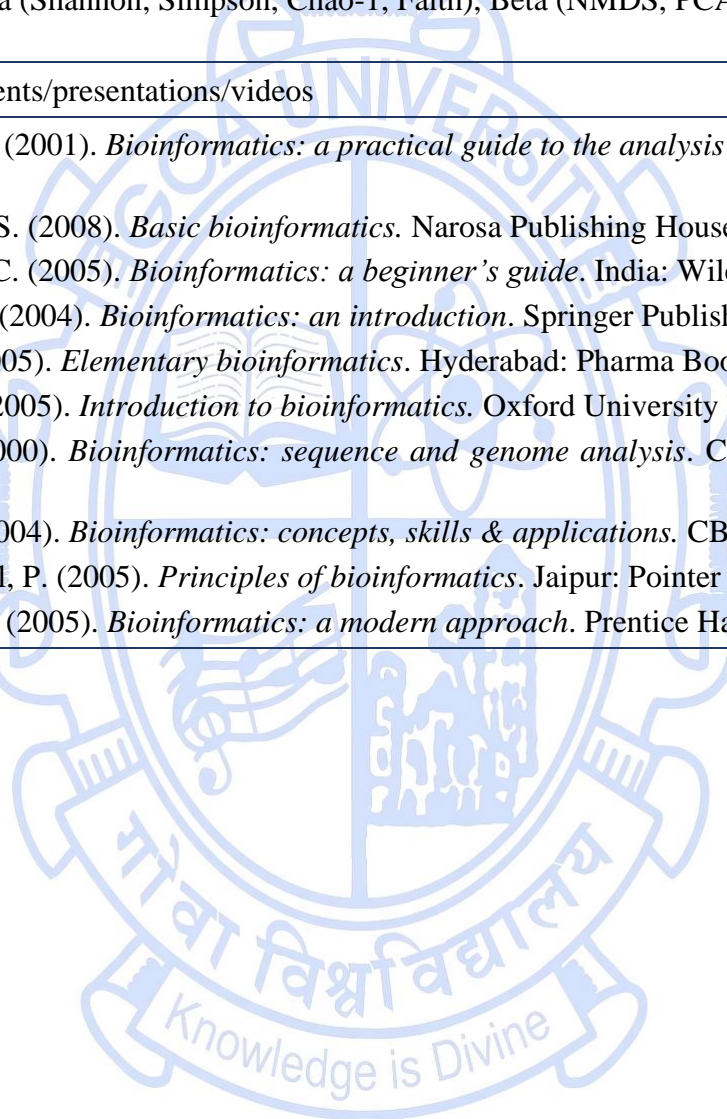
Title of the Course	Bioinformatics in Marine Microbiology
Course Code	MMI-6404
Number of Credits	2T + 2P
Theory/Practical	Theory + Practical
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To understand the basics of bioinformatics and learn to analyse phylogeny and metagenomics data for diversity studies.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Design workflow for phylogenetic analysis of microbial cultures.	PSO 2
	CO 2. Discuss metagenomics workflow for environmental studies.	PSO 2, PSO 5
	CO 3. Apply open-source bioinformatics software for use in microbiome analysis.	PSO 2, PSO 3
	CO 4. Design a roadmap for analysis of high throughput sequence data.	PSO 2, PSO 3
	CO 5. Identify microbial taxa present in environmental sample.	PSO 1

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	<p>Introduction to microbiome research. Data mining – DNA sequence assembly and annotation of genes. Types of User Interface (CUI, GUI). Biological Databases and search tools. Sequence alignment: Pairwise, Multiple. Similarity and homology of sequences. Orthologs, paralogs, analogs. Sequence alignment tools. Similarity and distance, similarity scores, weight matrices, Heuristic method, Hidden Markov Models. Gene annotation, phylogenetics: gene phylogeny versus species phylogeny. Sequence-based classification and identification, Operational Taxonomic Units, rooted and unrooted trees. Approaches in phylogenetic analysis: phenetic, cladistic, evolutionary systematic approach. Methods in tree construction: distance-based methods (Unweighted Pair Group Method with Arithmetic mean, Neighbour Joining, Minimum Evolution), character-based methods (Maximum Parsimony, Maximum Likelihood).</p>	15	CO 1, CO 3	K1, K2, K3, K4
Module 2:	<p>Metagenomics: 16S rRNA amplicon sequencing for metagenomics or targeted metagenomics pipelines to analyse the raw data generated from next generation platforms. Quality check and filtering of sequences, pairing of reads, grouping of reads into OTUs or/and Amplicon Sequence Variants (ASVs). Databases for taxonomic identification. Alignment of OTUs, α-(within group) and β-diversity (between groups) comparison. Full Shotgun DNA metagenomics – demultiplexing of raw reads, quality check, conversion to FASTQ format files, QIIME/QIIME2, clustering into OTUs, assigning taxonomy to the clusters, Prokka, metAMOS. Introduction to predictive functional analyses and tools for visualization (PICRUSt, KEGG).</p>	15	CO 2, CO 4, CO 5	K1, K2, K3, K4
Module 3:	<ol style="list-style-type: none"> 1. NCBI search tool, nBLAST, Downloading type sequences, creating FASTA files for alignment, sequence alignment, Construction of phylogenetic trees (MEGA). 2. Introduction to Galaxy workflow, QIIME2 workflow. 	30	CO 1, CO 2, CO 3, CO 4, CO 5	K1, K2, K3, K4, K5, K6
Module 4:	<ol style="list-style-type: none"> 1. Assemble short reads into contigs (MEGAHIT, SPAdes), Taxonomic classification (Kraken2, MetaPhlAn) 	30	CO 1, CO 2,	K1, K2, K3, K4,

	2. QC, trimming for sequence alignment, Krona plots for visualization, Diversity indices - Alpha (Shannon, Simpson, Chao-1, Faith), Beta (NMDS, PCA)		CO 3, CO 4, CO 5	K5, K6
Pedagogy:	Lectures/assignments/presentations/videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Baxevanis, A. (2001). <i>Bioinformatics: a practical guide to the analysis of genes and proteins</i>. John Wiley & Sons, New York. 2. Ignacimuthu, S. (2008). <i>Basic bioinformatics</i>. Narosa Publishing House, New Delhi. 3. Jean-Michel, C. (2005). <i>Bioinformatics: a beginner's guide</i>. India: Wiley Dreamtech. 4. Jeremy, J. R., (2004). <i>Bioinformatics: an introduction</i>. Springer Publishers, Dordrecht, The Netherlands. 5. Khan, I.A. (2005). <i>Elementary bioinformatics</i>. Hyderabad: Pharma Book Syndicate. 6. Lesk, A. M. (2005). <i>Introduction to bioinformatics</i>. Oxford University Press. 7. Mount, D. (2000). <i>Bioinformatics: sequence and genome analysis</i>. Cold Spring Harbor Laboratory Press, New York. 8. Rastogi, C. (2004). <i>Bioinformatics: concepts, skills & applications</i>. CBS Publishers, New Delhi. 9. Shanmughavel, P. (2005). <i>Principles of bioinformatics</i>. Jaipur: Pointer Publishers. 10. Srinivas, V.R. (2005). <i>Bioinformatics: a modern approach</i>. Prentice Hall of India, New Delhi. 			

[\[Back to Index\]](#)



SEMESTER IV

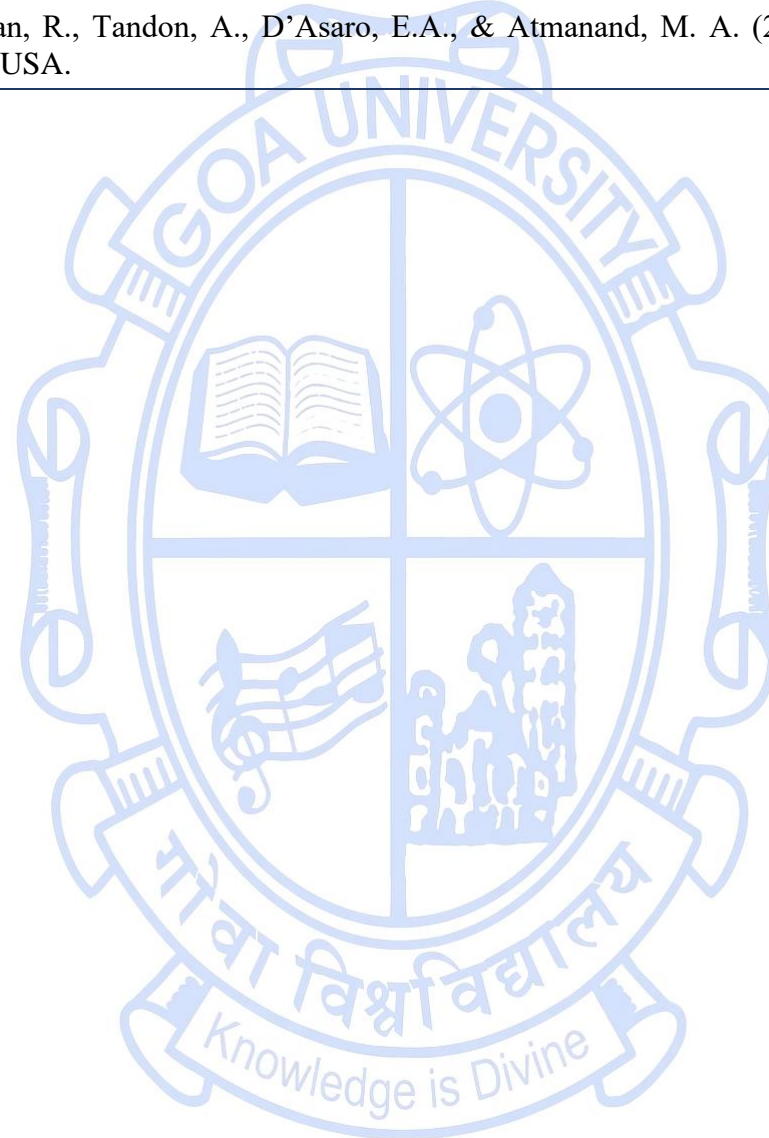
Generic Elective (GE) Courses

Title of the Course	Ocean Observations and Techniques	
Course Code	MMI-6201	
Number of Credits	03	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	No	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	To equip students with knowledge and skills in oceanographic platforms, analytical tools, bio-optical methods, and remote sensing techniques for understanding marine processes, ecosystem dynamics, and resource management	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Describe the facilities of Indian research vessels and the principles of oceanographic instruments	PSO 1, PSO2
	CO 2. Explain analytical methods for carbon measurement, respiration, enzymatic activity, and genomics/metagenomics in marine observations	PSO 1, PSO2

	CO 3. Apply advanced laboratory and field techniques to study microbial and biogeochemical processes		PSO 1, PSO2
	CO 4. Evaluate the applications of satellite-based observations for fisheries, climate interactions, and conservation strategies		PSO 1, PSO2
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Indian oceanographic research vessels and their facilities - oceanographic instruments: gliders, Argo, floats, acoustic doppler current profiler, current meters, radar, seawater samplers, Conductivity Temperature Depth (CTD), Expendable Bathythermograph (XBT), plankton net, sediment grab, corer, echosounder, Sound Navigation and Ranging (SONAR), underwater robots and vehicles	15	CO 1 K1, K2
Module 2:	Confocal laser scanning microscopy - carbon measurement methods: CHNS elemental analyzer, coulometer, TOC analysis using high-temperature combustion method - sediment traps (moored arrays/drifted traps) - ²³⁴ Thorium as a tracer for POC export estimates, respiration measurements of plankton, fluorometric assessment of enzymatic activity using 4-Methylumbelliferyl (MUF) substrate, genomic and metagenomics approaches	15	CO 2, CO 3 K1, K2, K3
Module 3:	Marine bio-optics, electromagnetic radiation, photosynthetically active radiation, optical properties of seawater, ocean color, chromophoric dissolved organic matter, polar orbiting and geosynchronous satellites and sensors, applications of remote sensing and societal benefits: primary productivity, sea surface temperature, salinity, wind speed and direction, ocean currents, ocean atmosphere heat exchange, bloom dynamics, assessment of carbon reservoirs and fluxes, potential fishing zones	15	CO 4 K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments/field trip		
References/ Readings:	<ol style="list-style-type: none"> 1. Andreas, S., & Brassington, G. B. (2011). <i>Operational oceanography in the 21st century</i>. Springer, Germany. 2. Jeffrey, S. W., & Veski, M. (1997). Introduction to marine phytoplankton and their pigment signatures. In: <i>Phytoplankton pigments in oceanography</i>. UNESCO Publishing, Paris. 3. Martin, S. (2004). <i>An introduction to ocean remote sensing</i>. Cambridge University Press, UK. 		

- | | |
|--|--|
| | <ol style="list-style-type: none">4. Munn, C. (2011). <i>Marine microbiology: Ecology & applications</i>. Taylor Francis Group, New York.5. Venkatesan, R., Tandon, A., D'Asaro, E.A., & Atmanand, M. A. (2018). <i>Observing the oceans in real time</i>. Springer, USA. |
|--|--|

[\[Back to Index\]](#)



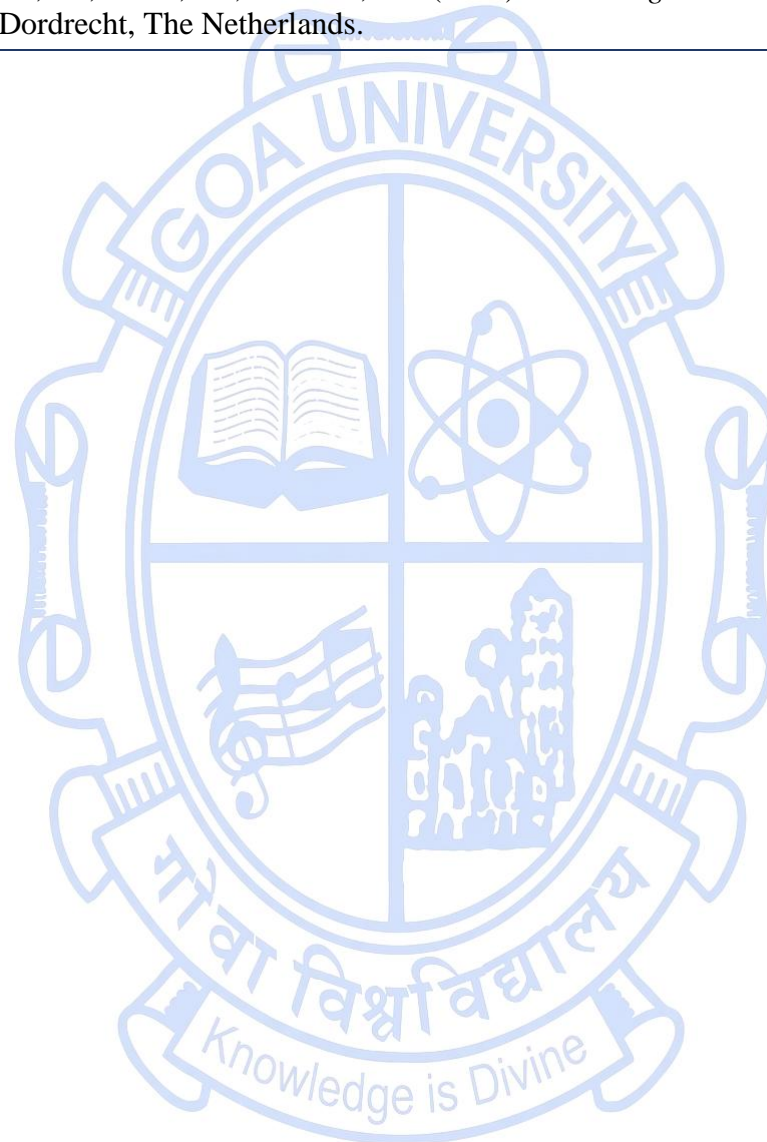
Title of the Course	Microbial Remediation in Marine Ecosystems
Course Code	MMI-6202
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	This course focuses on the use of using marine microorganisms as a tool for remediation of diverse pollutants.			
Course Outcomes:	Students will be able to	Mapped to PSO		
	CO 1. Describe the concept of microbial bioremediation.	PSO 1, PSO 5		
	CO 2. Apply various strategies for bioremediation of pollutants.	PSO 1, PSO 2		
	CO 3. Recommend suitable bioremediation strategies for different categories of pollutants.	PSO 2, PSO 5		
	CO 4. Predict the application of remediation in abatement of pollution.	PSO 2, PSO 5		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Concept of bioremediation, various strategies (bio-augmentation, bio-stimulation, co-metabolism, use of microbial consortia and genetically-modified microorganisms);	15	CO 1, CO 2,	K1, K2, K3, K4,

	<p>Bioremediation of metals mediated by marine microbes: heavy metal resistant bacteria/fungi/archaea. Metal resistance mechanisms (efflux mechanism, intracellular bioaccumulation, extracellular sequestration and surface biosorption, bioprecipitation, biotransformation and redox reaction, volatilization);</p> <p>Bioremediation of hydrocarbons in marine environments: oil spills/ tar ball management; Biodegradation – reactions, enzymes and pathways. Biosurfactants.</p>		CO 3, CO 4	K5
Module 2:	<p>Biodegradation of Complex Polysaccharides (CPs) by marine microorganisms: algal waste, CP-degrading enzymes – agarase, alginate lyase, carragenase, cellulase, and their role in degradation; Biodegradation of seafood waste by microorganisms: seafood waste, calcium carbonate-solubilizing bacteria, phosphate-solubilizing bacteria; the role of chitinase and protease enzymes, use of microbial consortia, application of seafood waste for ethanol production;</p> <p>Bioremediation of xenobiotics and pollutants in hypersaline environments using Sulfate-Reducing Bacteria (SRB) and archaea: pollutants in hypersaline environments – metals, xenobiotics, remediation strategies involving SRB, application in remediation of industrial effluents.</p>	15	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments/case-studies			
References/ Readings:	<ol style="list-style-type: none"> Judith, S.W. (2015). <i>Marine pollution: What everyone needs to know</i>. Oxford University Press New York. Kennish, M. J. (1996). <i>Practical handbook of estuarine and marine pollution</i>. CRC Press, Boca Raton. King, R. B., Sheldon, J. K., & Long, G. M. (1997). <i>Practical environmental bioremediation: the field guide</i>, Lewis Publishers, Boca Raton. Meena, S. N., & Naik, M. M. (2019). <i>Advances in biological sciences research</i>. Elsevier Publications, Cambridge, MA. Munn, C. B. (2020). <i>Marine microbiology: Ecology and applications</i>. (Third Edition), Garland Science, Taylor and Francis Group, New York. Naik, M., & Dubey, S. K. (2017). <i>Marine pollution and microbial remediation</i>. Springer Publications, Singapore. Prince, R. C., & Atlas, R. M. (2017). Bioremediation of marine oil spills. In: <i>Handbook of hydrocarbon and lipid microbiology</i>. Springer Publishers, Berlin. 			

- | | |
|--|--|
| | 8. Satyanarayana, T., Johri, B., & Anil, T. (2012). <i>Microorganisms in environmental management</i> . Springer Publishers, Dordrecht, The Netherlands. |
|--|--|

[\[Back to Index\]](#)



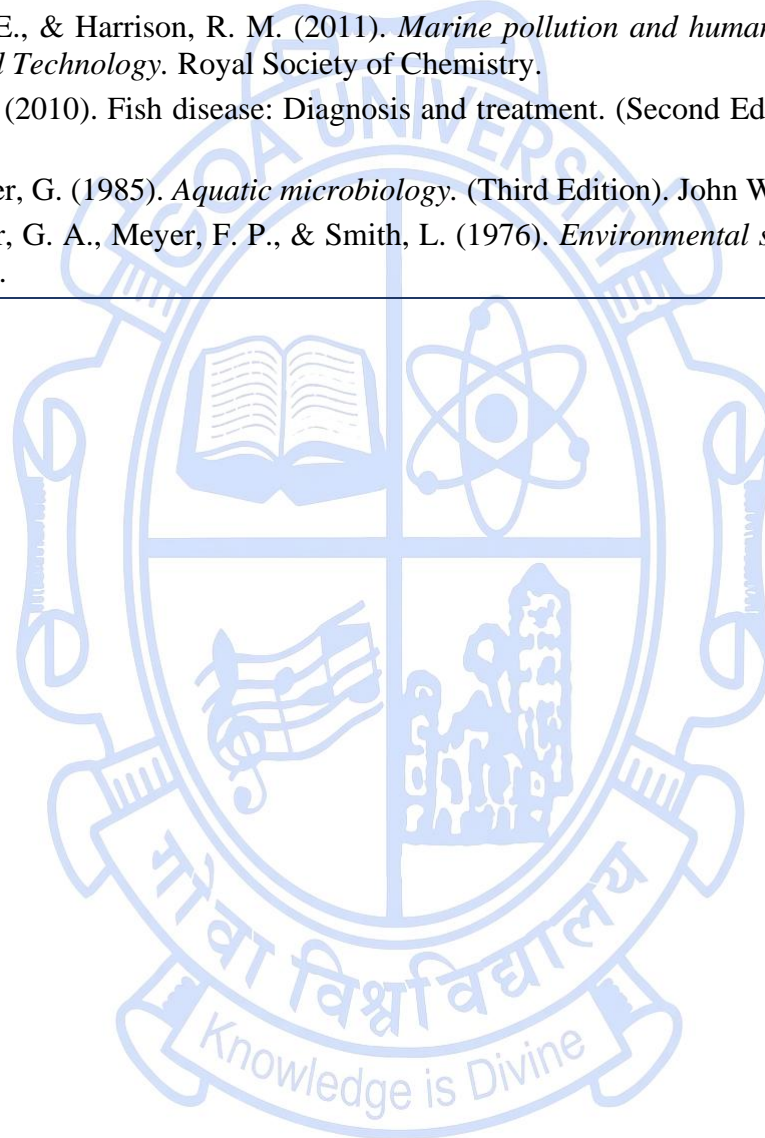
Title of the Course	Marine Environment and Public Health
Course Code	MMI-6203
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course deals with the effects of marine pollution and climate change on human health, the challenges for monitoring and control of pollution, long-term strategies in public health management, and advances in disease control in the marine environment.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. List the impacts of marine pollutants and climate change on marine biota and humans.	PSO 1, PSO 5
	CO 2. Apply the DPSIR framework to understand the causal links between human activities and environmental changes.	PSO 1, PSO 2
	CO 3. Explain the concept of microbial indicator systems with regard to water quality.	PSO 1, PSO 5
	CO 4. Summarize the approaches used in disease monitoring and public health surveillance.	PSO 1, PSO 5
	CO 5. Prepare long-term strategies in public health management.	PSO 1, PSO 5

	CO 6. Critically evaluate the health management protocols and biosecurity principles in aquaculture.		PSO 1, PSO 5
Content:		No of hours	Mapped to CO Cognitive Level
Module 1:	Environmental variables related to marine, coastal and aquatic ecosystems. Water quality and sediment characteristics. Climate change and impact on human health – migration of <i>Vibrio</i> , flooding of coastlines, influence of El Nino Southern Oscillation on cholera outbreaks. Disaster management (risk-based and needs-based assessment approach). Understanding marine ecosystem and human health with DPSIR model. Overview of marine and coastal pollution and its effects on aquaculture systems and fisheries. Challenges for monitoring and control of pollution and overfishing. Standards for various types of water.	15	CO 1, CO 2 K1, K2, K3, K4
Module 2:	Biological indicators and indices of water quality. Microbial indicator systems – Fecal Indicator Bacteria, <i>Clostridium</i> , <i>Cryptosporidium</i> , adenoviruses, <i>Bacteroides</i> , coliphages. Sanitation in aquaculture systems. Human pathogens: its distribution, diseases transmitted through marine and coastal water, <i>Vibrio</i> , wound sepsis, enteroviruses. Disease monitoring and surveillance. Algal blooms: their effect on fish production and human health, microbial toxins, mechanical, chemical and biological control of algal blooms.	15	CO 3, CO 4 K1, K2, K3, K4, K5
Module 3:	Bioinvasion, transport of pathogens through ballast water – impact, monitoring, rules and regulations. Quarantine, certification and import risk analysis. Application of health management protocols and biosecurity in aquaculture. Long-term strategies in health management. Advances in disease control and management. Principles of Specific Pathogen Free/Specific Pathogen Resistant (SPF/SPR).	15	CO 5, CO 6 K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments/case-studies		
References/ Readings:	<ol style="list-style-type: none"> 1. Belkin, S., & Colwell, R. R. (2005). <i>Oceans and health: Pathogens in marine environment</i>. Springer Publishers, New York. 2. Buller, N. B., & Plumb, J. A. (2004). <i>Bacteria from fish and other aquatic animals: A practical identification manual</i>. CABI Publishing, Wallingford, Oxfordshire, UK. 		

3. Clark, R. B., Frid, C., & Attrill, M. (2001). *Marine pollution*. Oxford University Press, Oxford, UK.
4. Hester, R. E., & Harrison, R. M. (2011). *Marine pollution and human health, Vol. 33, Issues in Environmental Science and Technology*. Royal Society of Chemistry.
5. Noga, E. J. (2010). *Fish disease: Diagnosis and treatment*. (Second Edition). Wiley-Blackwell Publishers, Ames, IA.
6. Rheinheimer, G. (1985). *Aquatic microbiology*. (Third Edition). John Wiley Publishers, New York.
7. Wedemeyer, G. A., Meyer, F. P., & Smith, L. (1976). *Environmental stress and fish diseases*. TFH Publications, New Jersey.

[\[Back to Index\]](#)



Title of the Course	Probiotics and Prebiotics in Aquaculture			
Course Code	MMI-6204			
Number of Credits	02			
Theory/Practical	Theory			
Level	500			
Effective from AY	2026-2027			
New Course:	Yes			
Bridge Course/ Value added Course	No			
Course for advanced learners	No			
Pre-requisites for the Course	Nil			
Course Objectives:	This course will introduce the concept of probiotics and prebiotics in aquaculture.			
Course Outcomes:	Students will be able to			Mapped to PSO
	CO 1. Define pre and probiotics.			PSO 1
	CO 2. Describe the source and enlist the types of pre and probiotics.			PSO 1, PSO 2
	CO 3. State the characteristics and benefits of pre and probiotics.			PSO 1, PSO 2, PSO 5
	CO 4. Relate the administration methods and the mechanisms of action of pre and probiotics.			PSO 1, PSO 4, PSO 5
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to prebiotics – definition, criteria for classification; Source and types of	15	CO 1,	K1, K2,

	prebiotics; Mechanism of action – stimulation of gut microbiota, enhanced short chain fatty acid (scfa) production, improvement of feed conversion ratio and nutrient absorption; administration methods; health benefits; applications in aquaculture, safety, case study		CO 2, CO 3, CO 4	K3, K4
Module 2:	Introduction to probiotics – definition, criteria for classification; Source and types of prebiotics – bacterial, yeast, microalgae, cyanobacteria; delivery methods; Mechanism of action – colonization, antimicrobial compound production, digestive enzyme activity enhancement, administration methods; benefits and applications in aquaculture, safety, case study	15	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments			
References/ Readings:	<ol style="list-style-type: none"> 1. Austin, B., & Sharifuzzaman, S. M. (Editors.) (2022). <i>Probiotics in aquaculture</i>. (1st Ed), Springer, Cham, Switzerland. 2. Belsare, S. S. (Ed.) (2024). <i>Aquaculture Nutrition: Gut Health, Probiotics and Prebiotics</i>. Delve Publishing. 3. Damodaran, A., Mithun, S.J., Sheeja, C.C., Maurya, A.K., Divya, L. (2023). <i>Probiotics and prebiotics in aquaculture</i>. In, Recent Advances in Aquaculture Microbial Technology. pp. 209–226. 4. Derome, N. (Ed.) (2019). <i>Microbial Communities in Aquaculture Ecosystems: Improving Productivity and Sustainability</i>. Springer Cham. 5. Elumalai, P., Soltani, M., & Others (2024). <i>Immunomodulators in Aquaculture and Fish Health</i>. CRC Press. 6. Martínez-Cruz, P., Ibáñez, A.L., Monroy Herмосillo, O.A., Ramírez-Saad, H.C. (2012). <i>Use of probiotics in aquaculture</i>. ISRN Microbiology, 916845. 7. Merrifield, D. L., & Ringø, E. (Eds.). (2014). <i>Aquaculture Nutrition: Gut Health, Probiotics and Prebiotics</i>. Wiley-Blackwell. 8. Romano, N. (2021). <i>Probiotics, prebiotics, biofloc systems, and other biocontrol regimens in fish & shellfish aquaculture</i>. In, Aquaculture Pharmacology, pp. 219–242. 9. Soltani, M., Elumalai, P., Ghosh, K., & Ringø, E. (Eds.) (2025). <i>Bacillus Probiotics for Sustainable Aquaculture</i>. CRC Press. 10. Verstrepen, M. W. A., Williams, B. A., & Ruckebusch, Y. (Eds.). (2018). <i>Probiotics and Prebiotics in Animal Health and Food Safety</i>. Springer. 			

[\[Back to Index\]](#)

Title of the Course	Deep Sea Microbiology
Course Code	MMI-6205
Number of Credits	04
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	No
Bridge Course/ Value added Course:	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course focuses on concepts in microbiology and ecology of the various habitats in deep marine environment.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Identify various deep-sea habitats.	PSO 1
	CO 2. Discuss ecological processes occurring in the deep sea.	PSO 1
	CO 3. Compare various procedures for sample collection and microbiome analysis.	PSO 4
	CO 4. Appraise new technologies for research in deep-sea habitats.	PSO 4
	CO 5. Evaluate the roles and contributions of major international organisations, global frameworks in advancing oceanographic research, and shaping global marine policy and governance.	PSO 3, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	The deep-sea environment. Basic and in-depth conceptualization of deep marine subsurface. Types of deep-sea habitats and resident microbiota, dark ocean biosphere/aphotic pelagic ocean habitats, trenches, ridges, habitats beneath the ocean water column, such as marine sediments, oceanic crust, abyssopelagic/abyssal, hadal plains, deep permafrost sediments. Antarctic Ocean and Southern Ocean deep environments. Marine deposits (sapropels, nodules).	15	CO 1, CO 2	K1, K2, K3
Module 2:	Sampling equipment: deep sea sampling equipment, submersibles, remotely operated underwater vehicles. Techniques for collecting water and sediment samples, corers: gravity, piston and multiple corers (MUC), giant box corer (GBC); drilling techniques, MEBO sea floor drill rig. Culturing of deep sea microbes (piezophilic/ barophilic microorganisms). Introduction to anaerobic and pressure culture chambers/systems, techniques for isolation and culturing of deep sea microorganisms under <i>in situ</i> and simulated deep sea conditions.	15	CO 3, CO 4	K1, K2, K3, K4
Module 3:	Hydrothermal vents, metals at hydrothermal vents, food webs, chemosynthesis, microbial communities. Diversity of higher organisms including the tube worm <i>Riftia pachyptila</i> , sponges, corals. Cold seeps. Nutrient cycling.	15	CO 1, CO 2	K1, K2, K3, K4
Module 4:	Deep-sea research and exploitation: International Seabed Authority, member states, strategic plans, UN Convention on the Law of the Seas, maritime zones, Regional Environmental Management Plans, India's Deep Ocean Mission (DOM), PMN (Polymetallic Nodules) Programme, Ridge Programme (PMS exploration), European Marine Board, Global Ocean Observing System (GOOS), Southern Ocean Observing System (SOOS), Scientific Committee on Antarctic Research (SCAR), Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC), World Climate Research Programme (WCRP), CLIVAR (Climate and Ocean Variability, Predictability, and Change), JPI Oceans	15	CO 5	K1, K2, K3
Pedagogy:	Lectures/assignments/presentations/videos			
References/	1. Kallmeyer, J., & Wagner, D. (2012). <i>Microbial life of the deep biosphere</i> . De Gruyter. eISBN: 9783110300130.			

Readings:	<ol style="list-style-type: none"> 2. Karl, D. M. (1995). <i>The microbiology of deep-sea hydrothermal vents</i>. CRC Press, New York. 3. Munn, C. (2011). <i>Marine microbiology: Ecology and applications</i>. (2nd Ed), Garland Science, Taylor and Francis Group, New York. 4. Seibold, E., & Berger, W. (2017). <i>The sea floor : An introduction to marine geology</i>. (4th Ed), Springer International Publishing, Switzerland. 5. Sharma, R. (2017). <i>Deep-sea mining resource potential, technical and environmental considerations</i>. Springer International Publishing, Switzerland.
Web Resources:	<ol style="list-style-type: none"> 1. https://isa.org/jm/about-isa/ 2. https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf 3. https://www.imo.org/en/ourwork/legal/pages/unitednationsconventiononthelawofthesea.aspx 4. https://www.prithvisphere.in/MOES/Deep-Ocean-Mission 5. https://goosocean.org/ 6. https://www.soos.aq/ 7. https://scar.org/ 8. https://www.ioc.unesco.org/en 9. https://www.wcrp-climate.org/about-wcrp/wcrp-overview 10. https://www.clivar.org/about 11. https://jpi-oceans.eu/en/about

[\[Back to Index\]](#)

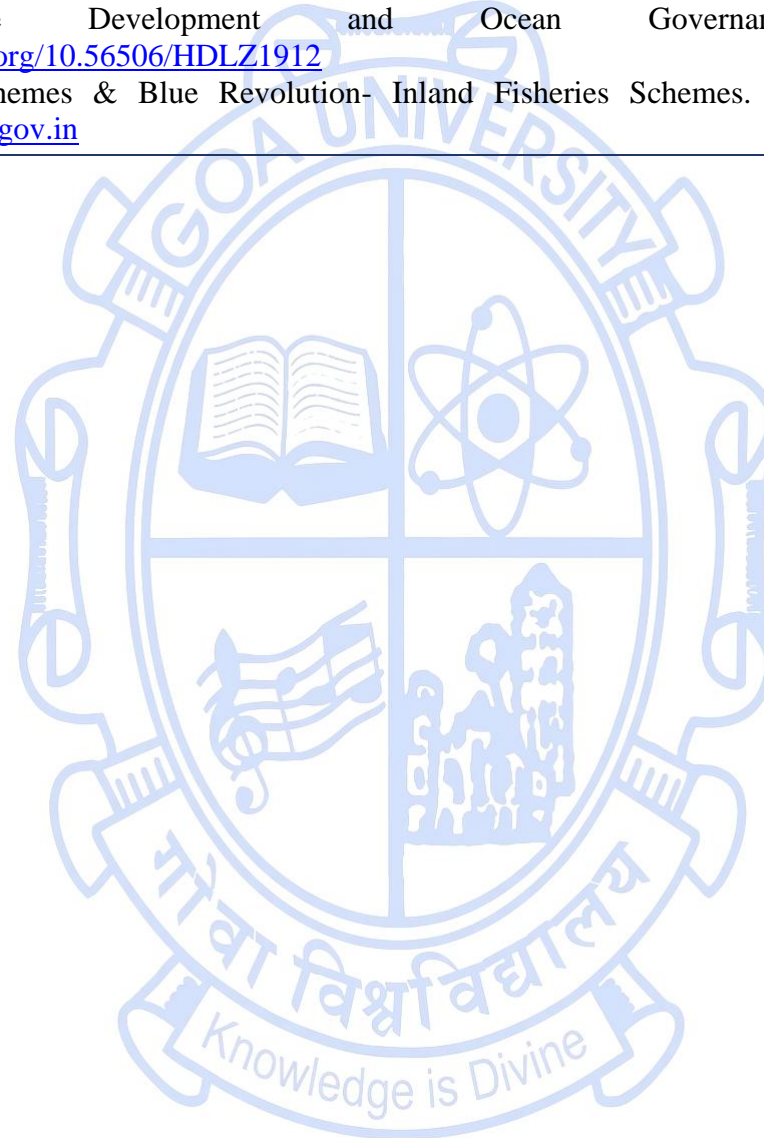
Title of the Course	Blue Economy
Course Code	MMI-6206
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course:	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Students will have in-depth knowledge on economic and ecological significance of blue economy specifically in Indian waters.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the conceptual foundations, global frameworks, and regional initiatives shaping the Blue Economy	PSO 1
	CO 2. Analyze India's Blue Economy policy framework, government initiatives, and international protocols.	PSO 1
	CO 3. Evaluate the potential of marine genetic resources (MGRs) and marine biotechnology for sustainable aquaculture, bioenergy, pollution control, and discovery of novel bioactive compounds.	PSO 2

	CO 4. Assess the issues, challenges, and opportunities of the Blue Economy in the context of climate change, microbial interventions, and sustainable exploitation of ocean resources.		PSO 5	
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Conceptualization and Framework of the Blue Economy: Global perspective - Origins and recognition of the Blue Economy at the Rio +20 Summit; definition, importance, and implications. Governance and sustainability (UNCLOS), framework for sustainable development, and role of Small Island Developing States (SIDS). Regional focus - Indian Ocean Rim Association (IORA) Blue Carbon Hub and India's Deep Ocean Mission. India's Blue Economy policy, National Fisheries Development Board (NFDB) schemes — Blue Revolution, Pradhan Mantri Matsya Sampada Yojana (PMMSY). Nagoya Protocol and its implications for access and benefit-sharing of marine resources. Role of marine biotechnology in achieving SDG 14 (Life Below Water), with emphasis on sustainable aquaculture, bioenergy, and pollution control.	15	CO 1, CO 2	K2, K3
Module 2:	Opportunities in the Indian Ocean region: Fish production, microbial feed additives, biotechnological interventions for post-harvest fish preservation, and exploitation of deep-sea minerals and trade benefits. Marine genetic resources (MGRs) - Access, benefit-sharing, and their potential. Bioprospecting of marine microbes for novel bioactive compounds, enzymes, antibiotics, and nutraceuticals. Climate change impacts and responses - Resilience strategies through climate-resilient probiotics in aquaculture, microbial monitoring as early-warning systems for harmful algal blooms (HABs) and pathogen outbreaks. Future directions - exploitation with conservation.	15	CO 3, CO 4	K4, K5
Pedagogy:	Lectures/assignments			
References/ Readings:	1. Blue Economy Policy - https://incois.gov.in/documents/Blue_Economy_policy.pdf 2. Diez S.M., Patil P.G., Morton J., Rodriguez D.J., Vanzella A., Robin D., Maes T., & Corbin C. (2019). Marine Pollution in the Caribbean: Not a Minute to Waste. http://documents.worldbank.org/curated/en/482391554225185720/pdf/Marine-Pollution-in-the-Caribbean-Not-a-Minute-to-Waste.pdf			

- | |
|--|
| <p>3. Morgan P.J., Huang M.C., Voyer M., Benzaken D., Watanabe A. (2022). Blue Economy and Blue Finance Toward Sustainable Development and Ocean Governance. ISBN 978-4-89974-252-4.
https://doi.org/10.56506/HDLZ1912</p> <p>4. NFDB Schemes & Blue Revolution- Inland Fisheries Schemes. National Fisheries Development Board.
http://nfdb.gov.in</p> |
|--|

[\[Back to Index\]](#)



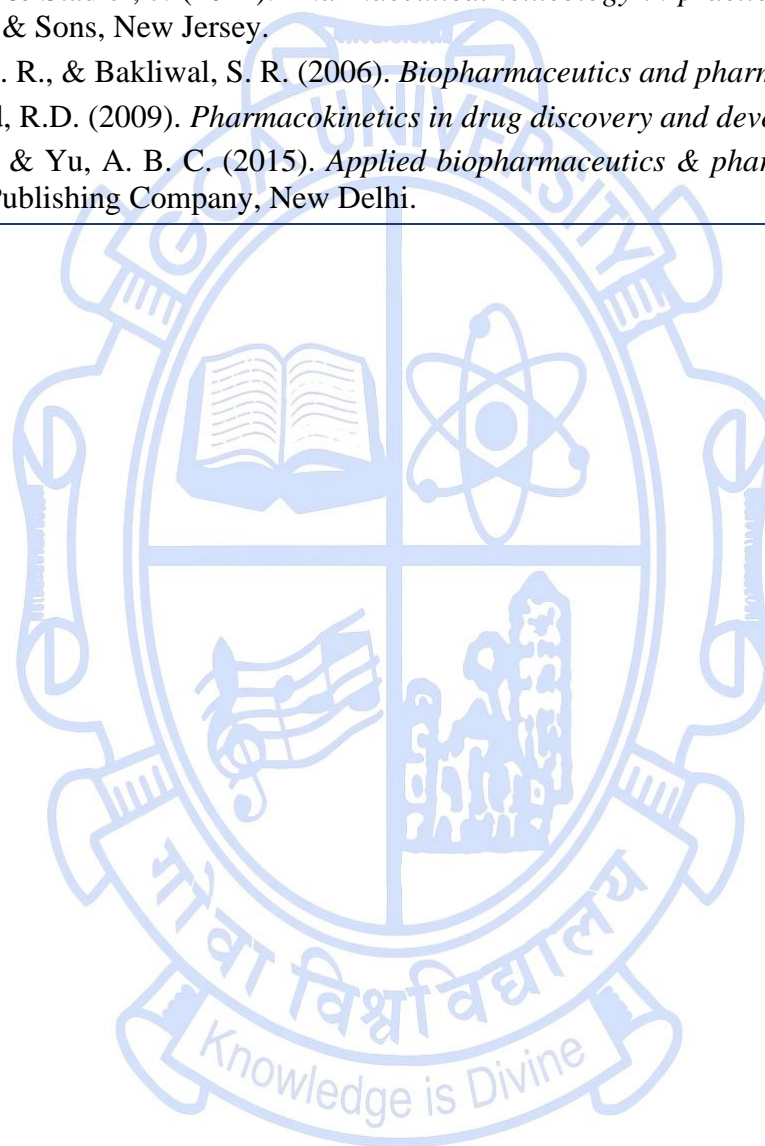
Title of the Course	Marine Drug Development and Metabolism
Course Code	MMI-6207
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil			
Course Objectives:	To introduce the concepts of clinical research for drug development, drug administration and metabolism.			
Course Outcomes:	Students will be able to	Mapped to PSO		
	CO 1. Describe the process of development of a drug from a marine source.	PSO 4		
	CO 2. Compare various biomolecules for their applications in pharmacology.	PSO 4		
	CO 3. Predict fate of any drug after administration in human body.	PSO 5		
	CO 4. Apply the concept of drug development for planning bioprospecting studies.	PSO 4		
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Marine drug discovery and development. Comprehensive Marine Natural Product Database (CMNPD). docking studies. Preclinical and clinical research. Food and Drug	15	CO 1, CO 2,	K1, K2, K3, K4,

	Administration (FDA) review. FDA post-market safety monitoring. Marine pharmacology: antibacterial, antiviral, antiinflammatory, antiparasitic, neuroprotective, anticancer, analgesic, antimicrobial, anti-malarial and nutraceutical. Marine drugs in clinical phase trials. Approved drugs of marine origin (Cytarabine, Vidarabine). <i>A priori</i> and <i>a posteriori</i> drug monitoring.		CO 4	K5
Module 2:	<p>Routes of drug administration.</p> <p>Absorption and distribution of drug through organ /tissue - factors affecting distribution. Physico- chemical properties of drugs, organ/tissue size, blood flow to the organ, physiological barriers to the distribution of drugs, drug binding blood/ tissue/ macromolecules. Protein/tissue binding of drugs – factors affecting protein binding of drugs, significance and kinetics, tissue binding of drugs. Biotransformation and metabolism. Organs of drug metabolism: hepatic and extrahepatic</p> <p>Mechanism – inactivation, bioactivation, reactive intermediates, Cytochrome P450 I (CYP I), Cytochrome P450 II (CYP II), and oxidation enzymes, epoxide hydrolase, quinone oxidoreductation, conjugation enzymes. Phase 1: CYP-Catalyzed: Hydroxylation (Primarily at C, N, some at S), Dealkylation (N- and O-dealkylation), Deamination, Epoxidation, Reduction. Non-CYP-Catalyzed: Oxidation (Alcohol and Aldehyde Dehydrogenase, Flavin-Containing Monooxygenase, Monoamine Oxidase), Reductase (Quinone Reductase), Hydrolysis (Esterases, Amidases, Epoxide Hydrolase). Phase 2: Glucuronidation, Sulfation, Acetylation, Glycine conjugation (minor), Glutathione conjugation (toxic substances). Extrahepatic metabolism. Factors affecting biotransformation.</p>	15	CO 3	K1, K2, K3, K4
Pedagogy:	Lectures/assignments/presentations			
References/ Readings:	<ol style="list-style-type: none"> 1. Brahmankar, D. M., & Jaiswal, S. B. (2015). <i>Biopharmaceutics and pharmacokinetics – a treatise</i>. (Third Edition), Vallabh Prakashan, Delhi. 2. Chakraborty, C., & Bhattacharyya, A. (2004). <i>Pharmacogenomics An approach to new drug development</i>. Biotech Books, Delhi. 3. Differding, E. (2017). The drug discovery and development industry in India – two decades of proprietary small molecule R&D. <i>Chem Med Chem Reviews</i>. 12, 786-818. doi:10.1002/cmdc.201700043. 			

4. Lodola, A., & Stadler, J. (2011). *Pharmaceutical toxicology in practice: a guide for non-clinical development*. : John Wiley & Sons, New Jersey.
5. Paradkar, A. R., & Bakliwal, S. R. (2006). *Biopharmaceutics and pharmacokinetics*. Nirali Prakashan, Pune.
6. Schoenwald, R.D. (2009). *Pharmacokinetics in drug discovery and development*. CRC Press. Boca Raton.
7. Shargel, L., & Yu, A. B. C. (2015). *Applied biopharmaceutics & pharmacokinetics*. (Seventh Edition), Tata Mc Graw Hill Publishing Company, New Delhi.

[\[Back to Index\]](#)



Title of the Course	Bio-entrepreneurship
Course Code	MMI-6208
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	Equip students with a foundational understanding of entrepreneurship within the marine microbiology and biotechnology sectors.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Demonstrate a comprehensive understanding of the principles and concepts of bio-entrepreneurship.	PSO 4
	CO 2. Develop an entrepreneurial mindset and aptitude, enabling them to recognize and capitalize on opportunities within diverse fields of marine microbiology.	PSO 1, PSO 2, PSO 4
	CO 3. Analyze and discuss case studies, gaining insights into bio-entrepreneurship challenges and opportunities.	PSO 4, PSO 5
	CO 4. Apply entrepreneurial skills and strategies to identify opportunities and develop innovative concepts.	PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Entrepreneurship: Definition, types, and legal forms. Exploring the potential and scope of entrepreneurial ventures in marine microbiology. Steps and skills involved in launching an enterprise. Identifying challenges and opportunities; exploring digital/AI tools to research solutions. Applying creativity to design innovative products or processes. Developing proof-of-concept, using mind-maps, and addressing limitations in implementation. Ethical considerations in bioentrepreneurship. Technological Readiness Levels (TRL), Market Readiness Levels (MRL), and Business Readiness Levels (BRL). Technology versus business model. Strategies for commercialization and market entry. Funding sources for startups (bootstrapping, crowdfunding, angel investors, venture capital, bank and microfinance loans, etc).	15	CO 1, CO 2	K1, K2, K3, K4
Module 2:	Marine microbiological applications: bioprospecting, value-added marine products, Types and stages of microbiological products/processes: microorganisms, metabolites, proteins, small molecules, and GMOs, scale-up, product stability, and shelf life. Regulatory frameworks and sustainability considerations for marine microbial products. Intellectual property rights-patents, Trade secrets and Design. Role of bioincubators and government support systems: Marine-based Incubators in India: Aquamarine Innovation Centre, Odisha Marine Biotechnology Research & Innovation Corridor and EDII Marine Products Business Incubation Forum. Motivational case studies and entrepreneur experiences of successful marine-based enterprises and translational research.	15	CO 3, CO 4	K1, K2, K3, K4
Pedagogy:	Lectures/ assignments/ videos/case studies.			
References/ Readings:	<ol style="list-style-type: none"> 1. Liu, S. (2020). <i>Bioprocess engineering: kinetics, sustainability, and reactor design</i>. Elsevier, Amsterdam, The Netherlands. 2. Ries, E. (2011). <i>The Lean Startup: How today's entrepreneurs use continuous innovation to create radically successful businesses</i>. Crown Business, New York, NY. 3. Tyagi, S. Classification of major microbial products. <i>Industrial Microbiology, 1</i>, 127. 4. Vala, A. K., & Dudhagara, D. R. (Eds.). (2025). <i>Marine Biotechnology: A Gateway to Blue Economy</i>. CRC Press, Boca Raton, Florida. 			

[\[Back to Index\]](#)

Title of the Course	Interface of Cancer Biology and Marine Natural Products
Course Code	MMI-6209
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learner	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course introduces the fundamentals of cancer biology and explores marine natural products as potential anticancer agents, emphasizing discovery, mechanisms, and evaluation through cell-based assays and models.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. To provide a comprehensive understanding of cancer biology and its molecular mechanisms.	PSO 2, PSO 3
	CO 2. To explore the potential of marine natural products as anticancer agents	PSO 1
	CO 3. To equip students with the ability to critically evaluate current research involving marine bioactive compounds.	PSO 2
	CO 4. Differentiate different cell culture techniques and assays for anticancer drug testing and development.	PSO 2, PSO 3, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Definition and classification of cancer (benign vs. malignant). Hallmark of cancer- Proliferative signalling, evading growth suppressors, resisting cell death, immortality, angiogenesis, and metastasis. Tumor Microenvironment and Extracellular Matrix. Molecular Basis of Cancer Development: Oncogenes, tumor suppressor genes, and their roles in cancer progression, Mutations in proto-oncogenes (e.g., Ras, Myc). The role of epigenetics in cancer, Characteristics and significance of cancer stem cells: Self-renewal and differentiation potential, Roles in tumor initiation, metastasis, and therapy resistance.	15	CO 1	K1, K2, K3
Module 2:	Marine Natural Products: Marine biodiversity as a source of anticancer compounds (Microorganisms, sponges, corals, algae and mollusks) and its classification. Marine-Derived Compounds (e.g., Trabectedin, Ecteinascidin-743, etc). in Chemotherapy and Targeted Therapy. Development of marine drugs as targeted therapies for cancer. Marine microbiomes and metagenomics in anticancer drug discovery. Characteristics and application of various cell lines in anticancer drug testing (e.g., HeLa, MCF-7, A549). Cell Proliferation Assays (MTT, XTT etc). Flow cytometry for cell cycle analysis. Apoptosis Assays (Annexin V/Propidium Iodide (PI) Staining, TUNEL Assay, Caspase Activity Assays, etc). Case studies	15	CO 2, CO 3, CO4	K1, K2, K3
Pedagogy:	Lectures/ tutorials/ assignments/ Videos			
References/ Readings:	<ol style="list-style-type: none"> 1. Bonifacino, J. S. (Ed.). (2001–2020). <i>Current Protocols in Cell Biology</i>. John Wiley & Sons, New York. 2. Weinberg, R. A. (2023). <i>The biology of cancer</i> (3rd ed.). W. W. Norton & Company New York. 3. Kalasariya, H. S., Maya-Ramírez, C. E., Cotas, J., & Pereira, L. (2025). Marine-based drug candidates: Cutting-edge innovations and strategies in modern drug discovery. In V. P. Singh (Ed.), <i>Natural product drugs: Discovery to development</i> (pp. 148–213). Royal Society of Chemistry, United Kingdom. 4. Teicher, B. A. (Ed.). (2011). <i>Anticancer drug development guide: Preclinical screening, clinical trials, and approval</i> (2nd ed.). Humana Press, USA. 			

[\[Back to Index\]](#)

Title of the Course	Biosafety and Bioethics in Laboratory	
Course Code	MMI-6210	
Number of Credits	02	
Theory/Practical	Theory	
Level	500	
Effective from AY	2026-2027	
New Course	Yes	
Bridge Course/ Value added Course	No	
Course for advanced learners	No	
Pre-requisites for the Course:	Nil	
Course Objectives:	The course introduces principles and practices of biosafety and bioethics in laboratory covering safe handling, risk assessment, containment, and ethical issues.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Apply biosafety principles for assessing and managing risks associated with laboratory work.	PSO 1
	CO 2. Awareness and practical knowledge of laboratory safety protocols and guidelines.	PSO 1, PSO 2, PSO 3
	CO 3. Analyse ethical issues in laboratory research.	PSO 1, PSO 2, PSO 3
	CO 4. Evaluate guidelines and frameworks governing biosafety and bioethics.	PSO 1, PSO 4

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction of biosafety; biosafety levels and risk assessment – pathogen groups (1-4), biosafety levels (BSL 1-4), hazard identification, design of facility; laboratory practices and equipment – SOPs, use of personal protective equipment (PPE), safety cabinets, autoclaves, waste disposal methods; biosafety regulations, biosafety guidelines – WHO, NIH, DBT, ICMR	15	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4
Module 2:	Introduction to bioethics, scope; ethics in research – biotechnology, microbiology, marine microbiology, use of animals, fish; guidelines, informed consent, confidentiality; contemporary issues – GMOs, stem cell research, IPR, responsible science; Regulatory framework; bioethical committees – UNESCO, ICMR, NIH; case studies	15	CO 1, CO 2, CO 3, CO 4	K1, K2, K3, K4
Pedagogy:	Lectures/ discussions/ case studies/ assignments			
References/ Readings:	<ol style="list-style-type: none"> 1. Beauchamp, T. L., & Childress, J. F. (2019). <i>Principles of Biomedical Ethics</i>. Oxford University Press, New York. 2. Bezuidenhout, L. M. (2019). <i>Ethics for Life Scientists</i>. Springer, Cham, Switzerland. 3. Department of Biotechnology (DBT), Govt. of India – Biosafety Guidelines for Research in GMOs. 4. Fleming, D. O., & Hunt, D. L. (2006). <i>Biological Safety: Principles and Practices</i>. ASM Press, Washington, D.C. 5. ICMR Ethical Guidelines for Biomedical Research on Human Participants (2017)., New Delhi. 6. Mishra, S. (2019). <i>Biosafety and Bioethics</i>. PHI Learning Pvt. Ltd. 7. National Institutes of Health. (2024). <i>NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules</i>. U.S. Department of Health and Human Services. https://osp.od.nih.gov/wp-content/uploads/NIH_Guidelines.pdf. 8. Singh, K. (2015). <i>Biosafety and Bioethics</i>. S. Chand Publishing, New Delhi. 9. UNESCO (2005). <i>Universal Declaration on Bioethics and Human Rights</i>. Paris: United Nations Educational, Scientific and Cultural Organization (UNESCO) https://unesdoc.unesco.org/ark:/48223/pf0000146180 10. <i>WHO Laboratory Biosafety Manual</i> (4th Ed., 2020). World Health Organization, Geneva. 			

[\[Back to Index\]](#)

Title of the Course	Marine Microbiomes
Course Code	MMI-6211
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	Yes
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	The course delves into the concept of the marine microbiome, its types, features, functions and relevance to the environment and society. The recent research initiatives and technological advancements pertaining to marine microbiomes are also emphasized.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Describe the composition, features and types of marine microbiomes.	PSO 1, PSO 5
	CO 2. Summarize the contribution of marine microbiomes to natural products' research and ecosystem functioning.	PSO 1, PSO 4
	CO 3. Identify the key research initiatives pertaining to ocean microbiomes.	PSO 1, PSO 5
	CO 4. Explain the advanced technological developments in ocean microbiome research.	PSO 1, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Concept of marine microbiome; types of marine microbiomes: coastal, oceanic, animal. Composition of the marine microbiome: bacteria, archaea, yeasts, protists, viruses; abundance, characteristic features and functions of the marine microbiome. Plankton microbiome; sponge and coral microbiomes. Marine microbiomes as a source of natural products; Key concepts associated with marine microbiomes: Microbial structuring of marine ecosystems. Trophic categories and microbial interactions. Influence on coastal ecosystem health and human populations. Discovery of SAR11, <i>Prochlorococcus</i> , viruses and pico-eukaryotes; ecosystem-level ocean microbiology; metabolic reprogramming by marine phages; resolving microbial dark matter.	15	CO 1, CO 2	K1, K2, K3, K4, K5
Module 2:	Research initiatives and advanced technologies in ocean microbiome research: use of flow cytometry in oceanographic vessels, open ocean time series experiments, measurement of ocean chlorophyll using SeaWiFS satellite, genome sequencing of key ocean microbes, Global Ocean Sampling community dynamics, International Census of Marine Microbes, <i>Tara</i> Oceans end-to-end ecosystem analysis, Malaspina expedition of deep ocean, high throughput DNA sequencing, automated microscopy for plankton imaging, genome-resolved microbial oceanography, single-cell genomics, nano-SIMS to explore single-cell physiology, launch of Ocean Sampling Day, multi-omics powered field discoveries.	15	CO 3, CO 4	K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments/case-studies			
References/ Readings:	<ol style="list-style-type: none"> 1. Kumar M., & Ralph, P. (2017). <i>Systems Biology of Marine Ecosystems</i>. Springer Cham Publishers, Singapore. 2. Lone, S. A., & Malik, A. (2021). <i>Microbiomes and the global climate change</i>. Springer, Singapore. 3. Munn, C.B. (2011). <i>Marine Microbiology Ecology and Applications</i>, Garland Science, New York. 4. Stal, L. J., & Cretoiu, M. S. (2022). <i>The marine microbiome</i>. Springer Cham Publishers, Singapore. 			

[\[Back to Index\]](#)

Title of the Course	Polar Microbiology
Course Code	MMI-6212
Number of Credits	03
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course	No
Bridge Course/ Value added Course	No
Course for advanced learners	No

Pre-requisites for the Course:	Nil	
Course Objectives:	This course highlights the unique characteristics of polar environments (the Arctic, Antarctic and the Southern Ocean), with emphasis on their microbial ecology, diversity, community interactions, and response to climate change.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Describe the unique features of diverse polar econiches.	PSO 1, PSO 5
	CO 2. Evaluate strategies to isolate and characterize polar microorganisms.	PSO 2, PSO 5
	CO 3. Understand the microbial diversity in polar environments.	PSO1
	CO 4. Assess the role of polar microorganisms in community interactions and biogeochemical cycling.	PSO 1, PSO 5
	CO 5. Distinguish between the impact of different categories of pollutants on polar ecosystems.	PSO 1, PSO 5
	CO 6. Evaluate the sensitivity of polar environments to climate change and pollutants.	PSO 1, PSO 5

Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Polar environments (Arctic, Antarctica, Southern Ocean), polar niches (atmosphere, dry valleys, ornithogenic soils, permafrost, cryoconites, sea ice, glaciers, lakes); Microbial ecology; Strategies to isolate and characterize polar microorganisms; Biotechnological importance of polar microorganisms: psychroenzymes, anti-freeze proteins, novel antibiotics and other bioactive compounds.	15	CO 1, CO 2	K1, K2, K3, K4, K5
Module 2:	Microbial diversity and factors influencing microorganisms in polar environments: archaea – <i>Thaumarchaeota</i> ; bacteria – <i>Glaciecola psychrophila</i> , <i>Pseudoalteromonas haloplanktis</i> , <i>Marinomonas primoryensis</i> ; cyanobacteria – <i>Oscillatoria</i> ; fungi and yeast – <i>Glaciozyma psychrophila</i> , and diatoms – <i>Fragilariopsis cylindrus</i> ; cellular, structural and physiological characteristics, community interactions and food webs, biogeochemical cycling; Viruses in polar ecosystems.	15	CO 3, CO 4	K1, K2, K3, K4, K5
Module 3:	The polar environment as a vulnerable ecosystem. Impact of anthropogenic pollutants and climate change on microbial communities. Effects of greenhouse gases, ozone depletion, global warming and ocean acidification on polar ecosystems. Melting of glaciers, intrusion of Atlantic waters into the Arctic region; Introduction, transport and fate of pollutants in polar environments: oil spills, microplastics, heavy metals, Persistent Organic Pollutants (POPs) xenobiotic compounds, acid rain, radioactive isotopes. Effects of iron fertilization on productivity and carbon export in the High-Nutrient-Low-Chlorophyll (HNLC) regions of the Southern Ocean and its impact on the Antarctic region.	15	CO 5, CO 6	K1, K2, K3, K4, K5
Pedagogy:	Lectures/assignments/case-studies.			
References/ Readings:	<ol style="list-style-type: none"> 1. Bej, A. K., Aislabie, J., & Atlas, R. M. (2009). <i>Polar Microbiology: The ecology, biodiversity and bioremediation potential of microorganisms in extremely cold environments</i>. CRC Press, Boca Raton, Florida. 2. Duarte, C. M. (2008). <i>Impacts of global warming on polar ecosystem</i>. Fundacion BBVA. 3. Fernandes-Duarte, A. W., Michel Rodrigo Passarini, M. R., Elster, J., & Singh, P. K. (2025). <i>Polar microbes and climate change</i>. Springer Nature, Switzerland. 4. Miller, R. V., & Whyte, L. G. (2014). <i>Polar Microbiology: Life in a deep freeze</i>. ASM Press, Washington DC. 			

[\[Back to Index\]](#)

Title of the Course	Marine Bioluminescence
Course Code	MMI-6213
Number of Credits	02
Theory/Practical	Theory
Level	500
Effective from AY	2026-2027
New Course:	Yes
Bridge Course/ Value added Course	No
Course for advanced learners:	No

Pre-requisites for the Course:	Nil	
Course Objectives:	To provide students with in-depth knowledge in occurrence, regulation and importance of bioluminescence in marine ecosystems.	
Course Outcomes:	Students will be able to	Mapped to PSO
	CO 1. Explain the evolution, distribution, ecological roles and biogeochemical significance of marine bioluminescence.	PSO1
	CO 2. Differentiate diverse bioluminescent systems with respect to their biochemical pathways, genetics, and evolutionary adaptations	PSO1
	CO 3. Assess the regulation of bioluminescence and interpret their ecological and biotechnological implications.	PSO5
	CO 4. Design experimental or applied strategies using bioluminescence and propose solutions	PSO2

to marine ecological and industrial challenges through case study analysis.				
Content:		No of hours	Mapped to CO	Cognitive Level
Module 1:	Introduction to bioluminescence: Definition, history and evolution, oceanographic distribution, ecology, biogeochemical significance (role in carbon cycling, particle transport). Aposematism, milky seas. Environmental triggers of luminescence. Types of bioluminescent systems: Cypridinid-based, Coelenterazine-based, D-luciferin-based, tetrapyrrole- based, bacterial bioluminescence, fungal bioluminescence. Symbiotic luminescence and bacterial expulsion phenomenon. Direct and Sensitized/ indirect luminescence. Bioluminescence shunt hypothesis. Yellow/blue fluorescent proteins. Detection and quantification (spectrophotometry, luminometry, imaging, flow cytometry-based detection).	15	CO 1, CO 2	K1, K2, K3
Module 2:	Species of luminous bacteria and dinoflagellates, characteristics, model organisms. Biochemistry and genetics involved in bioluminescence: Origin (anti-oxidative hypothesis), function and biochemistry, <i>luxCDABEG</i> and <i>ribEBHA</i> genes, expression and regulation of <i>lux</i> operon, omics in studying lux regulation; Flavin-initiated electron transfer mechanism, dioxirane mechanism, quorum sensing control of luminescence. The Microtox system. Biotechnological applications; Advanced HAB linkages: Luminescent dinoflagellates as indicators of eutrophication. Case studies.	15	CO 3, CO 4	K5, K6
Pedagogy:	Lectures/assignments			
References/ Readings:	<ol style="list-style-type: none"> 1. Ramasamy S. (2022). Bioluminescent Marine Plankton. Bentham Science Publishers, India. 2. Ramasamy S. (2023). Biology and Ecology of Bioluminescent Marine Fishes. Apple Academic Press, 1st edition, India. 3. Ramasamy S. (2024). Bioluminescent Marine Invertebrates. Daya Publishing House, India. 4. Thouand G., & Marks R. (2014). Bioluminescence: Fundamentals and <i>Applications in Biotechnology</i> - Volume 1, Springer Berlin, Heidelberg. 			

[\[Back to Index\]](#)