JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY

M.Sc. MICROBIOLOGY
(II SEMESTER)

2023-2024

Department of Biotechnology

Programme Name: MSc (Microbiology), MSc (Environment)

Course Name & Code: Environmental Microbiology; 19M21BT114

Course: Environmental Microbiology
Code: 19M21BT114 (4 credits)
Revised Course Outcomes

Course Outcomes (Cos): Upon completion of the course, students would be able to:

COURSE OUTCOMES: Upon completion of the course, students will be able to		**COGNITIVE LEVELS**
CO.1	Explain microbial associations and their contribution to various environments	Understand Level (C2)
CO.2	Identify application potential of microbes in different biotechnology sectors	Apply Level (C3)
CO.3	Make use of research advances in microbe-based technologies concerning microbial ecology and environmental balance	Apply Level (C3)
CO.4	Analyse different aspects of polluted environments and suggest methods of detoxification	Analyze Level (C4)

Brief Outline:

Fundamentals of Environmental microbiology, its significance, contribution of microbes to nutrient cycling and other ecosystem functions, microbial associations and belowground soil networks, microbes in aquatic and different extreme environments and their adaptations, microbes for remediation and detoxification, research studies of microbes applied for decontaminating environmental pollutants and other applications, regulatory measures in microbial application.

Detailed Syllabus

Lecture-Wise Breakup

Course Code	19M21BT114	**Semester:**	**Semester: II Session :** 2024 **Month from:** Jan-June, 2024	
Course Name	Environmental Microbiology			
Credits	3-1-0-4		**Contact Hours**	4

Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)	1. Prof. Krishna Sundari	
Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	General concept of Microbes, Microbial ecology & Environment	Concept of Microbes with respect to Environment & Ecosystem, Soil as an environment for diverse microorganisms, Understand the biogeochemical cycles, The global carbon cycle and microorganisms, carbon cycle and the green house effect, diversity of microbes, microbial communities in environment	6
2.	Microbial interactions in Environment	Microbial interactions - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition, Microbial interactions with plants–phyllosphere, mycorrhizae, rhizosphere and symbiotic association in root nodules.	4
3.	Microbes in aquatic environments	Aquatic habitats - freshwater - lakes, ponds and streams; marine habitats - estuaries, deep sea, hydrothermal vents, saltpans and microbes acclimatised, Factors affecting microbial growth in aquatic environments, coral reefs and mangroves and their microbial communities; zonation – food chain and food web.	3

4.	Microbes under extreme environments	Categories of extremophiles and extremotrophs, Distribution of extremophiles and extremotrophs, Types and diversity of thermophiles, psychrophiles, halophiles, alkaliphiles, acidophiles and barophiles.	3
5.	Microbes for improved soil health	Classification of soil, physical and chemical properties of soil, structure of soil, Soil microbes and fertility of soil, Soil microbes and fertility of soil. Biotechnology of nitrogen fixation, Biofertilizers VAM, Rhizobium, Frankia, Azospirillum, Azotobacter, cyanobacteria and Azolla and Biopesticides	6
6.	Microbiology of waste water	Principle microbial groups in waste water environment, their role, Treatment of liquid wastes –primary, secondary, tertiary treatment; anaerobic (methanogenesis), aerobic, trickling, activated sludge, oxidation pond.	4
7.	Microbes in remediation and biomass utilization	Bioremediation types (*in situ / ex situ*) and methods, Treatment of solid wastes -composting, vermiform composting, saccharification, gasification, treatment of liquid wastes, urban wastes, industrial wastes, microbes for utilization of starch and sugars in biomass, biogas and biofuels	6
8.	Microbes for degradation of xenobiotics and decontaminating polluted sites	Microbe assisted degradation of xenobiotics, Degrees of biodegradation, Factors needed for biodegradation and adaptation, solutions from Biodegradation, Biodegradable and non – biodegradable organic matter, toxicity testing, Bistimulation, Bioaggumentation, Biosorption, Biosensors, Bioindicators, microbes to address heavy metal pollution	4
9.	Microbial technologies for environmental applications	Application of microbes in various industries (paper & pulp, tanneries, distilleries, food processing & diary industry) microbes for treatment of Oil spills, radioactive spillage Biofilters, Biofuels, Bioplastics, Biofilms in industry & environment, Case studies	4
10.	Regulations for use of microbes	Microbes and biosafety levels, regulations for application of microbes in research and environment	2
Total number of Lectures			42

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20

End Semester Examination	35
TA	25
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Prescott's Microbiology, 10th Edition, Eds. Joanne Willey, Linda Sherwood and Christopher J. Woolverton, 2017
2.	Environmental Microbiology, 3rd Edition, **Eds:** Ian Pepper, Charles Gerba, Terry Gentry, Academic Press, 2014
3.	Environmental Science: toward a Sustainable Future. Richard T Wright, Dorothy F Boorse, 12th Edition, Pearson India education services pvt Ltd., 2015
4.	Basic Environmental technology: water supply, waste management and pollution control, Jerry A nathanson, Richard a Schneider, sixth edition, Pearson India education services pvt Ltd.,, 2017
5.	Research articles from refereed journals.

Course Description
Detailed Syllabus

MSc (Microbiology)

Enzyme & Bioprocess Technology (Sem II)

Course Code	19M21BT117	**Semester:** Even	**Semester:** 1st **Session:** 2023-24 **Month from:** Jan to June
Course Name	Enzyme & Bioprocess Technology		
Credits	3-1-0	**Contact Hours**	4

COURSE OUTCOMES: Upon completion of the course, students will be able to		**COGNITIVE LEVELS**
C120.1	Explain biochemical reactions and structure-function relationships of different classes of enzymes	Understand Level (C2)
C120.2	Apply production and optimization methods for industrial products	Apply Level (C3)
C120.3	Apply microbial growth kinetics and bioreactors for production	Apply Level (C3)
C120.4	Examine applications of enzyme technology and bioreactor engineering.	Analyze Level (C4)

Faculty (Names)	**Coordinator(s)**	Dr. Garima Mathur	
	Teacher(s) (Alphabetically)	1. Dr. Garima Mathur 2. Prof. Sudha Srivastava	
Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures**
1.	**Introduction and Scope**	Enzymes - Nomenclature and Classification, Biological Roles, Enzyme activity, Specific activity and turn over number, Coenzymes and cofactors, Isozymes, Synzymes scope of enzymes in medicine, detergents, food and beverage, textiles and leather. Significance of Acetyl choline esterase, creatine kinase, trypsin, amylase, cellulase;	5
2	**Structure function relationships**	3D- Structure of Enzymes, Active Site, Modifiers of Enzyme Activity, Enzyme Activators, Enzyme Inhibitors, structure-function relationships in model proteins like ribonuclease A, Triose phosphate isomerase, chymotrypsin etc.; Protein folding: folding of single and multiple-domain proteins, Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding	7

3.	**Production of Enzymes**	Sources of industrial enzymes (natural & recombinant), Screening for new and improved enzymes, different methods of extraction, isolation and purification of commercially important enzymes, large-scale industrial enzyme production and downstream processing	6
4.	**Techniques of enzyme Immobilization**	Immobilization - Definition, Advantages & Disadvantages, Types of Immobilization Techniques - Physical and chemical - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with examples; Overview of applications of immobilized enzyme systems, Enzyme electrodes and their application as biosensors in industry, health care, food and environment.	4
5.	**Microbial Growth kinetics**	Different growth stages – lag, log and stationary phase; Exponential growth model, substrate and product stoichiometry, multi-substrate growth kinetics, maintenance energy	7
6.	**Bioreactors**	Ideal and non-ideal culture system, types of Bioreactors- Brief introduction to design and operations;	5
7.	**Energy and Mass Transfer**	Energy and mass balance in biochemical processes; Aeration and agitation, volumetric mass transfer coefficient	4
8.	**Microbial fermentation**	Primary and secondary metabolite, Processes for production of alcohol, lactate, butyrate, butanol-acetone fermentation	4
		Total number of Lectures	**42**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Lehninger Principles of Biochemistry, 7th Edition; Freeman, WH & Company, 2017
2.	Biochemistry, 9th Edition by Jeremy Berg, Lubert Stryer, John Tymoczko, Gregory Gatto; WH Freeman, 2019
3.	Bioprocess Engineering: Basic Concepts; 3rd Edition by Matthew DeLisa, Fikret Kargi, Michael L. Shuler; Prentice Hall; 2017
4.	Methods in Enzymology series by Academic Press
5.	Principles of Fermentation Technology, 3rd Edition by Stanbury PF, Whitaker A and Hall SJ, Elsevier, 2017
6.	"Bioprocess Engineering Principles", Doran, P.M., Academic Press

Microbiology Lab –II (19M25BT112) **NBA code: C170**
AY 2023-24
Course coordinator: Dr. Pooja Choudhary
Faculty members: Dr. Sonam Chawla, Dr. Ankisha Vijay, Dr. Pooja Choudhary, Dr. Garima Mathur, Dr. Chakresh Jain

CO	Course Outcome	Cognitive Level
CO1	Application of microorganisms for environmental remediation and production of industrially important enzymes and metabolites	C3 Apply level
CO2	Apply immunological methods to understand microbial diseases	C3 Apply level
CO3	Examine the antimicrobial agents from medicinal plants	C4 Analyze level
CO4	Compare pathogenic microbial genomes using computational tools	C4 Analyze level

S.No	List of Experiment	Week
1	**Environmental Microbiology**	**Week 1-3**
(a)	Determination of enzyme activities as pollution indicator (e.g. esterase, lipase, dehydrogenases) in contaminated soil and water samples.	
(b)	Total coliform bacteria count in contaminated water samples from different locations	
(c)	Evaluating of health of agriculture soil (pH, Organic carbon, phosphorous, nitrate-nitrogen)	
2	**Enzyme & Bioprocess Technology**	**Week 4-6**
(a)	Production of industrial enzymes using microbial cultures	
(b)	Enzyme kinetics	
(c)	Optimization of enzyme yield	
3	**Immunology &Immunotechnology**	**Week 7-9**
(a)	Differential WBC counts	
(b)	Virtual Lab: Removal of spleen and thymus from mice and isolation of lymphocytes	
(c)	Antigen- antibody interactions	
4	**Medical Microbiology**	**Week 10-12**
(a)	Antimicrobial activities of various medicinal plant extracts using disc diffusion method	
(b)	Determination of IC50 of various plant extracts	
(c)	Comparative analysis of pathogenic microbial genomes using computation tools	

Project based learning: Each student will choose a suitable computational tool to compare the genome sequence of microorganisms and make a report on the same.

Evaluation Criteria

Components	Maximum Marks
Mid Sem	20
End Sem	20
Day to day	60 (lab test, PBL, lab records)
Total	**100**

Detailed Syllabus

Lecture-wise Breakup

Course Code	**19M21BT118**	**Semester** Even	**Semester** M.Sc. Microbiology II **Session** 2023 -2024 Month from **Jan-June**
Course Name	**Medical Microbiology**		
Credits	4	**Contact Hours**	4

Faculty (Names)	**Coordinator(s)**	Dr. Vibha Gupta
	Teacher(s) (Alphabetically)	Prof. Reema Gabrani, Dr. Vibha Gupta

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Explain basic concepts of epidemiology	Understand Level (C2)
CO2	Examine the association between microbes, immunity and human health	Apply Level (C3)
CO3	Apply classical and advanced laboratory techniques for disease diagnosis	Apply Level (C3)
CO4	Relate mechanisms of antimicrobial agents and emerging resistance.	Analyse Level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Introduction	Introduction, Human microbiome and health	2
2.	Diseases caused by microbes:	Diseases caused by bacteria, virus, fungus and parasites; host susceptibility; mechanism of their pathogenesis; Specific Virulence Factors	8
3.	Diagnostic methods	Microscopy, molecular and immunological diagnostics	11

4.	Antimicrobial agents and disease control	Targeting bacterial biological components; Drugs that Inhibit other Biochemical Targets; Bacterial Resistance; Combinations of Antimicrobial Agents; Gram positive and gram negative bacteria, virus (DNA and RNA) specific case studies; antimicrobial vaccines;	10
5.	Specific Acquired Immunity against pathogens	General Concepts; Basis of Acquired Resistance; Primary *vs* Opportunistic Pathogens; Protective Antigens; Immune Mechanisms; Preventive Immunity	8
6.	Global health and epidemiology	Chain of Infection; Epidemiologic Methods; Epidemic Investigation	3
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (Presentation, Assignments, PBL)
Total	**100**

PBL: Students individually or in a group of 2 will be engaged in following a case study or researching a disease caused by any microbe. They will inspect the epidemiology and pathogenesis, and identify different techniques for its diagnosis (molecular and immunological methods) as well as emerging therapeutics in treating microbial infection.

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	S. Baron, "Medical Microbiology"; https://www.ncbi.nlm.nih.gov/books/NBK7627/
2.	P. Murray, K. Rosenthal, M. Pfaller, "Medical Microbiology", 8th Ed., Elsevier, 2015
3.	FH Kayser, KA Bienz, J Eckert, **"**Medical Microbiology", Thieme, 2011
4.	Selected Research articles

Detailed Syllabus

Lecture-wise Breakup

Course Code	19M11BT116	**Semester :** Even	**Semester** M.Sc. Microbiology/Env Biotechnology **Session** 2023 -2024 **Month** from January - June
Subject Name	**Immunology and Immunotechnology**		
Credits	**4**	**Contact Hours**	**4**
Faculty (Names)	**Coordinator(s)**	Dr. Rachana	
	Teacher(s) (Alphabetically)	Dr. Rachana, Dr. Shalini Mani	
CO116.1	Explain the role of the Immune system in human health and diseases.		**(C2) Understand level**
CO116.2	Utilie immunological techniques for diagnosis of various diseases.		**(C3) Apply level**
CO116.3	Make use of antibody engineering for various applications.		**(C3) Apply level**
CO116.4	Analyse advanced Immunological principles and technology for clinical purposes.		**(C4) Analyze level**

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Component of Immune system	Cells and organs of immune system, Innate immunity, adaptive immunity, B cell receptor, T cell receptor	6
2.	Regulation of immune response	Antigen presentation, MHC molecules, Cytokines, Complement systems	4
3	Diseases related to immune system	Autoimmune diseases, hypersensitivity reactions, Immune deficiency, cancer, infectious diseases.	5
4	Organ and tissue transplantation	HLA typing, graft rejection, graft acceptance, case studies.	3
5	Antibody engineering	Antibody diversity, Polyclonal antibody, Hybridoma Technology and its application, Humanized antibody, Phage display technology.	6

6	Immunotechnology	Theory, cross reactivity, precipitation reactions, agglutination reactions, ABO blood grouping, Ouchterlony, Western blotting, Elispot, immunofluorescence (IHC, FACS), ELISA, Kits for diseases. RIA	10
7	Vaccine Technology and its application	Adjuvants, live, attenuated, killed, inactivated, toxoids, recombinants, sub unit, conjugate and DNA vaccines	**4**
8	Immunotherapy	Passive immunization, activation of NK cells, T Cells, generation of antibody	**4**
		Total number of Lectures	42

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)

1.	Immunology (3rd edition) Janus Kuby W.H. Freeman and company
2.	**Essentials of Immunogy** Ivan- Roit; 6th edition (1988); Blackwell Publ
3.	**Antibodies A laboratory Manual** Harlow and David Lane, Old spring Harbor Laboratory
4.	**Immunology – A Short Course**, Richard Coico, *et al*. 5th Ed., Wiley – Liss, 2003.
5.	**Immunology, 4th Ed** Richard Hyde. Lippincott Wilkins & Wilkins, 2000.
6.	**Microbiology & Immunology Online.** Richard Hunt. Univ South Carolina, School of Medicine, http://pathmicro.med.sc.edu/book/immunol-sta.htm
7.	Cellular and Molecular Immunology 9th Edition Abul Abbas Andrew H. Lichtman Shiv Pillai, Elsevier, 2019 https://www.worldcat.org/title/cellular-and-molecular-immunology/oclc/1108702033?referer=di&ht=edition

Agriculture Biotechnology

Integrated M.Tech, M.Tech, MSc (Microbio), MSc (Environment)

(Elective Course)

Detailed Syllabus

Brief Outline: National Agriculture Policy, Food security, Agriculture and climate change, formulations for Plant Growth Promotion and Combating Phytopathogens, Formulation Technology of Biocontrol Agents, Laws & Regulations governing Bioformulations, Quality control in agriculture and agri-products

Course Code	**22M12BT111**	**Semester:**	**Semester: II, IV, Session: Even 2024** Month from: Jan to June
Course Name	**Agriculture Biotechnology**		
Credits	3-0-3	**Contact Hours**	**3**
COURSE OUTCOMES: Upon completion of the course, students will be able to			**COGNITIVE LEVELS**
CO.1	Infer applications of agriculture biotechnology for improved quality and productivity.		Understand Level, C2
CO.2	Relate Physiological & Molecular mechanisms of plant, its genome and extra chromosomal genetic information.		Apply Level, C3
CO.3	Apply different agricultural & biotechnological methods to meet National food security goals.		Apply Level, C3
CO.4	Connect advances in agriculture biotechnology to quality control, transgenics, regulations & agriculture policies.		Analyze Level, C4

Faculty (Names)	**Coordinator(s)**		
	Teacher(s) (Alphabetically)	1. Prof. Krishna Sundari	
Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	Overview of agriculture biotechnology & NAP	Introduction and significance of biotechnology in agriculture, Climate change and its impact on agriculture, National agriculture Policy, food security, SDG & agriculture, quality control in agriculture & GAP	6
2.	Plant growth & Physiology	Fundamentals of Plant growth, Photosynthesis and genes involved, symbiotic and non-symbiotic nitrogen fixation, Role of lectins, nod genes, nif	6

		genes, Structure, function and regulation of nitrogenase, Leg-haemoglobin, Nodulins, Molecular aspects of regulation and enhancement of nitrogen fixation, Synthesis and metabolism of hormones and plant signaling	
3.	Plant Genome & Plant Genetic resources	Genome size and sequence components, Nuclear, cytoplasmic/organelle genomes and significance, conservation of plant genetic resources, seedbanks, germplasm conservation and cryopreservation	4
4.	Agriculture Biotechnology & methods for improved production	Concept of plasticity in plant development, Tissue culture, hybridization, Marker Assisted Breeding, Molecular markers for plant genotyping and germplasm analysis commercial application of plant tissue culture	8
5.	Plant genetic engineering & applications	Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid, Agrobacterium-mediated gene delivery, Cointegrate and binary vectors and their utility, Chloroplast transformation: advantages, vectors systems of plant genetic engineering, Enhancing crop yield and crop quality improvement through Genetic Engineering for quality improvement: Seed storage proteins; essential amino acids, Vitamins and minerals, heterologous protein production in transgenic plants for agriculture, industry and pharmaceuticals uses, biodegradable plastics	12
6.	Agriculture policies & Regulations for GM and non-GM crops	Provisions on crop genetic resources in Indian Biodiversity Act, CBD and Cartagena protocol, Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA), Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts; Impact of GE crops on Biodiversity	6
Total number of Lectures			**42**
Evaluation Criteria			

Components	Maximum Marks
T1	20
T2	20
End Semester Examination	35
TA	25
Total	**100**

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Genetics, Agriculture, and Biotechnology, Walter Suza, Iowa State University Donald Lee, Published by University of Nebraska-Lincoln, Copyright Year: 2021
2.	Textbook of Agriculture Biotechnology, Nag Ahindra, Second Edition, PHI publications, 2018
3	Plant Biotechnology and Agriculture-Prospects for the 21st Century, Eds. Arie Altman, Paul Hasegawa, Elsevier publications, 2nd Edition, 2020.
4.	Research articles from refereed journals.

Detailed Syllabus

Course Code	19M22BT213	**Semester** Even **(specify Odd/Even)**	**Semester IV Session** 2023-24 **Month from: Jan-June**
Course Name	**Microbiomics**		
Credits	3	**Contact Hours**	3

Faculty (Names)	**Coordinator(s)**	1. Dr. Chakresh KumarJain
	Teacher(s) (Alphabetically)	Dr Chakresh Kumar Jain

Module No.	**Subtitle of the Module**	**Topics in the module**	**No. of Lectures for the module**
1.	**Overview of microbiomics**	Fundamentals microbiomics and applications, Which functions are expressed in the microbiome - transcriptomics	7
2.	**Microbiomic theory of life**	human 'commensal' microbiota, Human microbiome project, soil or water microbiota, their features and role in living system	5
3.	**Microbiome diversity**	16s rRNA profiling analysis, Shotgun Metagenomics, andinternal Transcribed spacer (ITS), internal Transcribed region analysis, Taxonomic classification, Diversityanalysis	8
4.	**Sequencing methods**	Extracting whole genomes from the microbiome - genome sequencing through PacBio, Deep sequencing, shot gun sequencing and data analysis using computational tools and pipelines, such as MG-RAST server etc.	10
5.	**Human Microbiome**	Nexus of Food, Agriculture, Human Nutrition, and Gut Microbiome	7

6	**Environment and Microbiome**	Environmental influences on bacterial genomes: bacterial epigenome and itsanalysis	4
7.	**Applications and tools**	Human microbiota and infectious diseases, liver diseases, gastrointestinal malignancy etc.	5
Total number of Lectures			**42**

Evaluation Criteria

Components MaximumMarks

T1 20
T2 20
EndSemester Examination 35
TA 25 (Assignments 1, 2 / MCQ/PBL,Attendance)

Total 100

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books, Reference Books, Journals, Papers, Reports, Websites etc. in the IEEE format)	
1.	Vassilios fanos, " Metagenomics and microbiomics", 2016, pp 144, Academic press. ISBN 9780128053058
2.	Pierre Baldi and Søren Brunak "Bioinformatics The Machine Learning Approach" , February 2001, The MIT Press, Cambridge, London
3.	Research papers and online resources