M.Sc. Microbiology

Semester II

Enzyme & Bioprocess Technology (Sem II)

Course Code	19M21BT117	**Semester:** Even	**Semester:** 1st **Session:** 2022-23 Month from: **Jan to June**
Course Name	Enzyme & Bioprocess Technology		
Credits	3-1-0	**Contact Hours**	4

Faculty (Names)	**Coordinator(s)**	Prof. Sudha Srivastava
	Teacher(s) (Alphabetically)	Prof. Sudha Srivastava, Dr Vibha Gupta

COURSE OUTCOMES: Upon completion of the course, students will be able to		**COGNITIVE LEVELS**
CO117.1	Explain biochemical reactions and structure function relationships of different classes of enzymes	Understand Level (C2)
CO117.2	Apply production and optimization methods for industrial products	Apply Level (C3)
CO117.3	Summarize microbial growth kinetics and bioreactors for production	Understand Level (C2)
CO117.4	Research and present a contemporary application of enzyme technology and bioreactor engineering.	Analyze Level (C4)

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	6

		enzymes, different methods of extraction, isolation and purification of commercially important enzymes, large-scale industrial enzyme production and downstream processing	
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-subtrate 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, Prrocesses for production of alcohol, lactate, butyrate, butanol-acetone fermentation	4
		Total number of Lectures	**42**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 (PBL, Class test, Assignment)
Total	**100**

Project based learning component: The students will be provided with the insight into industrial production of primary and secondary metabolites. They will present the details on production of any industrial product.

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, LubertStryer, John Tymoczko, Gregory Gatto; WH Freeman, 2019
3.	Bioprocess Engineering: Basic Concepts; 3rd Edition by Matthew DeLisa, FikretKargi, 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

ENVIRONMENTAL MICROBIOLOGY

Course Code	19M21BT114	**Semester:**	**Semester: II** **Session:** 2023 **Month from:** Jan-June, 2023
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, 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	Bioremediation types (*in situ / ex situ*) and methods, Treatment of solid wastes -composting, vermiform	6

	biomass utilization	composting, saccharification, gasification, treatment of liquid wastes, urban wastes, industrial wastes, microbes for utilization of starch and sugars in biomass, biogas and biofuels	
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**

PBL component: students take part as productive team members in projects (project based learning) concerning to microbial ecology, soil and environmental microbiology. Involving reference of quality research papers, understand advanced research methods, real-world learning associating issues in environmental disturbances, involves constructive analytical thinking to offer biotechnolgical solutions for safer environment

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.

MEDICAL MICROBIOLOGY

Course Code	**19M21BT118**	**Semester:** Even	**Semester: II** **Session: 2022-23**Jan-June
Course Name	**Medical Microbiology**		
Credits	4	**Contact Hours**	4

Faculty (Names)	**Coordinator(s)**	Prof. Reema Gabrani
	Teacher(s) (Alphabetically)	Prof. Reema Gabrani, Dr. Shalini Mani

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO 1	Understand the association between microbes and human health	Understand Level (C2)
CO2	Apply advance techniques for disease diagnosis	Applying Level (C3)
CO3	Analyze antimicrobial agents and immune system in microbial diseases	Analyze Level (C4)
CO4	Explain the epidemiology of microbial diseases and their effect on global health	Understand Level (C2)

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	11
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;	7
5.	Specific AcquiredImmunity 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 (PBL, Class test, Assignment)
Total	**100**

Project based Learning: Students will choose a disease caused by microbe and inspect the pathogenesis and its commercial diagnosis (molecular and immunological methods).

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", 9th Ed., Elsevier, 2020
3.	FH Kayser, KA Bienz, J Eckert, "Medical Microbiology", Thieme
4.	Selected Research articles

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code	**19M21BT116**	**Semester :**Even	**Semester:** II **Session: 2021-22** 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 Immune system in human health and diseases.	**(C2)**
CO116.2	Apply immunological techniques for diagnosis of various diseases.	**(C4)**
CO116.3	Make use of antibody engineering for various applications.	**(C3)**
CO116.4	Apply the advanced Immunological principle and technology for clinical purposes.	**(C3)**

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

Project based learning: Each student in a group of 4-5 will search the authentic scientific sites (NCBI/Sciencedirect/companies/labs) for the relevant articles/reports discussing application of Immunotechnology and will present/discuss the topic among the class students. Students would also discuss the medical reports of patients (collected from home/friends/internet) and will learn the basic methodology and parameters which are relevant to diagnose a particular disease.

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 (2017); Blackwell Publications
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

MICROBIOLOGY LAB – II

Course Code	**19M25BT112**	**Semester:** Even **(specify Odd/Even)**	**Semester:** II **Session: 2022-23**Jan-June
Course Name	Microbiology Lab – II		
Credits	4	**Contact Hours**	8

Faculty (Names)	**Coordinator(s)**	Dr. Garima Mathur
	Teacher(s) (Alphabetically)	Dr. Smriti Gaur Dr Ankisha Vijay Dr. Garima Mathur Dr. Indira P. Sarethy Dr. Sonam Chawla Dr. Sujata Mohanty Dr. Vibha Gupta

COURSE OUTCOMES		**COGNITIVE LEVELS**
C170.1	Apply microorganisms for environmental remediation	C3 - Apply level
C170.2	Make use of microorganisms for production of industrially important enzymes and metabolites	C3 - Apply level
C170.3	Apply immunological principles for understanding of microbial diseases	C3 - Apply level
C170.4	Analyze and compare antimicrobial agents	C4 – Analyze level
C170.5	Compare pathogenic microbial genomes using computational tools	C4 – Analyze level

Module No.	**Title of the Module**	**List of Experiments**	**CO**
1.	Environmental Microbiology	Determination of enzyme activities as pollution indicator (e.g. esterase, lipase, dehydrogenases) in contaminated soil and water samples.	CO1
2.		Total coliform bacteria count in contaminated water samples from different locations	CO1
3.		Evaluating of health of agriculture soil (pH, Organic carbon, phosphorous, nitrate-nitrogen)	CO1
4.	Enzyme & Bioprocess Technology	Production of industrial enzymes using microbial cultures	CO2
5.		Enzyme kinetics	CO2
6.		Optimization of enzyme yield	CO2

7.	Immunology & Immunotechnology	Differential WBC counts	CO3
8.		Virtual Lab: Removal of spleen and thymus from mice and isolation of lymphocytes	CO3
9.		Antigen- antibody interactions	CO3
10.	Medical Microbiology	Antimicrobial activities of various medicinal plant extracts using disc diffusion method	CO4
11.		Determination of IC50 of various plant extracts	CO4
12.		Comparative analysis of pathogenic microbial genomes using computation tools	CO5
Total			**12**

Evaluation Criteria

Components	**Maximum Marks**
Mid Term Evaluation	20
End Term Evaluation	20
Day to Day Evaluation	60
Total	**100**

Project Based Learning: The students learn techniques in Microbiology Laboartory which are of Biotech industry relevance.

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.	Aneja, K.R. (Eds.), Laboratory manual of microbiology and biotechnology, First, Delhi Meditec, 2014
2.	Siva, N., Taniwaki, M.H., Junqueira, V.C.A., Silveira, N.F.A., Okazaki, M.M., Gomes, R.A.R., Microbiological examination methods of food and water: a laboratory manual, Second,CRC Press Balkema, 2013
3.	Technological notes from industries