M.Sc., MICROBIOLOGY

SYLLABUS
(2024-2025 onwards)

Department of Biology
The Gandhigram Rural Institute - Deemed to be University
Gandhigram-624302
Dindigul District
Tamil Nadu
India

PROGRAMME EDUCATIONAL OBJECTIVES(PEO)

PEO1: To gain technical aptitude and in-depth knowledge in the relevant discipline

PEO2: To independently carry out practical, research and interpret the results scientifically

PEO3: To utilize the skills developed for gainful employment

PEO4: To update their knowledge periodically to match International Standards.

PEO5: To enhance the intellectual foundation and prepare themselves for life in a complex, dynamic and technological world.

PEO6: To preserve, add to and transmit knowledge.

PROGRAMME OUTCOME (PO)

PO1: Become knowledgeable in the subject and apply the principles of the same to the needs of the subject of the Employer/Institution/Enterprise/Society.

PO2: Gain analytical skills in the field.

PO3: Be able to design/ conduct investigations and develop solutions to solve problems using appropriate tools.

PO4: Use knowledge gained from public health and safety, cultural, societal and environmental needs which are friendly and sustainable.

PO5: Work individually/ as group, have professional ethics, able to prepare & execute projects and use knowledge obtained/ update it lifelong.

PROGRAMME SPECIFIC OUTCOME (PSO)

The students of M.Sc., Microbiology should be able to:

PSO1: Apply their knowledge of Microbiology in the domain of agriculture, food, medicine.

PSO2: Utilize techniques/ procedures relevant to Microbiological research work in laboratory or field settings.

PSO3: Use mathematical, statistical tools and appropriate technologies in understanding microbiological data

PSO4: Extent knowledge and critically evaluate current views and theories in various areas of Microbiology

PSO5: Relate scientific knowledge to research on the topic, perform experimentation, collect, analyze and present data.

M. Sc., MICROBIOLOGY PROGRAMME
OBE Template

Name of the Programme	**M.Sc., MICROBIOLOGY PROGRAMME**					
Year of Introduction	**2002**				**Year of Revision**	**2024**
Semester-wise Courses and Credit distribution	**I**	**II**	**III**	**IV**	**Total**	
No. of Courses	**7**	**9**	**9**	**7**	**30**	
No. of Credits	**22**	**24**	**24**	**24**	**94**	

M.Sc., MICROBIOLOGY PROGRAMME

SCHEME OF EXAMINATION

S.No	Semester	Course Code	Course Title	Nature of the Course	C	L	P	E	CFA	ESE	Total Marks
1.1	I	24MIBP0101	Bacteriology	Major	4	4	-	3	40	60	100
1.2		24MIBP0102	Mycology	Major	4	4	-	3	40	60	100
1.3		24MIBP0103	Advanced Biochemistry	Major	4	4	-	3	40	60	100
1.4		24MIBP0104	Advanced Bacterial Genetics and Molecular Biology	Major	4	-	4	3	40	60	100
1.5		24MIBP0105	Practical I: Bacteriology and Mycology	Major	2	-	4	3	60	40	100
1.6		24MIBP0106	Practical II: Advanced Biochemistry and Bacterial Genetics & Molecular Biology	Major	2	4	-	3	60	40	100
1.7		24GTPP0001	Gandhi in Everyday Life	-	2	2	-	-	50	-	50
				Total	**22**	**18**	**08**				
2.1	II	24MIBP0207	Bioinstrumentation and Research Methods	Major	4	4	-	3	40	60	100
2.2		24MIBP0208	Bacterial Metabolism and Development	Major	3	3	-	3	40	60	100
2.3		24MIBP0209	Advanced Environmental and Agricultural Microbiology	Major	3	3	-	3	40	60	100
2.4		24MIBP0210	Advanced Biostatistics	Major	4	4	-	3	40	60	100
2.5		24MIBP0211	Practical III:Bioinstrumentation and Bacterial Metabolism	Major	2	-	4	3	60	40	100
2.6		24MIBP0212	Practical IV: Advanced Environmental & Agricultural Microbiology	Major	2	-	4	3	60	40	100
2.7		24BIOP02GX	Elective: Generic	Generic Elective	3	3	-	3	40	60	100
2.8		24ENGP00C1	Communication and Soft Skills	Soft Skills	2	2	-	-	50	-	50
2.9		24MIBP0213	Summer Internship / Mini Project (30 days during II -Semester Break)	Major	1	-	-	-	50	-	50
				Total	**24**	**19**	**08**				
3.1	III	24MIBP0314	Applied Virology	Major	4	4	-	3	40	60	100
3.2		24MIBP0315	Immunotechnology	Major	4	4	-	3	40	60	100
3.3		24MIBP0316	Advanced Medical Microbiology	Major	4	4	-	3	40	60	100
3.4		24MIBP0317	Practical -V: Applied Virology and Immunotechnology	Major	2	-	4	3	60	40	100
3.5		24MIBP0318	Practical -VI: Advanced Medical Microbiology	Major	2	-	4	3	60	40	100

3.6		24MIBP03DX	Elective: Discipline Centric	Discipline Centric Elective	3	3	-	3	40	60	100
3.7		24MIBP03MX	Modular Course	Modular	2	2	-	-	50	-	50
3.8		24MIBP03 F1	Institutional/Industrial Visits	Major	1	-	2	-	50	-	50
3.9		24EXNP03V1	Village Placement Programme	VPP	2	-	-	-	50	-	50
				Total	**24**	**17**	**10**				
4.1	**IV**	24MIBP0419	Food and Fermentation Microbiology	Major	4	4	-	3	40	60	100
4.2		24MIBP0420	Bioprocess Technology	Major	4	4	-	3	40	60	100
4.3		24MIBP0421	Microbial Biotechnology and Genetic Engineering	Major	4	4	-	3	40	60	100
4.4		24MIBP0422	Practical -VII: Food, Fermentation, Bioprocess Technology and Microbial Biotechnology	Major	2	-	4	3	60	40	100
4.5		24MIBP04MY	Modular Course	Modular	2	2	-	-	50	-	50
4.6		24MIBP0423	Dissertation	Major	6	-	10	-	75	75^{*+} 50^{*}	200
4.7		24GTPP00H1	Human Values and Professional Ethics	-	2	2	-	-	50	-	50
				Total	**24**	**16**	**14**				
			Grand Total Credits		**94**						

#Courses may be offered under MOOC/NPTEL based on availability online and the syllabus will be modified as per MOOC/NPTEL with equal credits	**@ A portion of the Course may offered under MOOC/NPTEL based on availability online**
*Evaluation by External Examiner	C-Credits
**Evaluation by External and Internal Examiners	CFA-In-semester continuous assessment
L-Lecture Hours	ESE-End Semester Assessment
P-Practical Hours	VPP – Village Placement Programme
E-Exam Hours	

List of Elective: Discipline Centric Courses (3 credits)	**List of Modular Courses (2 Credits)**	**List of Generic Elective Courses offered to other Departments (3 credits)**
24MIBP03D1 Microbial Nanotechnology	24MIBP03M1 Advanced Molecular Techniques	24BIOP02G1 Food Microbiology
24MIBP03D2 Microbiome Biology	24MIBP03M2 Bioinformatics	24BIOP02G2 Industrial Microbiology
24MIBP03D3 Marine Microbiology	24MIBP03M3 Intellectual Property Rights	24BIOP02G3 Biofertilizer and Mushroom technology

VALUE ADDED COURSE (21MIBP0VA)

Course Code	**Course Title**	**Credit**
24MIBP0VA1	Rural Entrepreneurship	2
24MIBP0VA2	Food Microbiology	2
24MIBP0VA3	Biofertilizer &Mushroom technology	2
24MIBP0VA4	Industrial Microbiology	2

Possible Online Courses to be introduced in I to IV Semesters through NPTEL / MOOC modes based on its availability		
1. Molecular Biology	5. Industrial Biotechnology	9. Bio-electrochemistry
2. Applied Environmental Microbiology	6. Experimental Biotechnology	10. Bioreactors
3. Fundamentals of Biotechnology	7. Genetic Engineering &Applications	--
4. Biochemistry	8. Biomathematics	--

Semester	**FIRST**	Course Code	**24MIBP0101**
Course Title	**BACTERIOLOGY**		
No. of credits	**4**	No. of contact hours per week	**4**
New Course Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core course		
Scope of the Course (May be more than one)	• Basic understanding on the morphology and functions of the structures with the prokaryotes and eukaryotes • Skill development in microbial cultures • Creates employability scope in microbiological laboratories / hospitals / industries		
Cognitive Levels addressed by the course	**K-1** Ability to remember historical and recent developments **K-2** Grasp the comprehensive knowledge on Systematic bacteriology **K-3** Use microbiological tools for better understanding of microbial structures and their functions **K-4** Capacity to analyse factors influencing microbial growth **K-5** Make new techniques to study microbial activity in nature **K-6** Assessment of disease-causing microorganisms		
Course Objectives	The course aims to: • Enhance the student's knowledge in historical aspects • Acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes. • Make the students knowledgeable on the various cultural techniques involved in the microbiological lab • Give an overview on the disease caused by various microorganisms		

UNIT	**Content**	**No. of Hours**
I	**Introduction and classification** Introduction-Major Characteristics Used in Taxonomy - Bacterial classification according to Bergey's manual of Systematic Bacteriology. - Haekel's three kingdom concept-Whittaker's five kingdom concept -three domain concept of Carl Woese.	**13**
II	**Morphology, arrangement, Structure and Function** Morphology -Cell size, shape and arrangement. Ultra structure of bacteria.Cell-wall-Composition and detailed structure of Gram-positive and Gram-negative cell walls, archaebacterial cell wall. Cell membrane – structure, composition and properties. Structure and function of flagella, fimbriae, pili and gas vesicles – Chromosomes, carboxysomes – Cell division –Spores.	**13**
III	**Characteristics of Bacteria** Gram negative and Gram-positive bacteria: characteristics and examples. Study of typical bacteria -*Bacillus, Clostridium, Staphylococcus, Streptococcus, Escherichia, Salmonella, Shigella, Vibrio, Helicobacter, Mycoplasma* and *Chlamydia.*	**12**
IV	**Cultivation & Nutritional types and Reserve food materials** Cultivation of bacteria- aerobic – anaerobic. Culture media: natural and synthetic media, complex media, selective, differential, enriched and enrichment media. Growth – growth curve, batch culture, continuous culture. Factors affecting bacterial growth. Reserve food materials-Polyhydroxybutyrate-Polyphosphate Granules-Oil droplets-Cyanophycin granules and sulphur inclusions.	**13**

V	**Applied Bacteriology** General features- Role bacteria in biotechnology- Application of bacteria in food industry –Flavor, texture, Baking and Enzymes. Secondary metabolites: Pharmaceutical- Erythromycin, Bacteriocin- Probiotics and applications. Agriculture- Biofertilizers, *Azotobacter, Azospirillum-Phosphobacteria- Biological control- Bacterial insecticides- Bacillus thuringiensis.*	**13**
References	**Text Books:** 1. Jeffery C. Pommerville (2016). Alcamo's Fundamentals of Microbiology (Third Edition). Jones and Bartlett Learning. LLC, Burlington, MA 01803. 2. Tortora, G.J, Funke B.R. and Case, C.L..2010. Microbiology: An introduction 10th Ed, Benjamin Cummings, N.Y. 3. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2009. Prescott's principle of Microbiology, Mc Graw Hill, N.Y. 4. Dubey, R.C and Maheswari, D.K 2005. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company. **Reference Books:** 1. .Prescott,M.J.,Harley,J.P.andKlein,D.A.Microbiology.5thEditionWCBMcGrawHill,NewYork,(2002). 2. Tortora,G.J.,Funke,B.R.andCase,C.L.Microbiology:AnIntroduction.PearsonEducation,Singapore, (2004). 3. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. 4. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 5. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi. 6. Hans G. Schlegel. 2012(Reprint). General Microbiology. VII Ed. Cambridge University Press. UK. 7. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 8. John L. Ingrahm and Catherine Ingrahm. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA. 9. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed. WCB/McGraw Hill Company. 10. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms: Milestones in Microbiology. Prentice-Hall International Inc. London. 11. Talaro, K and Talaro, A. 1996. Foundations in Microbiology, 2en Ed., Wm. C. Brown publishers, Toront **Web resources:** 1. https://www.cliffsnotes.com › biology › microbiology 2. https://www.livescience.com 3. https://www.nature.com microbiology techniques	
Course Outcomes	**On completion of the course, students should be able to:** **CO1**: Discuss important milestones and accomplishments to appreciate the historical aspect **CO2**: Identify key organelles and their functions in both eukaryotes and prokaryotes **CO3**: Describe the overall classification and diversity of microorganisms **CO4**: Demonstrate the different cultural techniques in bacteriology **CO5**: Explain the disease caused by various microorganisms	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	3	3	3	3

Semester	**FIRST**	Course Code	**24MIBP0102**
Course Title	**MYCOLOGY**		
No. of credits	**4**	No. of contact hours per week	**4**
New Course Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core course		
Scope of the Course (May be more than one)	1. Basic understanding on the morphology and functions of the fungus 2. Skill development in fungal cultures 3. Creates employability scope in microbiological laboratories / hospitals / industries		
Cognitive Levels addressed by the course	**K-1** Ability to remember historical and recent developments in mycology **K-2** Grasp the comprehensive knowledge on mycology **K-3** Use microbiological tools for better understanding of fungal structures and their functions **K-4** Capacity to analyse factors influencing growth **K-5** Make new techniques for production of industrial products **K-6** Assessment of disease-causing fungus		
Course Objectives	The course aims to: • Enhance the student's knowledge in historical aspects • Acquire an overall knowledge on the morphology and functions of the structures in fungus • Make the students knowledgeable on the various industrial techniques involved in the lab • Give an overview on the disease caused by various microorganisms		

UNIT	Content	No. of Hours
I	**Introduction, Structure, Growth and Ecosystem of fungi** Introduction, -Characteristics, classification, cellular & thallus organization of fungi. General features, structure, nutrition, reproduction of different fungi group - Zycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Hyphae and non-motile unicells and multicells, motile cells, spores, dormancy, growth, population and colonies- Effect of environment on growth, prevention of fungal growth. Saprophytes.	**13**
II	**Fungi—Zygomycota and Ascomycotina and Basidiomycotina** Zygomycotina-Zygomycetes, Trichomycetes- General Characteristics, Life cycle and Economic importance of Mucor, Dimargaris, Chlamidoabsidia Ascomycotina-Hemiascomycetes,Plectomecetes, Pyrenomycetes, Discomycetes Laboulberiomycetes-General Characteristics, Life cycle and Economic importance of Penicillium, Candida, Claviceps.	**12**
III	**Fungi-Basidiomycotina and Deutromycotina** Basidiomycotina-Teliomycetes, Hymenomycetes- General Characteristics, Life cycle and Economic importance of Agaricus, Ustilago and Puccinia. Deutromycotina-Hypomycetes-Coelomycetes-Blastomycetes General Characteristics, Life cycle and Economic importance of Alternaria, Colletotrichum and Trichoderma.	**13**
IV	**Applied Mycology** General features, Role of fungi in biotechnology, Mushroom cultivation, Application of fungi in food industry –Flavor, texture, Baking and Enzymes. Secondary metabolites: Pharmaceutical-Penicillin. Agriculture- Biofertilizers, Mycorrhiza - ectomycorrhiza, endomycorrhiza. Biological control- Myco insecticides-Beaveria and Mettarrhizium-Fungi and bioremediation.	**13**
V	**Mycopathology** Terms and concepts; General symptoms; Geographical distribution of diseases. Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases. Important plant diseases caused by fungi- symptoms, disease cycles and control- Late & Early blight, Blackrust, Smut, Wilt and Red rot. Important animal diseases caused by fungi- Dermatomycosis, systemic mycosis and candidiasis.	**13**

References	**Text Books:** 1. B.K.Mishra(2017),MycologyandPhytopathology,KalynaiPublishers,NewDelhi. 2. Fundamentals of Mycology, J.H Burnett, Publisher: Edward.Arnold Crane Russak 3. The Fungi. M.Charlile & S.C. Atkinson, Publisher: Academic press 4. Fundamentals of Mycology. E.Moore – Landeekeer, Publisher: PrenticeHall **Reference Books:** 1. Sharma,P.D.(2017).MycologyandPhytopathologyRastogiPublication,Meerut. 2. Agrios,G.N.1997PlantPathology,4thedition,AcademicPress,U.K. 3.Alexopoulos,C.J.,Mims,C.W.,Blackwell,M.(1996).IntroductoryMycology,JohnWiley&Sons(Asia)Singapore.4thedition. 4.Webster,J.andWeber,R.(2007).IntroductiontoFungi,CambridgeUniversityPress,Cambridge.3rd edition. 5. Sethi,I.K.andWalia,S.K.(2011).TextbookofFungiandTheirAllies,MacmillanPublishers India Ltd. 6. Mehrotra,R.S.(2011).PlantPathology.TataMcGraw-illPublishingCompanyLimited,NewDelhi **Web resources:** 1. https://www.cliffsnotes.com › biology › microbiology 2. https://www.livescience.com 3. https://www.nature.com › ... › microbiology techniques
Course Outcomes	**On completion of the course, students should be able to:** CO 1: Discuss important milestones and accomplishments to appreciate the historical aspect CO2: Identify key organelles and their functions in fungus CO3: Describe the overall classification and diversity of fungus CO4: Demonstrate the different cultural techniques in mycology CO5: Explain the disease caused by fungus

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	2	2	1	2
CO4	3	2	2	1	2
CO5	3	3	3	3	3

Semester	**FIRST**	Course Code	**21MIBP0103**
Course Title	**ADVANCED BIOCHEMISTRY**		
No. of credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	50
Category	Core Course		
Scope of the Course (May be more than one)	1. Basic understanding on the various biological molecules and their importance 2. Skill development for analysis of enzymatic reaction 3. Creates employability scope in the biochemical laboratories / hospitals / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember basics of biomolecules K-2 Develop comprehensive knowledge on classification of protein, carbohydrates, lipids & nucleic acid K-3 Use biochemical tools for better understanding of structures of biomolecules and their functions K-4 Capacity to analyze the functions of carbohydrates, proteins, and lipids K-5 Make new techniques to study Biochemical importance and regulation K-6 Assessment of metabolic pathways and their biochemical importance		

Course Objectives	The course aims to: • Understand the chemical nature of biological molecules and their importance • Acquire overall knowledge on enzymes and their kinetics • Impart knowledge on the generation and flow of energy in living systems • Create interest on the metabolic pathways of carbohydrates, proteins and lipids	
UNIT	**Content**	**No. of Hours**
I	**The foundation of Biochemistry** Cellular foundation: Cells are the structural and functional units of all living organisms, Phylogeny of the three domains of life, organisms differ widely in their sources of energy and biosynthetic precursors. Chemical foundation: Biomolecules are compounds of carbon with variety of functional group, cells contain a universal set of small molecules, Macromolecules are the major constituents of cells, Interaction between biomolecules are stereospecific. Physical foundation: living organisms exist in dynamic steady state, organisms transform energy and matter from their surroundings, flow of electron provides energy for the organisms, Enzymes promotes sequence of chemical reactions, metabolism is regulated to achieve balance and economy. Genetic foundation: genetic continuity is vested in single DNA molecule; the structure of DNA allows for its replication and repair with three-dimensional structure.	13
II	**Biological Macromolecules** Classification, Structure, chemistry, and functions of macromolecules: Nucleic acid – purine, pyrimidine, nucleosides and nucleotides; RNA, DNA, A-form, B-form, and Z-form of DNA. Proteins – amino acids, primary, secondary, tertiary and quaternary structures of proteins. Carbohydrates – monosaccharides, disaccharides, oligosaccharides and polysaccharides; structure, physical and chemical properties. Lipids Lipids – simple, compound and derived. – Phospholipids, Glycolipids, Lipoproteins and Steroids. Structure; physical and chemical properties of lipids.	13
III	**Enzyme classification and catalysis** General introduction of enzymes, enzyme classification, Enzymes are biological biocatalysts, Reversible reactions, The specificity of substrate binding, Factors influencing the rate of an enzyme-catalysed reaction, Inhibitors and their effects on enzyme, specificity, active site, activity unit, isozymes. Enzyme kinetics: Michaelis - Menton equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, principles of allosteric regulation.	13
IV	**Cellular metabolism of Biomolecules** Basic principles – anabolism and catabolism. Biosynthesis of macromolecules: synthesis of carbohydrates, nucleic acids (salvage and de novo pathway), protein and lipids (Triglyceride synthesis). Breakdown of carbohydrates (Glycolysis, Pentose – Phosphate pathway, Krebs cycle), lipids (β – oxidation), proteins (aminoacid oxidation, Glucogenic, ketogenic, urea synthesis) and nucleic acids.	14
V	**Signal transduction pathways** Generalized signal transduction pathway and organization, basic concept of signals, Receptors: soluble receptor, transmembrane receptor, enzyme coupled receptor, G-protein coupled receptor, Ion-channel receptor. Second messengers-cyclic nucleotide(cAMP, cGMP), Ca^{2+}. Amplifies-protein kinases, G-protein. Integrators and Inhibitors. Basic concepts of acids, base, pH and buffers.	11

References	**Text Books:** 1. David L. Nelson and Michael M. Cox (2017). Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York. 2. Donald Voet, Judith G. Voet, Charlotte W. Pratt (2016). Fundamentals of Biochemistry Fifth Edition. John Wiley & Sons Inc, New York. 3. J.L. Jain 2003 Fundamental of Biochemistry S. Chand of company Ltd, New Delhi.S 4. G.S. Sandhu 2002 Textbook of biochemistry 18th Edn. Campus books International, New Delhi. 5. A.C. Deb. 2000 Fundamentals of Biochemistry New Central book Agency, Ltd, Calcutta. J.H. Well 1997. General biochemistry. 6th Edn. New Age International (P) Ltd pub; New Delhi. 6. Hiram F. Gilbert. Basic concepts in biochemistry Mc Graw Hill publication 7. U. Sathyanarayana, U. Chakrapani .2013. Biochemistry. 4th edition. Elsevier publication **Reference Books:** 1. D.Papachristodoulou, A. Snape, W.H. Elliott and D. C. Elliott (2014). Biochemistry and Molecular Biology. 5th Edn. Oxford University Press 2. Jeremy M Berg, John L Toymoczko and Lubert Stryer Stryer (2006). Biochemistry VI Edition. W.H. Freeman and Company, New York 3. Lansing M. Prescott, John P. Harley and Donald A. Klein (2002). Microbiology. Mc Graw Hill companies. 4. Buchanan, Gruissum and Jones, (2000). Biochemistry and Molecular Biology of Plant; ASPP, USA. David Rawn(2012). Biochemistry. Panima Publishers. **Web resources:** 1. Onlinelearning.hms.harvad.edu/biochemistry 2. Aldrin.tripod.com/biochemistry 3. https://study.com/biochemistry-class-online.html 4. Canterbury.libguides.com/bchm/websites
Course Outcomes	On completion of the course, students should be able to: CO 1: Explain the basic concepts in biochemistry and nature of the biomolecules. CO2: Discuss the classification, structural and chemical properties of carbohydrates, protein, nucleic acids and lipids CO3: Demonstrate classification of enzymes and can understand the characteristics of enzyme reactions. CO4: Outline the concepts of bioenergetics. CO5: Describe the metabolic pathways and their biochemical importance.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**FIRST**	Course Code	**24MIBP0104**
Course Title	**ADVANCED GENETICS AND MOLECULAR BIOLOGY**		
No. of credits	4	No. of contact hours per week	4
New Course / Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core course		
Scope of the Course (May be more than one)	1. Basic understanding on the molecules of life 2. Developing skills to for analysis mutagenesis 3. Creates employability scope in the molecular screening laboratories		

Cognitive Levels addressed by the course	**K-1** Ability to remember historical developments of genetics and molecular biology **K-2** Comprehensive knowledge on molecules of life **K-3** Capacity to analyze mutagenesis and molecular recombination **K-4** Use molecular techniques for better understanding of structures of DNA, RNA and Proteins **K-5** Make new techniques to study molecular mechanism of antisense molecules **K-6** Assessment of functions of DNA, RNA and Proteins
Course Objectives	The course aims to: • Impart information on the historical developments of genetics and molecular biology. • Give an in-depth knowledge on mutagenesis. • Make the student knowledgeable on concepts and mechanism of DNA replication process • Expose the students on mechanisms of transcription process in prokaryotes and in eukaryotes. • Enhance student's interest to distinguish translation processes in prokaryotes with eukaryotes.

UNIT	Content	No. of Hours
I	**Introduction to genetics and molecular biology** A Brief Overview of the Modern History of Genetics-The Three General Areas of Genetics-Classical, Molecular, and Evolutionary Genetics-Mendel's Experiments, Segregation, Dominance, Independent Assortment-Genotypic Interactions-Epistasis, Mechanism of Epistasis- Biochemical Genetics, Inborn Errors of Metabolism, One-Gene-One-Enzyme Hypothesis Genetic Material-Early observation on the mechanism of heredity, DNA and RNA as genetic material, Properties of Genetic material. Structure of DNA - primary, secondary and different forms (A, B & Z). Prokaryotic and Eukaryotic Chromosome Organization-Genes – definition, types and functional organization. Fine structure of gene-Central dogma of Molecular biology.	**13**
II	**Mutagenesis and Recombination at the molecular level** Mutation – Types – Molecular and biochemical basis of mutation. Mutagenesis – Spontaneous and induced – Base – analog, physical agents, chemical mutagens, intercalating substances and mutator genes. Reversion – definition – Types – Mechanisms – application (Ames test). Mutants – Types and Uses – bacterial mutants-Recombination at the molecular level. Crossing over during cell division breakage and re-joining of intact DNA molecules, Holliday model of homologous recombination – events at the molecular level; role of recA, recBC and chi sequences, Site- specific recombination – eg. Bacteriophage λ; FLP/FRT and Cre/Lox recombination.	**13**
III	**DNA Replication** Basic rule. The Geometry of DNA replication – Semi-conservative replication of double – stranded DNA and Circular DNA molecules. Enzymology – DNA Polymerases, DNA ligase and DNA gyrase. Events in the replication fork – Continuous and discontinuous. Plasmid and ØX174 DNA replication- DNA damages – DNA repair mechanism – photoreactivation, excision repair, recombinant repair and SOS function.	**13**
IV	**Transcription** Basic factors of RNA Synthesis - RNA polymerases – I, II and III - Transcription Mechanisms in prokaryotes and eukaryotes – chain Initiation, elongation and termination. Significance of pribnow box, TATA box, CAAT box and enhancers in transcription initiation. Rho dependent and Rho independent termination of transcription. Classes of RNA Molecules – Messenger, ribosomal and transfer RNA. Post –transcriptional modification - RNA splicing – role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping and tailing of 5' and 3' termini of Eukaryotic mRNA molecules. Antisense and Ribozyme technology – Molecular mechanism of antisense molecules -inhibition of splicing, polyadenylation, and transition – disruption of RNA	**13**

	structure and capping -biochemistry of ribozyme (hammerhead, hairpin and other ribozyme).	
V	**Translation** Genetic code – Definition, deciphering of codons – Universality of the code – Wobble hypothesis and codon degeneracy - codon dictionary. Mechanism of protein synthesis -importance of Initiation (IF), elongation (EF) and releasing factors (RF) - post translational modifications – protein splicing and folding – role of molecular chaperones. Regulation of gene expression in prokaryotes –Operon concept – inducible and repressible operons Eg. lac, trp.- Bacterial small RNA (sRNA) and its role in regulation of gene expression. Functional genomics, Validation of gene function. Gene silencing, PTGS, RNAi, Antisense technology, Applications. Molecular Pharming. Genome Editing CRISPR-Cas9.	**12**
References	**Text Books** 1. E.J. Gardner, M.J. Simmons, D.P. Snustad, 2006. Principles of Genetics (8th Ed.) John Wiley & Sons, New York. 2. Robert H. Tamarin, Principles of Genetics, 2001, McGraw-Hill Higher Education. 3. Benjamin Pierce, Genetics: A Conceptual Approach, 2016, WH Freeman 4. David Freifelder, 2020, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 5. Lansing M. Prescott, John P. Harley and Donald A. Klein (2020). Microbiology (11thEd.). Mc Graw Hill companies. 6. Michael M. Cox, Molecular Biology Principles and Practice, 2012 by W. H. Freeman and Company. 7. James D. Watson, Molecular biology of the gene, 7th Edition,2014, Cold Spring Harbor Laboratory. **References** 1. Geoffrey M. Cooper - The Cell A Molecular Approach, 8th Edition, Oxford University Press (2019). 2. Lizabeth A. Allison., Fundamental Molecular Biology, 2nd Edition, 2012 John Wiley & Sons, Inc. 3. David P. Clark, Molecular Biology, 3 rd Edition, 2019 Elsevier Inc. 4. Robert F. Weaver, Molecular Biology, 5th Edition 2012 by The McGraw-Hill Companies, Inc. 5. Bruce Alberts, Molecular Biology of Cell, 6th Edition,2015, Garland Science, Taylor & Francis Group, LLC **Web resources** 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio/ 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html	
Course Outcomes	**Upon completion of this course, students be able to:** **CO1**: Outline the fundamental concepts of molecules of life **CO2**: Discuss the various kinds of mutagenesis and their importance **CO3**: Explain the mechanisms of DNA replication & repair mechanisms **CO4**: Evaluate the differences of transcription process in prokaryotes with eukaryotes **CO5**: Compare the mechanisms of translation in prokaryotes with that in eukaryotes	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester		Course Code	24MIBP0105
Course Title	PRACTICAL I: BACTERIOLOGY AND MYCOLOGY		
No. of credits	2	No. of contact hours per week	4
New Course / Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core course		
Scope of the Course (May be more than one)	1. Basic knowledge on the important aspects of bacteria and fungus 2. Developing skills in the isolation and handling of microorganisms 3. Creates employability scope in microbiological laboratories/ diagnostic centres/ industries		
Cognitive Levels addressed by the course	K-1 Ability to remember safety measures and rules to be followed in a microbiological laboratory K-2 Comprehensive knowledge on Handling and Care of Microbiological Instruments K-3 Use of microbiological Instruments for better understanding of microbes K-4 Capacity to analyze microbes from soil, water, and air K-5 Make new techniques to study microbes K-6 Assessment of pure culture techniques, methods of culturing preservation and maintenance of microorganisms		
Course Objectives	The course aims to: • to enhance the student's knowledge and impress upon them on the important aspects of microorganisms • to provide practical knowledge and skills in the isolation and handling of microorganisms • to understand the working procedure and principles of microscopes. • to know pure culture techniques, methods of culturing preservation and maintenance of microorganisms • to gain skill in isolation of microorganisms from various samples.		

Practical	Topics covered	Hours
1.	Safety measures and rules of conduct to be followed in a microbiological laboratory and Cleaning of Glassware.	4
2.	Microscopic Examination and Measurement of bacterial and fungal spore using Micrometry.	4
3.	Bacterial staining techniques – Gram's staining	4
4.	Fungal staining techniques – Lactophenol cotton blue staining	
5.	Preparation and sterilization of different media: synthetic media, complex media-Nutrient agar, McConkey agar and EMB agar.	4
6.	Demonstration techniques for pure culture of bacteria- serial dilution technique, pour plate, spread plate and streak plate technique.	4
7.	Introduction to the world of fungi - Unicellular, septate mycelium	4
8.	Preparation of Potato Dextrose Medium.	4
9.	Enumeration and isolation of Bacteria and Fungi from soil using serial dilution and plating technique.	4
10.	Isolation and identification of pathogenic and non-pathogenic fungi.	4
11.	Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor* and *Saccharomyces,*	4
12.	*Aspergillus and Penicillium:* study of asexual stage from temporary mounts.	4

References

1. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (I Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India.
2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India.
3. Aneja. K.R, 2002. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, III Ed. New Age International publishers (P) Ltd, New Delhi.
4. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. Edition (Volumes. 1 – 5) (2001 – 2003).
5. B.K.Mishra(2017),MycologyandPhytopathology,KalynaiPublishers,NewDelhi.

	6. Fundamentals of Mycology, J.H Burnett, Publisher: Edward. Arnold Crane Russak.
Course Outcomes	**On completion of the course, students should be able to:** CO1: Demonstrate standard methods for the isolation, identification and culturing of microorganisms. CO2: Explain the ubiquitous nature of microorganisms CO3: Identify the different groups of microorganisms from different habitats. CO4: Demonstrate the different cultural techniques in mycology CO5: Explain the disease caused by fungus

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	2	2	2

Semester	**FIRST**	Course Code	**24MIBP0106**
Course Title	**PRACTICAL II: ADVANCED BIOCHEMISTRY AND BACTERIAL GENETICS & MOLECULAR BIOLOGY**		
No. of credits	2	No. of contact hours per week	4
New Course / Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core course		
Scope of the Course (May be more than one)	1. Basic knowledge on the measurement: criteria of reliability, precision, accuracy, sensitivity, specificity 2. Developing skills in estimation of protein, carbohydrates, and lipids 3. Creates employability scope in biochemical laboratories/ diagnostic centres/ industries		
Cognitive Levels addressed by the course	**K-1** Ability to remember safety measures and rules to be followed in a microbiological laboratory **K-2** Comprehensive knowledge on various biomolecules and their importance **K-3** Handling and use of Instruments used to analyse biomolecules **K-4** Capacity to analyse and quantify DNA, RNA and sugar **K-5** Make use of techniques to demonstrate antibiotic resistance mechanism **K-6** Assessment of DNA isolation and transformation protocol		
Course Objectives	The course aims to: • impart a practical knowledge on estimation of protein, carbohydrates, and lipids • acquire practical knowledge on estimation of sugar, DNA, and RNA. • develop art of practical skills to estimate lipid, sugar, and nucleic acid • develop skills to demonstrate antibiotic resistance mechanism • develop skills to isolate chromosomal and plasmid DNA		

Practical	**Topics covered**	**Hours**
1.	Safety in the laboratory	1
2.	Qualitative Analysis of Carbohydrates	4
3.	Estimation of Maltose from any Fruit Juice	4
4.	Estimation of Proteins - Folin Lowry's method	4
5.	Qualitative Analysis of Amino acids.	4
6.	Qualitative Analysis of Lipids	4
7.	Estimation of urea DAM method.	4
8.	Estimation of DNA by DPA method	4
9.	Estimation of RNA by spectrophotometry	4

10.	Isolation of chromosomal DNA from *E.coli.*	4
11.	Plasmid DNA isolation	4
12.	Bacterial transformation	4
13.	Isolation of antibiotic resistant mutants	4
	References: 1. Sengar, R.S. Reshu Chaudhary (2014) Laboratory Manual of Biochemistry. 2. Kavita Rawat; Shailendra Singh; Naresh Kurachiya; Swatantra Singh and Rajesh Vandre, Deepika D. Caesar (20) Practical Manual on Advance Techniques in Biochemistry, Mahi Publication 3. Keith Wilson And John Walker (2010). Principles and Techniques of Biochemistry and Molecular Biology Seventh edition Cambridge University Press 4. Sambrook J and Russell DW (2001). Molecular cloning - A laboratory manual, Cold Spring Laboratory Press, New York, 3rd Edition. Vol. 1, 2, 3. 5. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd Edition; ASM press; 2007.	
Course Outcomes	**On completion of the course, students should be able to:** CO1: Discuss the concepts in qualitative analyse of sugar, amino acid, Lipid CO2: Identify the different methods in quantification of Protein and urea CO3: Evaluate the DNA and RNA present in the biological sample CO4: Describe the Isolation of Genomic DNA and RNA from the bacterial strain CO5: Identify the AMR bacteria from the natural environment	

Mapping of COs with PSOs:

CO \ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	2	2
CO2	3	2	1	2	3
CO3	3	2	1	2	3
CO4	3	2	1	2	3
CO5	3	2	1	2	3

Semester	**FIRST**	Course Code	**24GTPP0001**
Course Title	**GANDHI IN EVERYDAY LIFE**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20%
Category	-		
Scope of the Course (may be more than one)			
Cognitive Levels addressed by the Course			
Course Objectives	**The Course aims** 1. To understand and appreciate the principles and practices of Gandhi and their relevance in the contemporary times. 2. To develop noble character and attitude to enable the students to cope up with the challenges of daily life.		

UNIT	Content	No. of Hours
I	**Understanding Gandhi:** Childhood days, Student days, influence of dramas, books, individuals, religions, family and social factors - Gandhi as rebel, mimicking western civilization, acquaintance with vegetarianism, as lawyer - encountering and transforming humiliation in India: with British Agent - in south Africa: train incident, Coach incident, on path way, at court, attack by protesters - Gandhi as political leader, social reformer and Constructive worker.	**7**

II	**Management**: Gandhi's experiments in managing family - Eleven vows - Managing Organizations - community living and financial ethics - Managing Social and political movements - Transvaal March - Noncooperation movement and Salt Satyagraha - non -attachment to position.	**6**
III	**Conflict Resolution**: Pursuance of Truth and nonviolence - Rights and duties, Ends and means - Openness, love and kindness in handling relationship - nonviolent communication - nonviolent Direct Action (Satyagraha) and conflict Transformation - Conflict resolution practices in interpersonal relations, forgiveness and reconciliation - Shanti Sena.	**7**
IV	**Humanism**: Trust in goodness of human nature - Respect for individual and pluralistic nature of society - equal regard for all religions (Sarvadharma Samabhava) - simple and ethical life - swadeshi and unity of humankind.	**6**
V	**Sarvodaya**: Concept of Sarvodaya - Constructive Programmes - Gandhian alternatives to poverty, terrorism, environmental degradation, issues in education, science and technology, centralization of power and governance and health and hygiene.	**6**

References	M.K. Gandhi, An Autobiography or The Story of My Experiments with Truth, Navajivan Publishing House, Ahmedabad. ---. Satyagraha in South Africa, Navajivan Publishing House, Ahmedabad. ---. Constructive Programme: Its Meaning and Place, Navajivan Publishing House, Ahmedabad. ---. Key to Health, Navajivan Publishing House, Ahmedabad. ---. Diet and Diet Reform, Navajivan Publishing House, Ahmedabad. ---. Basic Education, Navajivan Publishing House, Ahmedabad. ---. Village Industries, Navajivan Publishing House, Ahmedabad. ---. Hind Swaraj, Navajivan Publishing House, Ahmedabad. ---. Trusteeship, Navajivan Publishing House, Ahmedabad. ---. India of my Dreams, Navajivan Publishing House, Ahmedabad. Vinoba, Shanti Sena, Sarva Seva Sangh Prakashan, Varanasi. V.P.Varma, Political Philosophy of Mahatma Gandhi and Sarvodaya, Lakshmi Narain Agarwal, Agra. Louis Fisher, Gandhi: His Life and Message . B.R. Nanda. Mahatma Gandhi: A Biography, Allied Publishers Private Ltd., New Delhi. N.K. Bose. Studies in Gandhism, Navajivan Publishing House, Ahmedabad. Gopinath Dhawan, The Political Philosophy of Mahatma Gandhi, Navajivan Publishing House, Ahmedabad. N. Radhakrishnan, Gandhi's Constructive Programmes: An Antidote to Globalized Economic Planning?, Gandhigram Rural Institute, 2006.
	Web Link: › www.mkgandhi.org › https://www.mkgandhi.org/ebks/gandhian_thought.pdf
	Films. 1. Richard Attenborough, Gandhi. 2. Syam Benegal, Making of The Mahatma. 3. Anupam P. Kher, Mein Gandhi Ko Nahin Mara. 4. Peter Ackerman and Jack Duvall, A Force More Powerful.
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the life and message of Gandhi in modernity. **CO2**: Know the Gandhian way of Management. **CO3**: Practice the Gandhian model of conflict resolution. **CO4**: Lead a humane life on Gandhian lines. **CO5**: Become a Gandhian constructive worker.

Semester	**Second**	Course Code	**24MIBP0207**
Course Title	**BIOINSTRUMENTATION AND RESEARCH METHODS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20%
Category	Core		
Scope of the Course (may be more than one)	1. Facilitate the students to understand the instrumentation techniques 2. Learning the fundamental and working principles of instruments 3. Understand the concept of research methodology.		
Cognitive Levels addressed by the Course	**K1**- Enrich the knowledge in the field of bioinstrumentation **K2**- Gaining factual ideas in bioinstrumentation and research methods **K3**- Application of recent instrumentation techniques in research **K4**- Focus on the working principles of instruments in the field of Biology **K5**- Developing competence and writing skills in thesis and publications **K6**- Promote and establish the research activities in the field of Zoology		
Course Objectives (Maximum:5)	The Course aims • To understand the principles and applications of ordinary and electron microscopes • To learn the techniques in isolation and separation of cell organelles, micro and macromolecules. • To imbibe the principle and applications of Electrophoresis, colorimetry and calorimeter • To understand the research methods, thesis writing and presentation • To learn the article publication, ethics and IPR.		
Unit	**Content**		**No. of Hours**
I	**Microscopy, pH and Buffer** Microscopy- Principle and Applications- phase contrast, Confocal– Electron Microscopy -SEM and TEM - pH basic principles – pH electrodes- Principles, application and preparation of common buffers- Citrate, acetate, tris and phosphate		**11**
II	**Centrifugation and Chromatography** Homogenization- Manual, mechanical and sonication- Centrifugation techniques- Basic principles, Different types of Centrifuges, Analytical and preparative ultracentrifugation methods – Chromatography- Paper, thin layer, Ion-exchange, column- separation of amino acids and sugars- Gas liquid chromatography, HPLC. Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes-		**13**
III	**Electrophoresis, Colorimetry and Calorimeter** Electrophoresis- General Principles Horizontal & Vertical gel electrophoresis and immune electrophoresis -Electrophoresis of proteins and nucleic acids- Spectroscopic techniques- UV-Visible and FT-IR – Flame photometer, Bomb calorimeter, AAS, Mass Spectra, NMR – Principle and applications. Radioscopic techniques.		**13**
IV	**Research, Thesis writing and Presentation** Research- Definition, objectives, types and importance- Research methods in Biological Sciences- Research process- Literature and reference collection – sources- Role of Libraries in research-e-journals and e-books- Scientific databases- Indexing data bases, Citation data bases: Web of Science, Scopus, Google Scholar-Research report writing- Parts of Thesis and Dissertation- Presentation in seminars and conferences		**13**
V	**Article Publication, Ethics and Intellectual Property Rights** Writing scientific paper- Organization of scientific paper- Publication in research journals- Standards of Research journals- Peerreview-Types- Impact factor- citation index, h-index, i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Ethics in research-Plants and animals-Intellectual Property Rights- Origin and history of Indian Patent system- Basis of patentability- Patent application procedure in India.		**14**

References	**Text Books** 1. Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai. p.39-98;113-153;185-375. 2. C.R. Kothari and Gaurav Garg.2019. Research Methodology- Methods and Techniques. New Age International Publishers, New Delhi.pp.1-25. 3. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publishing House, NewDelhi. 4. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani 5. G.R. Chatwal and S.K. Anand. 2014. Instrumental Methods of Chemical Analysis. Himalaya Publishing House
	Reference Books 1. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai. 2. G.H. Mitchell 2017. Gel Electrophoresis: Types, Applications and Research. Nova Science, Publishers Inc 3. B.K. Sharma 2014 Instrumental Method of Chemical Analysis. Krishna Prakashan Media(P)Ltd. 4. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 5. Keith Wilson and John Walker 2002 Practical biochemistry – Principles and techniques. Fifth Edn. Cambridge Univ. Press.
	E-Resources 1. http://nptel.ac.in/syllabus.php?subject Id= 102107028. 2. http://b-ok.xyz/book/674611/288bc3 3. http://www.researchgate.net/publication/317181728- Lecture Notes on Laboratory Instrumentation and Techniques. 4. iiscs.wssu.edu/drupal/node/4673 5. http://www.studocu.com/en/search/research methodology?languages=language_en&type =document *(NPTEL) -National Programme on Technology Enhanced Learning.
Course Outcomes	On completion of the course, students should be able to
	CO1: Enabling the students to understand the principles and applications of different types of microscopes, pH meter and buffers. CO2: Providing excellence in isolation and separation techniques. CO3: Enhance the application and separation techniques of various micro and macromolecules CO4: Explain the basic information on research methods CO5: Crate awareness on the importance of article publication and IPR.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Semester	**SECOND**	Course Code	**24MIBP0208**
Course Title	**BACTERIALMETABOLISM AND DEVELOPMENT**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	30%
Category	Core Course		
Scope of the Course (May be more than one)	1. Basic understanding on the microbial physiology 2. Develop skills on microbial metabolism and its functions. 3. Creates employability scope in fermentation and pharmaceutical industries		

Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in microbial physiology K-2 Comprehensive knowledge on types, general pattern, and specific functions of microbial metabolism K-3 Use techniques to study microbial respiration and bioenergetics K-4 Capacity to analyze special fermentations found in microorganisms K-5 Make new techniques to study bacterial photosynthesis K-6 Assessment of bioluminescence mechanisms and quorum sensing in different bacterial species
Course Objectives (Maximum: 5)	The course aims • To make the students knowledgeable on the types, general pattern and specific functions of microbial metabolism • To give an overall concept on microbial respiration and bioenergetics • To create interest to distinguish the special fermentations found in microorganisms • To highlight photosynthetic pathways in different bacterial groups. • To study the principle, mechanisms of bioluminescence &quorum sensing in bacterial species

UNIT	Content	No. of Hours
I	**Introduction to Bacterial Physiology and Metabolism** The Escherichia coli Paradigm- typical bacterial cell, Membrane transport – nutrient uptake and protein excretion: Ionophores: models of carrier proteins, Diffusion, Active transport and role of electrochemical gradients, ATP-dependent transport: ATP-binding cassette (ABC) pathway, Group translocation, Precursor/product antiport, Ferric ion (Fe(III)) uptake. Export of cell surface structural components: Protein transport- General secretory pathway (GSP), Twin-arginine translocation (TAT) pathway, ATP-binding cassette (ABC) pathway.	**13**
II	**Energy Production and Metabolite Transport** An overview of aerobic and anaerobic metabolism – glycolysis – Pentose Phosphate pathway – citric acid cycle. Anaerobic respiration – electron transport, bioenergetics, and importance - nitrate respiration, sulphate respiration, halo-respiration. Basic aspects of bioenergetics – entropy – enthalpy – electron carriers – Substrate-Level Phosphorylation, Oxidative Phosphorylation, Electron Transport Systems, Anaerobic Respiration, Generating ATP in Alkalophiles, Metabolite Transport: Facilitated Diffusion, Mechanosensitive Channels, ATP-Binding Cassette Transporter Family, Chemiosmotic-Driven Transport, Establishing Ion Gradients.	**13**
III	**Special fermentations** ATP regeneration by fermentation. Alcoholic fermentation by yeasts and bacteria. Lactic acid fermentation - homo / hetero fermentation, lactate fermentation - propionic acid fermentation – formic acid fermentation – butyric acid – butanol fermentation	**13**
IV	**Bacterial photosynthesis** Cyanobacteria, Anaerobic photosynthetic bacteria, Aerobic anoxygenic phototrophic bacteria, Photosynthetic pigments: Chlorophylls, Carotenoids, Phycobiliproteins, Pheophytin, Absorption spectra of photosynthetic cells. Photosynthetic apparatus: Thylakoids of cyanobacteria, green bacteria, purple bacteria, Heliobacteria and aerobic anoxygenic phototrophic bacteria. Light reactions: Properties of light, Excitation of antenna molecules and resonance transfer, Electron transport: Photosystem I and II in cyanobacteria, green sulfur bacteria, purple bacteria, Aerobic anoxygenic photosynthetic bacteria. Carbon metabolism in phototrophs: CO2 fixation, Carbon metabolism in photo-organotrophs: purple bacteria, heliobacteria and aerobic anoxygenic photosynthetic bacteria, green sulfur bacteria, Cyanobacteria. Photophosphorylation in halophilic archaea.	**13**
V	**Microbial development and Quorum sensing (through NPTEL Course)** Microbial development: sporulation and morphogenesis; hyphae vs yeast forms and their significance. Multicellular organization of microbes. Dormancy. Quorum-sensing: The phenomenon of microbial communication– Introduction, Types of Autoinducers, Acyl Homoserine Lactone Molecules, Synthesis of Autoinducers, Quorum sensing in Gram-negative bacteria- LUXI/LUXR. Quorum sensing in Gram-positive bacteria: peptide mediated quorum sensing- The Streptococcus	**12**

	pneumoniae ComD/ComE Competence System. Quorum Sensing and Quorum Quenching: The Yin and Yang of Bacterial Communication.	
References	**Textbooks** 1. Hans G.Schlegel. 2002. General Microbiology, VII Ed., Cambridge University Press, Cambridge. 2. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig. (2000). Microbiology. V Ed.Tata McGraw Hill Book Company. 3. Salle, A.J. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York. 4. Gottschalk, G. 1986. Bacterial Metabolism. II Ed. Heidelberg, Springer. 5. U. Sathyanarayana, U. Chakrapani .2013. Biochemistry. 4th edition. Elsevier publication	
	References 1. David L. Nelson and Michael M. Cox (2017). Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York 2. Jeremy M Berg, John L Toymoczko and Lubert Stryer Stryer (2006). Biochemistry VI Edition. W.H. Freeman and Company, New York 3. Byung Hong Kim, Geoffrey Michael Gadd Bacterial. 2008. Physiology and Metabolism, Cambridge university press. 4. Donald Voet, Judith G. Voet, Charlotte W. Pratt (2016). Fundamentals of Biochemistry Fifth Edition. John Wiley & Sons Inc, New York. 5. Hiram F. Gilbert. Basic concepts in biochemistry Mc Graw Hill publication	
	E-Resources: 1. https://www.the-scientist.com/brush-up-quorum-sensing-in-bacteria-and-beyond-70711 2. https://chemistry-europe.onlinelibrary.wiley.com/doi/abs/10.1002/cbic.200800521 3. https://pubmed.ncbi.nlm.nih.gov/11544353/	
Course Outcomes	On completion of the course, students should be able to do. CO1: Discuss the fundamental chemical principles and reactions are utilized in biochemical processes. CO2: Outline the principal mechanisms of aerobic and anaerobic respiration in microorganisms. CO3: Explain the special fermentation types in specific group of microbes. CO4: Apply the principal mechanism of bacterial photosynthesis. CO5: Compare bioluminescence and quorum sensing in different bacterial organisms	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	1
CO2	2	3	2	3	2
CO3	3	3	3	3	2
CO4	3	3	2	1	2
CO5	3	3	3	1	3

Semester	**SECOND**	Course Code		**24MIBP0209**
Course Title	**ADVANCED ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**			
No. of Credits	3	No. of contact hours per Week		3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**		20%
Category	Core Course			
Scope of the Course (may be more than one)	1. Students will be able to develop their skills on microbes in environment and agriculture 2. Students will be able to develop Employability in bioinoculants and biopesticides production technology			
Cognitive Levels addressed by the Course	K-1: Remember soil, ecosystems and agriculture K-2: Understand role of microbes in transformations of minerals K-3: Apply various techniques involved in bioinoculants and biopesticides production K-4: Analyze plant microbe interaction. To understand infection process and control measures			

	K-5: Evaluate importance of bioinoculants and biopesticides K-6: Create knowledge on environmental pollution, bioinoculants and biopesticides
Course Objectives (Maximum: 5)	The Course aims to • to impart in-depth information on ecosystems and microbial transformations of minerals • to make the students understand Microbial analysis of drinking water Waste management & Sewage Treatment &Aero microbiology • to give an over view on Bioremediation & Microbial leaching Biosafety & Environmental monitoring • to know the importance of Symbiotic and Non-Symbiotic nitrogen fixation and Bioinoculants production • plant pathogenic microorganisms and Biopesticides

UNIT	Content	No. of Hours
I	**Ecosystems and Microbial transformations of minerals** Composition of Lithosphere, Soil-Structure, Types, Physical and Chemical properties, Soil Microbiology. Factors influencing soil microbial population. Rhizosphere, R:S ratio. Biogeochemical cycles-Carbon, Nitrogen, Phosphrous, Sulphur.	**13**
II	**Microbial analysis of drinking water Waste management & Sewage Treatment &Aero microbiology** Microbial analysis of drinking water: Tests for coliforms (presumptive, confirmed and completed tests). Purification of water: Sedimentation, Filtration (slow and rapid sand filters) and Disinfection. Nature of sewage and its composition. Physical, chemical and biological properties of sewage (BOD, COD etc). Sewage systems and types. Sewage Treatment: Single Dwelling Unit, municipal sewage treatment - primary, secondary and tertiary treatments (Trickling filters, activated sludge process, Oxidation lagoons and Imhoff tank). Waste management - Utilization of solid and liquid waste pollutants for production of Single-Cell protein. Aeromicrobiology - Air Pollution – aerosol, droplet nuclei and infectious dust. Examination of air microflora.	**13**
III	**Bioremediation, Microbial leaching, Biosafety & Environmental monitoring** Polluted heterogeneous environment. Indicator organisms for pollution and abatement of pollution. Bioremediation – Types and uses - Microbes and Environmental clean-up - Genetically Engineered microbes for Bioremediation. Microbial leaching: In situ & Ex situ methods -copper and uranium mining Environmental regulations - Biohazards - Types of hazardous emission - Biosafety measures - Biomonitority of waste water toxics - Monitoring of Genetically Engineered Microbes in the Environment.	**13**
IV	**Symbiotic and non-symbiotic nitrogen fixation and Bioinoculant production** Biological Nitrogen fixation – symbiotic - root nodulation, non-symbiotic, organisms,*Azotobacte*r sp and *Azospirillum* sp and their functions - Cyanobacteria (BGA) and their associations in Nitrogen fixation. Genetics and Biochemistry of nitrogen fixation-Factors influencing nitrogen fixation –Importance of nitrogen fixation. Bioinoculants- Phosphate solubilizing microbes. Mycorhizae and plant growth promoting rhizobacteria (PGPR). Role of biofertilizers. Quality control (BIS specification).	**13**
V	**Plantpathogenic microorganisms and Biopesticides** Algal, bacterial, fungal, mycoplasma, Nematode and viral, diseases and symptoms. Definition and History of Biopesticides–Viral(NPV, CPV&GV),bacterial (*Bacillus thuringiensis, B.popillae & Pseudomonas* sp.), Fungal (*Entomophthora musca, Beaveria* sp.,*Metarrhizium*sp .*&Verticillium*sp.),Protozoan (*Mattesia* sp., *Nosema*sp., *Octospora muscaedomesticae & Lambornella* sp.), Case study of biopesticides.	**12**
References	**TextBooks:** 1. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2nd edition, New Delhi. 2. Neelima Rajvaidya and Dilip Kumar Markandey.(2006). Agricultural Applications of Microbiology, Nangia S.B. and A.P.H. publishing corporation, New Delhi 3. Gupta, S.K.2014 Approaches and trends in plant disease management. Scientific publishers,	

	Jodhpur, India. 4. Jamaluddin *etal* 2013 Microbes and sustainable plant productivity. Scientific Publishers Jodhpur, India. G 5. SubbaRao, N.S.1997.Biofertilizers in Agriculture and Forestry, IIIEd., Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.
	Reference Books: 1. Gaur, A.C.,1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 2. Kannaiyan. S. (2002), Biotechnology of Biofertilizers, Alpha science international, 1stedition. 3. Glick, B.R.ANDPasternak, J.J1994. Molecular Biotechnology,ASMPress,WashingtonDC. 4. Purohit, S.S., Kothari,P.R. and Mathur1993.Basic and Agricultural Biotechnology, Agrobotanical Publishers (India). Bikaner. 5. Newton, W.E and Orme, Johnson, W.H.1980. Nitrogen fixation vol II: Symbiotic Associations and Cyanaobacteria. University Park Press Baltimore, USA. 6. Vidhyasekaran, P. (2007). Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms, 2nd edition, APS press,U.S.A 7. Wheeler, B.E.1976. An Introduction to Plant Disease. ELBS and John Wiley and Sons, Ltd. 8. Subba Rao, N.S.1995.Soil microorganisms and plant growth. Oxford&IBH Publishing Co.Pvt.Ltd. New Delhi. 9. Martin Alexander1983. Introduction to Soil Microbiology, Wiley eastern Ltd., New Delhi. 10. Agrios, G. N. 2000. Plant pathology. Harcourt Asia Pvt.Ltd. 11.Geoffrey Clough Ainsworth (1981). Introduction to the History of Plant Pathology 1st edition, Cambridge university press,U.K.
	E-Resources: 1. https:/microbewiki.keyon.edu/index.php/agricultural-microbiology 2. mic.microbiologyresearch.org/3.https://www.microbe,net/resources/microbiology web-resources 3. microbiologyonline.org
Course Outcomes	On completion of the course, students should be able to do CO1: Understand the Composition of Lithosphere, Soil and biogeochemical cycles CO2: Understand the microbial analysis of drinking water, water purification Waste water treatment and Aeromicrobiology CO3: To know the value of Bioremediation & Microbial leaching Biosafety & Environmental monitoring CO4: To have an in-depth knowledge on symbiotic and non-symbiotic nitrogen fixation and bioinoculants production CO5: To know about the different plant pathogenic microorganisms and biopesticides

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	2	2	1	3
CO2	3	3	3	3	3
CO3	1	3	3	3	3
CO4	3	3	1	2	3
CO5	1	3	3	2	3

Semester	**SECOND**	Course Code	**24MIBP0210**
Course Title	**ADVANCED BIOSTATISTICS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	30
Category	Core		
Scope of the Course (may be more than one)	1. It helps researchers determine sample sizes and designing scientific experiments 2. Choose appropriate statistical methods based on the data type 3. Biostatistical techniques to draw conclusions about populations based on sample data		
Cognitive Levels addressed by the Course	**K1**- Understanding advanced concepts in Bio-Statistics **K2**- Comprehending statistical measures in the biological data analysis **K3**- Ability to interpret the statistical inference		
Course Objectives	The Course aims • To be familiar with summarize statistics and its applications in biology • To develop proficiency in carrying out multivariate statistical analyses efficiently. • To understand the impact of sampling variability on decision-making. • To evaluate treatment effects, group differences, and associations. • To identify scenarios where nonparametric approaches are appropriate		

Unit	Content	No. of Hours
I	**Basics of Biostatistics:** Definition and Applications of Biostatistics. Descriptive and Inferential Statistics. Level of Measurement. Descriptive Statistics: Measures of central tendency and dispersion. Frequency distribution and graphical representation of data.	**8**
II	**Multivariate Analysis:** Correlation – Concept – Types – Simple Correlation - Karl Pearson and Spearman rank - Multiple Correlation (Three variables). Regression – Concept – Types – Simple linear and Multiple Linear (Three variables) regression.	**6**
III	**Sampling Distribution and Hypothesis Testing:** Sampling distribution – Student t distribution, F distribution, $\chi 2$ distribution – Applications and properties - Basic concepts and types of hypotheses – Standard error - Type I and II error – Level of significance – Confidence Interval – Testing procedure.	**8**
IV	**Parametric Test:** Large sample tests - Tests for single mean and difference between two means, confidence intervals for mean(s), Test for single proportion and difference between two proportions. Small sample tests - Test for single mean and difference between two means, paired t – test, $\chi 2$ test, F – test. ANOVA: one-way and two-way classification.	**12**
V	**Non-Parametric Test:** One sample test - Run test, Sign test and Wilcoxon-Signed Rank tests (single and paired samples). Two independent sample tests - Median test, Wilcoxon, Mann-Whitney U test. Kruskal-Wallis test, Friedman's Rank test.	**12**

References

Text Books

1. Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004.
2. Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017.
3. Goon, A.M., M. K. Gupta and B. Das Gupta, Fundamentals of Statistics- Vol. II., World Press, Ltd, Kolkata. 2016.
4. Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012.
5. Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020.

Reference Books

1. Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008.
2. Rohatgi, V. K. and Md. Ehsanes Saleh. A.K, An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi, 2009.
3. Siegel, Sideny, Non-Parametric Statistics for Behavioral Sciences, New Delhi: MCGraw Hill, 2006.

	4. Verma B.L, Shukla G.D and Srivastava.R.N, Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 1993. 5. Veer Bala Rastogi, Biostatistics, Medtech publication, (3rd revised Edition), 2017.
	E-Resources 1. https://www.biostat.washington.edu/about/biostatististics 2. http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_BiostatisticsBasics 3. https://www.edx.org/course/biostatistics-0 4. https://www.agrimoon.com/wp-content/uploads/Statistics.pdf 5. https://www.coursera.org/courses?query=biostatistics
Course Outcomes	On completion of the course, students should be able to
	On completion of the course, students will be able to do the following: **CO1**: Get acquainted with advanced concepts of statistics and its relevance subject. **CO2**: Known about the various sampling techniques to real-world scenarios. **CO3**: Acquire knowledge distributions and hypothesis testing allows drawing meaningful conclusions from data **CO4**: Interpret from the various estimation and parametric hypothesis testing procedures covered. **CO5**: Suitable scenarios chose to data non-normal conditions, select other tests.

Mapping of Cos with PSOs

PSO / CO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	2
CO2	3	2	3	2	2
CO3	2	3	2	3	3
CO4	3	3	3	3	2
CO5	2	3	3	2	3

Semester	**SECOND**	Course Code	**24MIBP0211**
Course Title	**PRACTICAL III: BIOINSTRUMENTATION AND BACTERIAL METABOLISM**		
No. of Credits	**2**	No. of contact hours per week	**4**
New Course/ Revised Course	**New Course**	If revised, Percentage of revision effected	**-**
Category	Core		
Scope of the Course (may be more than one)	1. Rewarding opportunity to update the recent techniques in bioinstrumentation 2. Able to learn the principles, procedures and applications of chromatography, electrophoresis, UV-Vis spectroscopy, and NMR. 3. Enhance the potential to understanding on the microbial enumeration 4. Basic understanding on the genus identification 5. Develop skills on microbial metabolism and its functions.		
Cognitive Levels addressed by the Course	K1- Exposure to the instruments in biological sciences K2- Imbibe the techniques involved in bioinstrumentation K3- Demonstrate knowledge and understanding on the basic principle of instruments K4- Use biochemical and cultural techniques to study microbial identifications K5- Capacity to analyze antimicrobial studies		
Course Objectives (Maximum:5)	The Course aims to: • To know the preparation of various chromatographic techniques. • To separate gas and organic acids using GC and HPLC • To demonstrate through experiments the effects of environmental factors on growth of bacteria • To identify unknown bacteria based on biochemical and culture characteristics		

	Content	No. of Hours
1.	Separation of amino acids and sugars using thin layer chromatography	3
2.	Separation of pigments by column chromatography	3

3.	Separation of gas and organic acids using GC and HPLC (Demonstration)	6
4.	Estimation of sodium, potassium, calcium and magnesium using Flame photometer	3
5.	Demonstration of Biological samples using SEM, FT-IR, AAS, NMR	6
6.	Isolation of microbial strain from natural geographical region	
7.	Genus identification of unknown bacterial strains using the Bergey's Manuals: Gram staining IMVIC test for enteric bacteria Carbohydrate fermentation Triple Sugar Iron agar test. H_2O_2 production by catalase and Oxidase activity	8
8.	Determination of MIC of a given antibiotic.	4
9.	Determination of TDP and TDT of an unknown microbe	4
10.	Effect of pH on growth of an unknown microbe	4
11.	Effect of carbon and nitrogen sources on the growth	4
12.	Study and plot the of growth curve of unknown bacteria by standard plate count techniques	4
References	1. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India. 2. J. Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi. 3. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology A Laboratory Manual, VI Ed., (I Indian Reprint) Pearson Education (Singapore) Pvt.. Ltd., India 4. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 5. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Separate amino acids and sugars using paper and thin layer chromatography CO2: Estimate proteins, sodium, potassium, calcium and magnesium using spectrophotometer and flame photometer. CO3: Know the biological applications of SEM, FT-IR, AAS and NMR CO4: Identify unknown bacteria and fungi based on biochemical and culture characteristics CO5: Demonstrate the effects of environmental factors on growth of bacteria	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	2	3	1
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	1

Semester	**SECOND**	Course Code	**24MIBP0212**
Course Title	**PRACTICAL -IV: ADVANCED ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**		
No. of Credits	2	No. of contact hours per Week	4
New Course/ Revised Course	Course	If revised, Percentage of Revision effected **(Minimum20%)**	20%
Category	Core Course		
Scope of the Course (may be more than one)	1. Students will be able to develop their skills on environmental and agricultural microbiology 2. Students can execute Field Projects on the environmental pollution and agriculture		

Cognitive Levels addressed by the Course	K-1: Remember isolation and characterization of microbes important in environment and agriculture K-2: Understand the environmental pollution and plant-pathogen interaction K-3: Apply potential biofertilizers in agricultural field K-4: Analyze microbes present in different environment K-5: Evaluate the role of microbes in environmental pollution management and agriculture K-6: Create knowledge on environmental and agricultural microbiology
Course Objectives (Maximum:5)	The Course aims • to understand the microbes, present in different environment • to understand the role of microbes in environmental pollution management • toprovidepracticalknowledgeintheisolationandcharacterizationofmicrobesimportantin agriculture. • to understand the plant-pathogen interaction • to be able to isolate organisms that have potential as biofertilizers

S. No.	Content	No.of Hours
1.	Isolation and identification of micro flora of sewage and air	**3**
2.	Physical, Chemical & Microbial assessment of water. Colour, pH, alkalinity, acidity, MPN test.	**6**
3.	Determination of BOD of polluted water	**3**
4.	Determination of COD of polluted water	**3**
5.	Isolation of cellulose degraders, chitinase and pesticide degraders	**3**
6.	Demonstration of Winogradsky column	**6**
7.	Isolation of Rhizobium from soil and root nodules and authentication of by biochemical and by plant infection test (tubes and Leonard jar experiment)	**6**
8.	Isolation of bioinoculants from soil a.*Azotobacter* sp. b.*Azospirillum* sp. c.AM Fungi d.Cyanobacteria e.Phosphobacter	**6**
9.	Study the growth response of crops due to bioinoculants application.	**3**
10.	Compost making-testingthequality of compostmade, Fortification of compost by inoculating beneficial microbes and rock phosphate.	**6**
11.	Study on plant pathogens, collection, identification and submission.	**6**
12.	Mass propagation of *Azolla-Anabaena* for bioinoculants.	**3**

References

TextBooks:

1. Dubey,R.Cand Maheswari, D.K.2002. Practical Microbiology,1st Ed., Chandand CompanyLtd., India.
2. K.R. Aneja. 1993.Experimentsin Microbiology,Plant Pathology and Tissue Culture. Wishwa Prakashan. New Delhi. India.
3. Sadasivam, S and Manikam, A.1992. Biochemical methods for agricultural sciences. Wiley EasternLtd., New Delhi.
4. Aaronson S. (1970). Experimental Microbial Ecology, Academic Press, New York.
5. Darsha Dharajiya, Hitesh Jasani, (2015). Environmental Microbiology and Biotechnology - A Practical Manual

ReferenceBooks:

1. Collins CH, Lyne PM. (1985). Microbiological methods. Butter worths, London.
2. Clesceri LS, Greenberg AE, Eaton AD. (1998). Standard methods for examination of water & waste water. American Public Health Association.

E-Resources:

1.https://www.google.com/search?client=firefox-d&q=1.+Demonstration+of+Winogardsky+coloumn.

2.https://www.google.com/searchIsolation+of+biofertilizers+from+soil

Course Outcomes	On completion of the course, students should be able to do CO1: Be able to know the different environmental pollutions CO2:Methods to determine the environmental pollution CO3:Be able to understand the importance of microbes in agriculture CO4: Be able to know the methods of isolation, identification and mass production of Bioinoculants CO5: Be able to know the methods to identify plant pathogens

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	2	2	3
CO2	3	2	3	3	1
CO3	1	2	2	3	3
CO4	3	3	3	3	3
CO5	1	1	1	2	1

Semester	**THIRD**	Course Code	**24MIBP0314**
Course Title	**APPLIED VIROLOGY**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New Course	If revised, Percentage of Revision effected	--
Category	Core Course		
Scope of the Course (may be more than one)	1. Students will be able to develop their skills on virology 2. Students will be able to develop Employability in applied virology		
Cognitive Levels addressed by the Course	**K-1**: Remember concept and scope of applied virology **K-2**: Understand viruses in functional gene delivery. **K-3**: Apply to know of viruses in phage therapy. **K-4**: Analyse newly emerging and life-threatening diseases and control measures **K-5**: Create knowledge on virology bioterrorism.		
Course Objectives (Maximum: 5)	**The Course aims** • The students will learn about concept and scope of virology • The student will able to learn applications of viruses in therapy system. • The student will able to learn the basic concepts phage therapy. • The students will learn about public health perspectives of virology. • The student will able to learn good laboratory practices.		

UNIT	Content	No. of Hours
I	**Viruses as model systems in Molecular Biology** Exploitation of viruses as model systems in understanding the replication of nucleic acids and regulation of gene expression strategies and cancer biology (SV-40, adenoviruses)-Viruses as unique genetic resources: Exploitation of viral genes / sequences in the construction of varied types of gene vectors (cloning, shuttle, expression and transcription) and their applications; virus genes as a source of novel enzymes, gene expression activators and silencers.	**13**
II	**Viruses as functional gene delivery/therapy systems** Exploitation of viruses as functional gene delivery/therapy systems: Retro-, adeno- and parvoviruses; Display of foreign peptides on virion surface and applications. -Viruses as biocontrol agents (viral biopesticides): Bacterial, algal, fungal and insect viruses – mass production and their application as biocontrol agents against bacterial and fungal pathogens of plants, algae and insect pests.	**13**
III	**Phage display and phage therapy:** Exploitation of bacteriophages for peptide display and therapy-Recombinant antibodies: In vitro production of rDNA technology-based antibodies (monoclonal antibodies and scFv) to viruses and their applications-Modern vaccines to viruses: Designing of modern vaccines, modern vaccines—recombinant proteins, subunit vaccines, mRNA-based vaccines, VLP	**13**

	vaccines, DNA vaccines, peptides, immune modulators (cytokines), vaccine delivery & adjuvants, large scale manufacturing-QA/QC issues, Animal models and vaccine potency testing; extraction of antiviral compounds from natural resources and their characterization.	
IV	**Public health Virology:** Biology, prevention and control of common nosocomial, enteric (food and water-borne, hepatitis A & E, polio, rotaviruses), blood-borne (hepatitis B & C, HIV), contact transmitted (common cold, flu, corona) and insect-borne (Japanese encephalitis, dengue, chikungunya) viruses-Virus resistant crops: Production of virus resistant/tolerant crops through transgenic technology by exploiting genes derived from viruses, guidelines for testing and releasing the transgenic lines in India- Virus-based nanotechnology: Viral nanoparticles (VNPs), virus-like particles (VLPs), plant virus-derived nanoparticles (PVNs), biodistribution and pharmacokinetics, application of plant viruses as biotechnological tools in medicine, industry and agriculture.	**13**
V	**Viruses as biological warfare, bio-crime and bioterrorism agents:** Small poxvirus (variola),viral encephalitis and viral hemorrhagic fevers; HIV, viral hemorrhagic fevers (Ebola),corona viruss and yellow fever virus.-Biosafety and Biosecurity: Laboratory bio-safety, Classification of bio-safety levels and risk groups, containment, Good microbiological practices, Good Laboratory practices (GLP), Disinfection, Decontamination and Sterilization procedures, solid versus liquid waste, safety rules, preparedness and response for the emergency conditions in the laboratory.- Ethics in Virology: Ethics in Virus-related research, ethical and regulatory issues in animal experiments, issues related to Good Manufacturing Practices (GMP), Importance of Intellectual Property Rights and Indian patent system.	**13**
References	**Text Books:** 1. Govind. Rao, Rodrigo A. Valverde & C.I. Dovas, Techniques in diagnoses of Plant Viruses (Plant Pathogens -6) -(2008), Stadium Press. 2. Forbes, Bailey and Scotts' Diagnostic Microbiology, 2002, 11th Edition, Mosby publisher. 3. Richmanet, Clinical Virology, 2002, 2nd edition, ASM 4. S. Primrose, R. Twyman and B. Old, Principles of gene manipulation, 2002, 6th edition, Blackwell Science. 5. Hull, Matthews' Plant Virology, 2001, Academic Press. 6. S.J.Flint, L. W. Enquist, R.M.Krug, V.R.Racaniello and A.M. Skalka, Principles of Virology-Molecular biology, pathogenesis and control, 2000, ASM press.	
	Reference Books: 1. Knipe D.M., Howley P.M., and Griffin D.E., (2023). *Fields Virology*. (7thed). Vols - I, II. Lippincott, Williams &Wilkins. 2. Bamford, 2021 Encyclopedia of virology, 4thedition, Academic Press, Elsevier Ltd.	
	E-Resources: 1. https://www.sciencedirect.com/journal/virology 2. . https://www.news-medical.net/health/What-is-Virology.aspx	
Course Outcomes	On completion of the course, students should be able to do **CO1**: Understand the recent development in virology. **CO2**: Understand the functional gene delivery system by viruses. **CO3**: Understands bacteriophages as tools in therapy. **CO4**: Understand prevention and control measures of viruses. **CO5**: Understand the safety rules in emergency conditions in the laboratory.	

Mapping of COs with PSOs:

CO \ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	1	1	2	3
CO2	3	3	3	3	2
CO3	3	3	1	2	1
CO4	1	1	3	3	3
CO5	2	3	2	1	1

Semester	**THIRD**	Course Code	**24MIBP0315**
Course Title	**IMMUNOTECHNOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected	30%
Category	Core Course		
Scope of the Course (may be more than one)	1. Students will be able to develop their skills on immunology and Immunotechnology 2. Students will be able to develop Employability in clinical field		
Cognitive Levels addressed by the Course	**K-1**:(Remember Concept and scope of immunology and Immunotechnology) **K-2**:(Understand cells and organs of immune system) **K-3**:(Apply various immunological techniques) **K-4**:(Analyze structural features of the components of the immune system) **K-5**:(Evaluate functions and responsiveness of immune system) **K-6**:(Create knowledge on immunology and Immunotechnology)		
Course Objectives (Maximum:5)	TheCourse aims • The students will learn about history and types of immunity • The student will able to learn different cells and organs of immune system. • The students will learn about immunogens and immunoglobulins. • The student will able to learn the immunological techniques and hypersensitivity. • The student will able to learn the immunohematology,Tumor immunology & Vaccines		

UNIT	Content	No. of Hours
I	**Basics and types of Immunity** History of Immunology. Types of Immunity (Innate &Acquired immunity), Components Innate immunity - Acquired immunity, Antigens and antigen recognition, MHC and antigen presentation-Types of immune response, humoral and cell mediated.	**13**
II	**Cells and Organs of the Immune System** Cells (T cell, B cell, macrophages, neutrophils, Natural killer cells, mast cells, basophils, and eosinophils etc)-Organs of Immune system- Primar lymphoid organs-Thymus and Bone marrow- Secondary lymphoid organs-lymph node, spleen, MALT, NALT,GALT, BALT, CALT.	**13**
III	**Immunogens, immunoglobulins and Antigen - antibody reactions** General properties of antigens-B-cell and T-cell epitopes, super antigens, haptens, adjuvants-Antibodies-antibody structure-classes of immunoglobulin- Antigen - antibody reaction, *Invitro* methods: Agglutination - precipitation, complement fixation, Immunofluorescence, ELISA, RIA - Monoclonal antibodies.	**13**
IV	**Complement System and Hypersensitivity** The Complement System, classical pathway, alternative pathway, the mannan-binding lectin pathway, the formation of membrane-attack complex, biological functions of complement proteins-Hypersensitivity reactions- Antibody mediated – Type I Anaphylaxis-Type II Antibody dependent cell cytotoxicity-Type III Immune complex reactions-Type IV hyper sensitivity reactions.	**13**
V	**Immuno haematology, Tumor immunology & Vaccines** Immuno haematology of blood groups, forensic serology - ABO and Rh incompatibility. Transplantation. HLA tissue typing–major histocompatibility complex-MHC restriction-antigen presentation (Organisation & inheritance of MHC, MHC molecules & genes), Role of Antigen presenting cells (APCs)- Immune suppression. Tumor immunology - Tumor antigens - Immunotherapy of malignancy - Autoimmune disease. Principles underlying the preparation of live, attenuated vaccines and recombinant vaccine, a case study of vaccines.	**12**
References	**Text Books:** 1. The elements of immunology, 2009, Fahim Halim Khan, Pearson Education, India 2. Ananthanaryan and Paniker's, Textbook of Microbiology, 2017, 10th edition, Orient Blackswan, Hyderabad. 3. Ramesh, Immunology, 2017, McGraw Hill Education (India) Private Limited, New Delhi.	

	ReferenceBooks: 1. Judith A. Owen, Jenni Punt, Sharon A. Stanford, 2013. Kuby Immunology, 7th Ed. W. H. Freeman and Company, New York 2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2016. Essential Immunology, 13 Ed. Blackwell Scientific Publishers. USA.
	E-Resources: 1. https://www.microbe.net/resources/microbiology/web-resources/ guides.emich/immunology 2. http://oew.mit.edu/courses/.../hst-176-cellular-and-molecular.immunology-fall-2005. 3. https://www.sciencedirect.com/journal/virology 4. https://www.news-medical.net/health/What-is-Virology.aspx
Course Outcomes	On completion of the course, students should be able to do **CO1**: Understand the Basics and types of Immunity **CO2**: Understand the various Cells and different Organs involving in the immunity development **CO3**: Understandtheantigenantibodyreactionsandprinciplesofhypersensitivity. **CO4**: Understand the Immunological Techniques and Hypersensitivity **CO5**: Understand vaccine, immunohematology and tumor immunology.

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	2	2
CO2	1	3	3	3	1
CO3	3	2	2	1	3
CO4	3	3	3	3	1
CO5	2	2	1	2	2

Semester	**THIRD**	Course Code	**24MIBP0316**
Course Title	**ADVANCED MEDICAL MICROBIOLOGY**		
No. of Credits	**4**	No. of contact hours per week	**4**
New Course/ Revised Course	Revised Course	If revised, percentage of revision effected **(Minimum20%)**	50%
Category	Core Course		
Scope of the Course (may be more than one)	1. Students gain the knowledge of common medically important microorganism and the diseases. 2. Learn diagnostic approaches for microbial pathogens and various control measures.		
Cognitive Levels addressed by the Course	**K-1**: Remember the basics of medical microbiology and Epidemiology **K-2**: Understand various types of infection **K-3**: Apply to know host parasite relationship and virulence factors associated with the pathogen. **K-4**: Analyze diseases caused by bacterial and protozoa **K-5**: Evaluate on various viral and fungal diseases **K-6**: Create knowledge on the types and mode of action of various antimicrobial compounds and antimicrobial resistance		
Course Objectives (Maximum:5)	The Course aims to • Introduce the basic concepts of medical microbiology and Epidemiology • Impart basic knowledge on various types of infection, host parasite relationship and virulence factors associated with the pathogen. • Elaborate the diseases caused by bacterial and protozoa • Give an insight on various viral and fungal diseases • Explain the types and mode of action of various antimicrobial compounds and antimicrobial resistance		

UNIT	Content	No. of Hours
I	**Introduction to medical microbiology** Introduction to medical microbiology, Historical background, Classification of medically important microorganisms. Microbial interaction with human: beneficial interaction- Normal flora, Harmful interaction-disease. Concepts of microbial disease: Microbial mechanisms of disease- Pathogenicity and virulence, Defensive strategies, Offensive strategies; Stages of microbial disease- The incubation stage, The prodromal stage, The illness stage, The stage of decline, The convalescence stage. Basic concepts of infections: types of infection, sources of infection, reservoirs and vectors of infection, predisposing factors. Epidemiology and cycle of microbial disease: Concepts of epidemiology, cycle of microbial disease, nosocomial infections.	**13**
II	**Bacterial and Fungi** Gram-positive cocci: *Staphylococcus aureus*; Gram-negative cocci: *Neisseria meningitidis*; Gram-positive rods: spore forming Gram-positive rods- *Bacillus*; Non-spore forming Gram-positive rods: *Corynebacterium diphtheriae*; Gram-negative rods related to the enteric tract: *Escherichia, Shigella, Klebsiella;* Gram-negative rods related to the respiratory tract: *Haemophilus, Bordetella*; Gram-negative rods related to animal sources (zoonotic organisms): *Brucella, Francisella; Mycobacteria; Actinomycetes.* Fungal diseases -Cutaneous mycoses- Dermatophytoses; Subcutaneous mycoses- sporotrichosis; Systemic mycoses- Coccidioides; Opportunistic mycoses- Candida	**14**
III	**Viral and Protozoan diseases** General properties of viruses Host interactions: DNA enveloped virus: Herpesvirus; DNA non-enveloped virus: Adenovirus; RNA enveloped virus: Human immunodeficiency virus, Coronavirus; RNA nonenveloped virus: Enterovirus. Protozoan diseases: Causative agents, Symptoms, mode of transmission, prophylaxis and control: Malaria, Kala-azar.	**13**
IV	**Clinical and diagnostic microbiology** Isolation of pathogens from clinical specimens; Growth-dependent identification method; Testing cultures for antimicrobial sensitivity; Antibody titers and diagnosis of infectious disease; Fluorescent antibodies; Monoclonal antibodies; Clinical useful ELISA test; Agglutination tests in clinical laboratory; Immunoblotting procedure; Nucleic acid probes in clinical diagnostics; Diagnostic virology; Safety in the clinical laboratory.	**15**
V	**The control of pathogenic microorganisms** Physical methods and chemical methods. Antibiotic and chemotherapeutic agents: Antibiotics and their classification, Mode of action, Antibiotic assay and sensitivity test. Antiviral drugs-Antibiotic/Drug resistance: Intrinsic resistance, Acquired resistance; origin, cause, and clinical implication with special references of multidrug resistant bacteria. Superbugs, a case study drugsresistance.	**12**
References	**Text Books:** 1. Ananthanarayanan. R. and C.K. Jayaram Panicker, 1997. Textbook of Microbiology Orient Longman. 2. Broude A. I, 1981. Medical “Microbiology": and Infectious Diseases W.B. Saunders & Co., Philadelphia 3. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection. Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996. 4. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg, 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 5. Greenwood D, Richard C.B.and.Peutherer S.J., 2000. Medical Microbiology. Churchill Livingstone. 6. D.C. Shanson, Wright PSG, Microbiology in Clinical Practice., 1982. 7. Baron EJ, Peterson LR and Finegold SM Mosby, 1990. Bailey and Scott's Diagnostic Microbiology.	

	Reference Books: 1. Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. 2004. Molecular Microbiology: Diagnostic Principles and Practice. American Society for Microbiology Press 2. Hacker J and Dorbindt U. ed. 2006. Pathogenomics: Genome analysis of pathogenic microbes. Wiley- VCH. 3. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003). 4. Prescott, Harley and Klein, McGraw-Hill, 2003. Microbiology 5. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. 6. Thomas D. Brock, Michael T. Madigan. 1991 6th edition. Biology of Microorganisms 7. Robert I. Krasner 2012. Microbial Challenge. American Society for Microbiology Press 8. Warren Levinson. Fourth edition. Review of medical microbiology and Immunology. McGraw-Hill (2016) 9. Geo.F.Brooks, Karen C. Carroll, Janet S. Butel, Stephan A. Morse, Timothy A. Mietzner. Medical Microbiology 26th edition. McGraw-Hill (2013) 10. Tortora, Funke, Case. 9th edition 2007. Microbiology an introduction 11. Michael J. Pelczar, JR. E.C.S.Chan, Noel R. Krieg. 2015. Microbiology. McGraw-Hill 12. Jeffrey C. Pommerville. 11th edition 2018. Fundamentals of Microbiology
	E-Resources 1. . https://www.microbe.net/resources/microbiology/web-resources/ 2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php 3. guides.emich/immunology
Course Outcomes	On completion of the course, students should be able to: CO1: Understandthe basic concepts of medical microbiology CO2: Explain the processes in microbial pathogenesis CO3: Familiar with bacterial diseases, epidemiology and virulence factors associated with the pathogen. CO4: Compare and contrast between different viral and fungal diseases CO5: Describe the measures in prevention and control of microbial diseases

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	2	2	2	2
CO5	3	3	2	2	2

Semester	**THIRD**	Course Code	**24MIBP0317**
Course Title	**PRACTICAL - V: APPLIED VIROLOGY &IMMUNOTECHNOLOGY**		
No. of Credits	2	No. of contact hours per Week	**4**
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	30
Category	Core Course		
Scope of the Course (may be more than one)	1. Demonstrate practical skills in the use of tools and methods in virology, immunology and medical microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember clinical microbiology and immunology techniques microbiological laboratory K-2 Comprehensive knowledge on isolation and titre of bacteriophages K-3 Use of immunological kit and immunoelectrophoresis K-4 Capacity to analyses clinical samples to diagnose the disease condition K-5 Make new techniques to demonstrate ELISA and staining, K-6 Assessment of techniques in virology, immunology and medical microbiology		

Course Objectives (Maximum: 5)	The Course aims to • enhance the student's knowledge and impress upon them on the important aspects of virology, immunology and medical microbiology • provide practical knowledge and skills in diagnostic tests based on antigen antibody reaction • understand the working procedure and principles of virology methods. • know the techniques of immunoelectrophoresis and ELISA • gain skill in performing clinical laboratory tests.

UNIT	Content	No. of Hours
1.	Isolation of Bacteriophages from sewage and natural environments	**3**
2.	Estimation of viral titer by plaque assay.	**3**
3.	Detection of HIV & HBs Ag by ELISA	**3**
4.	ABO Blood grouping and Rh typing	**3**
5.	Detection of HCG hormone by lateral flow assay	**3**
6.	Western Blotting	**6**
7.	Dot blot	**3**
8.	Agglutination tests a) WIDAL b) VDRL Test (RPR). c) RA d) ASO (Anti streptolysin 'O' Test).	**6**
9.	Precipitation Tests a) Immunodiffusion b) Immunoelectrophoresis	**6**
10.	Amplification of DNA by PCR	**6**
11.	Visit to Diagnostic Labs and Hospitals	**3**

References	**Text Books**: 1. Horold J Benson (1998). Microbiological Applications - Laboratory Manual in General Microbiology. Seventh International edition, Mc Grew-Hill, Boston. 2. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, 6th Edn. Pearson Education Publication, New Delhi. 3. Collee, J.C., Duguid, J.P., Fraser, A.C. and Marimon, B.P. (1996) Mackie and McCartney. Practical Medical Microbiology, 14th Edn. Churchill Livingstone, London. 4. Turgeon, M.L., 1990. Immunology and serology in laboratory medicine, St.Louis, C.V. Mosby Co. 5. Talwar G.P and Gupta S.K(1992). A hand book of practical and clinical immunology. CBS Publication, New Delhi, India
	Reference Books: 1. D. Harlow, David Lane (2014). Antibodies– A Laboratory Manual; 2nd Edn. CSHL Press 2. Brian WJ Mahy and Hillar O Kangro (1996) Virology Methods Manual, Elsevier Ltd.
	E-Resources 1. https://currentprotocols.onlinelibrary.wiley.com/journal/1934368x 2. https://microbiologysociety.org/ 3. https://www.abpischools.org.uk/topic/diseases/
Course Outcomes	On completion of the course, students should be able to: CO1: Demonstrate standard methods for the isolation and titer of bacteriophages. CO2: Explain the collection, and transport of clinical specimens for the diagnosis of disease-causing microorganism CO3: Perform various staining techniques to identify the pathogenic microorganisms CO4: Carryout ABO Blood grouping and Rh typing CO5: Diagnose antigen/antibody present in the samples by using agglutination tests

Mapping of Cos with PSOs:

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	2	2	2

Semester	**THIRD**	Course Code	**24MIBP0318**
Course Title	**PRACTICAL -VI: ADVANCED MEDICAL MICROBIOLOGY**		
No. of Credits	2	No. of contact hours per Week	**4**
New Course / Revised Course	**New Course**	If revised, Percentage of Revision effected **(Minimum 20%)**	--
Category	• Core Course		
Scope of the Course (may be more than one)	• Demonstrate practical skills in the use of tools and methods in medical microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember clinical microbiology techniques microbiological laboratory K-2 Comprehensive knowledge on isolation and processing of pathogenic microbes K-3 Use of various staining techniques to identify the medically important microbes K-4 Capacity to analyse clinical samples to diagnose the disease condition K-5 Make new techniques to find sensitivity patten of bacteria and fungi K-6 Assessment of techniques in Diagnostic Labs and Hospitals		
Course Objectives (Maximum: 5)	The Course aims to • Enhance the student's knowledge and impress upon them on the important aspects of medical microbiology • Provide practical knowledge and skills in diagnostic tests • Understand the working procedure and principles of bacterial methods. • Know the techniques of antimicrobial assay • Gain skill in performing clinical laboratory tests.		

UNIT	**Content**	**No.of Hours**
1.	Basic laboratory procedure in microbiology	3
2.	Collection/transport of specimens for microbiological investigations (Demonstration)	3
3.	Isolation and identification of bacteria and fungi from hospital environment	3
4.	Isolation and identification of microbial flora of mouth teeth crevices	3
5.	Isolation and identification of microbes from skin/pus	3
6.	Preparation of culture media and inoculation pH adjustment, ma,king agar slant, making culture plates, aseptic transfer, streaking	6
7.	Microscopic examination-Direct examination (wet mount)	6
8.	Examination of stained smear (Dry mount) a) Ziehl –Neelsen method for AFB b) Leishman's staining c) Albert's staining d) Giemsa's staining	6
9.	Isolation and identification of microorganisms from urine sample	3
10.	Identification of fungus including direct microscopy, culture methods including slide culture, fungal staining.	3
11.	Antimicrobial agents-Preparation, susceptibility testing, MIC	3
12	Determination of Minimum Bactericidal Concentration MBC.	3
13	Visit to Diagnostic Labs and Hospitals	3

References

1. Horold J Benson (1998). Microbiological Applications - Laboratory Manual in General Microbiology. Seventh International edition, Mc Grew-Hill, Boston.
2. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, 6th Edn. Pearson Education Publication, New Delhi.
3. Collee, J.C., Duguid, J.P., Fraser, A.C. and Marimon, B.P. (1996) Mackie and McCartney. Practical Medical Microbiology, 14th Edn. Churchill Livingstone, London.
4. D. Harlow, David Lane (2014). Antibodies– A Laboratory Manual; 2nd Edn. CSHL Press
5. Kanai L Mukherjee, Anuradha Chakravarthy (2017) Medical laboratory technology, Mc Grew-Hill, Boston.

E-Resources

1. https://currentprotocols.onlinelibrary.wiley.com/journal/1934368x
2. https://microbiologysociety.org/
3. https://www.abpischools.org.uk/topic/diseases/

Course Outcomes	On completion of the course, students should be able to: CO1: Demonstrate standard methods for the isolation and Identification of clinically important bacteria. CO2: Explain the collection, and transport of clinical specimens for the diagnosis of disease-causing microorganism CO3: Perform various staining techniques to identify the pathogenic microorganisms CO4: Carryout antimicrobial assay CO5: Diagnose of pathogen in Diagnostic Labs and Hospitals

MappingofCoswithPSOs:

PSO / Co	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	2	2	2	2
CO5	3	3	2	2	2

Semester	**FOURTH**	Course Code	**21MIBP0419**
Course Title	**FOOD AND FERMENTATION MICROBIOLOGY**		
No. of Credits	**4**	No. of contact hours per Week	**4**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum 20%)	**25%**
Category	Core Course		
Scope of the Course	1. Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products 2. Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food quality analysis K-4 Capacity to analyze the role of government organizations involved in food quality control K-5 Make new techniques to study food spoilage organisms and Food borne diseases K-6 Assessment of quality and safety assurance in the food industry		
Course Objectives (Maximum:5)	The Course aims to: • introduce the scope and development of food microbiology • highlight fermentation technologies in the food processing industry. • create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control. • give an overview on food spoilage organisms- Food borne diseases- to understand infection process and food borne outbreaks. • impart knowledge on quality and safety assurance in the food industry.		

UNIT	**Content**	**No. of Hours**
I	**Microbes in Food** The evolution of food microbiology: origin of food microbiology as a science, scope of food microbiology. Food as an ecosystem. Microorganism important in food microbiology: Molds, yeast and yeast like fungi, bacteria. Food as a substrate for microorganism: Hydrogen-ion concentration, moisture requirement: the concept of water	13

	activity, oxidation-reduction potential, nutrient content, accessory food substances, inhibitory substance and biological structure, combined effects of factors affecting growth.	
II	**Food poisoning and Food-borne diseases** Food infection and Food intoxication. Food hygiene and sanitation- cross contamination. Food borne diseases: *Salmonella* spp *Staphylococcus* spp, *and Clostridium* spp. infections and mycotoxins, viral and parasitic food borne diseases. - Microflora of milk and sources ofContamination: On the Farm, In Transit and at the Manufacturing Level, Preservation: Asepsis, Removal of Microorganisms, Use of Heat, Use of Low Temperatures, Drying, Use of Preservatives. Spoilage: Milk and Cream, Condensed and Dry Milk Products, Frozen Desserts, Butter.	13
III	**Microbial fermentations** Alcoholic Beverages- alcohol, wine, brandy and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented foodpreparations - Sauerkraut preparations and natural Vinegar. Fermentedmilk and milk products: Buttermilk, Cream, Yogurt, Cheese and Kafir.Fermented soybean products, microorganisms as food -single cell protein-yeast, algae and fungal biomass production.	13
IV	**Food processing and preservation** (*Source NPTEL cou**rse***) Aseptic handling, pasteurization of milk. Methods of food preservation -, Physical: radiation, irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere. Chemicals: organic acids, nitrates, nitrites & cresols; Biological: Probiotics and bacteriocins. Advanced and conventional microbiological method for examination of foods	13
V	**Quality control in food microbiology** Quality and Criteria, Sampling Schemes: Two-class Attributes Plans, Three-class Attributes Plans, Choosing a Plan Stringency, Variables Acceptance Sampling. Quality Control Using Microbiological Criteria, Control at Source: Training, Facilities and Operations, Equipment, Cleaning and Disinfection. Codes of Good Manufacturing Practice, The Hazard Analysis and Critical Control Point (HACCP): Concept, Hazard Analysis, Identification of Critical Control Points (CCPs), Establishment of CCP Criteria, Monitoring Procedures for CCPs, Protocols for CCP Deviations, a case in food microbiology.	12
References	**Text Books:** 1. Carl, A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press, London. 2. Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd., New Delhi. 3. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 4. K. Vijaya Ramesh 2007, Food Microbiology. MJP publishers 5. M. K. Rao. Food and Dairy Microbiology.Manglam Publications, 2007.	
	Reference Books: 1. Britz, T.J. and Robinson, R.K.2008 Advanced Dairy Science and TechnologyBlackwell publ.,U.K. 2. Thomas J. Montville and 2007. Food Microbiology: An Introduction 2nd ed. Edition. American Society for Microbiology. 3. M. R. Adams, M. O. Moss, 2007. Food Microbiology. New Age International. 4. William C. Frazier and Dennis C. Westhoff. 2014.Food microbiology; Edition: 4th ed, Mc Fraw Hill publication	
	Web resources: 1. http://www.microbes.info 2. http://www.fsis.usda.gov/ 3. http://www.cdc.gov. 4. http://www.microbes.info/ resource/food microbiology 5. http://www.binewsonline.com/1/what is food microbiology.html	
Course Outcomes	On completion of the course, students should be able CO1: Explain the role of microorganisms in food (beneficial as well as harmful) and the factors influencing their growth. CO2: Discuss and demonstrate processing and preservation of perishable food products and understand the microbial hazards involved CO3: Assess the techniques/processes used in microbial products using fermentation technology.	

	CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.

Semester	**FOURTH**	Course Code	**24MIBP0420**
Course Title	**BIO-PROCESS TECHNOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course /Revised Course	New Course	If revised, Percentage of Revision effected	-
Category	**Elective -Discipline Centric**		
Scope of the Course	1. Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries 2. Students can execute field Projects on the microbial technology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in bioprocess technology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives	The Course aims to: • impart information on historical aspects of fermentation and its techniques • make the student knowledgeable on screening methods for fermentative microbes • expose the students on different types of fermentation media • give an in-depth knowledge on various types of fermentation and product recovery. • enhance student's interest on rules and regulation of industrial effluent disposal and biosafety		
UNIT	Content		No. of Hours
I	**History and Fermentor (source NPTEL)** Introduction- Fermentor -Structure, and components - Agitator, Aerator, Valves, Steam traps and Stirrer. Measurement Parameters Temperature, Pressure, pH, DO. Fermentor - types - design - mode of operation. Bioprocesses – concepts – Pasteur and fermentation. Scope and future prospects of fermentation microbiology and biotechnology. Fermentation process- upstream and downstream.		**9**
II	**Screening methods for Industrial microbes** Industrial important microbes. - Growth cycle - Strain selection and improvement - mutation and recombinant DNA technique for strain development. Detection and assay of fermentation products.		**10**
III	**Biology of Industrial important Microorganisms** Large scale cultivation of Industrially important microbes - Bacillus, Penicillium and Streptomyces. Production media - Formulation strategies of production media - carbon, nitrogen, vitamin and mineral sources, role of buffers, precursors, and antifoams agents. Pure culture method - plating method. Maintaining culture.		**10**
IV	**Types of Fermentation & Product recovery** Solid state fermentation- Submerged fermentation - Batch, Fed-Batch and continuous fermentation - Recovery and purification of intracellular and extra cellular fermented products – cell disruption, centrifugation, filtration, precipitation, solvent extraction and drying. Microbiological assay of antibiotics and vitamins. Antigens, antibodies, vaccine, insulin, toxin, toxoid.		**10**
V	**Rules and regulation** Computer Applications in bio-process technology - monitoring and control strategies - industrial prospects. Newer Approaches to Industrial waste and sewage treatment and disposal. Institutional Biosafety Committee.		**9**
References	**TextBooks:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi.		

	2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi. 4. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 5. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited
	Reference Books: 1. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed, Pergamon Press. 2. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 3. Casida, L.E. 1986. Industrial Microbiology, Eastern Limited, New York
	E-Resources: 1.www.rmit.edu.au/courses/034150 2. microbiologyonline.org 3. https://www.omicsonlineorg/.../industrial-microbiology-journals-articles- ppt-list.php 4. www.nature.com/nrmicro/series/appliedandindustrial
CourseOutcomes	**On completion of the course, students should be able to:** CO1: Discuss the historical aspects of fermentation and its techniques. CO2: Explain screening methods for fermentative microbes. CO3: Outline the different types of fermentation media. CO4: Delineate various types of fermentation and product recovery CO5: Describe the rules and regulation of industrial effluent disposal and biosafety

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	1	2
CO2	3	2	3	3	3
CO3	3	2	1	1	1
CO4	1	3	3	3	3
CO5	3	3	3	3	1

Semester	**FOURTH**	Course Code	**24MIBP0421**
Course Title	**MICROBIAL BIOTECHNOLOGY AND GENETIC ENGINEERING**		
No. of Credits	**4**	No. of contact hours per Week	**4**
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Core Course		
Scope of the Course	1. Basic understanding on basic concepts in microbial biotechnology 2. Skill development for biotransformation and production of useful compounds 3. Creates employability scope in the biotechnology industries		
Cognitive Levels addressed by the ourse	K-1 Ability to remember basic concepts in microbial biotechnology K-2 Comprehensive knowledge on immobilization techniques K-3 Use techniques for biotransformation and production of useful compounds K-4 Capacity to analyze alternate energy resources K-5 Make newer approaches to develop genetically engineered microbes K-6 Assessment of on biosafety, bioethics, hazards of environmental engineering		
Course Objectives (Maximum:5)	**The course aims** • To impart knowledge on the concepts & scope in biotechnology • To provide an in-depth study on biotransformation techniques and biosensors • To enhance interest in alternate energy resources. • To understand genetic engineering concepts & techniques. • To know the transgenic organisms and to acquire knowledge on GMOs.		

UNIT	Content	No. of Hours
I	**Concepts and Scope in Microbial Biotechnology** Scope of importance of Microbial Biotechnology - Historical development - Protoplast culture technique and its applications. Germplasm and cryopreservation. Immobilization of microbial cells / enzymes – Adsorption, entrapping, ionic bonding, cross linking, encapsulation and microencapsulation. Application of immobilized microbial cells & enzymes. Microbial technology for agriculture: Mycorrhizae – Rhizobacteria -Viruses as pest control agents -Bacterial pest control –Microbial toxins for insect and weed control Single cell protein, microbial flavours and food colorants.	13
II	**Biotransformation and Biosensors *(Source NPTEL course)*** Biotransformation and production of useful compounds – Glycerol, butanol, acetone, alkene oxide, Poly hydroxy butyrate and valerate(PHBV), Xanthangum and Microbial Leaching. Biosensors – definition and outline design- types of electrode systems – Oxygen electrode system, Fuel cell type electrode, Potentiostatic, Piezoelectric membrane and Dye-coupled electrode membrane filter systems –Biosensors for nutrients (glucose sensors). Sensor for cell population (Lactate sensor) - Biosensor for products (alcohol sensor, formic acid sensor and methane sensor) - Biosensor for environmental control (BOD sensor, Ammonia sensor, Nitrite sensor and Sulfite Ion sensor).	13
III	**Biomass and Bio-energy** Energy sources – nuclear energy, fossil fuel energy and non-fossil and non-nuclear energy. Biomass energy – Composition of biomass-wastes as sources of renewable source of energy – Composition wastes – sources of wastes (Industrial, agricultural, forestry, municipal sources). Biomass conversion – non-biological process, direct combustion (Pyrolysis, Gasification, liquefaction); biological process (enzymatic digestion, anaerotic digestion, aerobic digestion). Bioenergy products – ethanol, biogas and Hydrogen.	13
IV	**Genetic Engineering *(Source NPTEL course)*** Definition and outline strategy: Enzymology – Restrict enzymes, DNA ligases, reverse transcriptase, klenow fragment, Alkaline phosphatase, Polynucleotide kinase, terminal transferase, Dnase and Rnase. Vectors used in molecular cloning: Plasmids (eg.pUC, pBlueScript, pGEM vectors; Expression vectors; pMal, GST - based, pET vectors), Bacteriophage λvectors (λgt10, λgt11, λ ZAP and replacement vectors – EMBL), Phagemids (M13, derived vectors), cosmids, Artificial chromosome vectors (YACs; BACs), and Other viral vectors(SVO40, vaccinia, baculovirus & retroviral vectors. Gene cloning strategy – Isolation of foreign DNA and recombinant DNA construct – Transformation – Screening and selection. Expression of cloned genes in prokaryotic and eukaryotic systems – minicell, maxicell, Fused and unfused gene expressions. Expression and Purification of recombinant proteins – His -tag, GST-tag, MBP-tag etc., Molecular Pharming - commercially available hosts - *E.coli*, yeast, Baculovirus, and *Agrobacterium tumefaciens.*	13
V	**Applications of Genetic engineering *(Source NPTEL course)*** Genetically modified Microorganisms (GMOs) and its applications - Engineering microbes for the production for antibiotic, hGH, interferon, monoclonal antibodies, and human insulin (Humulin). Engineering microbes for clearing oil spills. Brief outline on Superbug bacteria– Rules and regulation in biotechnology - biosafety, bioethics, hazards of environmental engineering and intellectual property rights (IPR) and protection (IIP).	12
References	**Text Books** 1. Dubey R.C., 2014.Advanced Biotechnology 1st Edition. S. Chand & Company Ltd., New Delhi. 2. S.B. Primrose, R.M. Twyman, and R.W. Old (2012). Principles of Gene Manipulations; 6th Edn. Blackwell Science. 3. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Ed, Anmol Publications Pvt. Ltd., New Delhi. **Reference Books** 1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S. Chand &Company Ltd., New Delhi.	

	2. Demain, A.L., Solomon, N.A. 1986." Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington. 3. Robert F. Weaver, 2012Molecular Biology; McGraw Hill 4. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. 5. T. A. Brown 2006 Gene Cloning and DNA analysis- An Introduction, 5th Edition, Wiley Blackwell Publishing **Web resources** 1. https://www.edx.org/learn/biotechnology 2 .https://biog.feedspot.com/genetics-blogs/ 3. learn.genetics.utah.edu/ 4. http://bmc biotechnol.biomedcentral.com	
Course Outcomes	**Upon completion of this course, students be able to:** CO1: Discuss on the history and concepts of microbial biotechnology CO2: Explain on biotransformation methods and working systems of biosensors CO3: Compare alternate energy sources and generation of bioenergy products from biomass CO4: Outline on concepts and techniques of Genetic Engineering CO5: Assess applications of GMOs and on Ethical issues	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	2
CO2	3	2	1	2	2
CO3	3	2	1	2	2
CO4	3	2	1	2	2
CO5	3	2	1	2	2

Semester	**FOURTH**	Course Code	**21MIBP0422**
Course Title	**PRACTICAL -VII: FOOD, FERMENTATION, BIOPROCESS TECHNOLOGY AND MICROBIAL BIOTECHNOLOGY**		
No. of Credits	**2**	No. of contact hours per Week	**4**
New Course/ Revised Course	**New Course**	If revised, Percentage of Revision effected	--
Category	Core Course		
Scope of the Course	1. Basic understanding on basic concepts in food, industrial and biotechnology 2. Skill development for biotransformation and production of useful compounds 3. Creates employability scope in the Food and biotechnology industries		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food, industrial and biotechnology K-2 Comprehensive knowledge on microbial quality of food products K-3 Use techniques for microbial food analysis K-4 Capacity to analyze traditional fermented products to industrial fermentation K-5 Make newer approaches to develop genetically engineered microbes K-6 Assessment of on biosafety, bioethics, hazards of environmental engineering		
Course Objectives (Maximum:5)	The Course aims to • To provide practical knowledge and skills in production as well as evaluate microbial quality of food products. • To make the modern technical capabilities to analyse food for specific microorganisms • To encourage development of skills in co-operative learning in small groups to design methods for microbial food analysis as a team and communicate the decisions of the design to peers • To extend knowledge on traditional fermented products to industrial fermentation products in the applied areas of food microbiology • To give skills in the isolation of probiotics.		

Practical	Topics covered	No. of Hours
1.	Enumeration of microorganisms from various food samples	4
2.	Direct microscopic count and standard plate count from milk and dairy products.	4
3.	Assessment of milk quality by methylene blue reduction test	4
4.	Performance of phosphatase test for pasteurized milk.	4
5.	Wine production by *Saccharomyces cerevisiae.* and analysis of physiochemical properties of wine	4
6.	Demonstration of role of yeasts in fermented food – Bread and some traditional fermented foods.	4
7.	Enumeration of anaerobic bacteria from canned foods.	4
8.	Enumeration of microbial load in fruit pulp, carbonated beverages and ice creams	4
9.	Detection and assay of bacteriocin by probiotic lactic acid bacteria.	4
10.	Studydifferentparts offermenter (demonstration)	4
11.	Production of Alkali Protease by submerged fermentation	4
12.	Production of Cellulase by solid state fermentation	4
13.	Immobilization of cell using calcium alginate	4
14.	Microbialfermentationsfortheproductionandestimation of Amylase	4

References	**References:** 1. Spencer, JFT and De spencer, ALR. 2001. Food Microbiology protocols, Humama press, Totowa, New Jersey. 2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, 1st Ed., Chand and Company Ltd., India. 3. Precott, H. 2002. Laboratory excercises in Microbiology. 5th Edition. The Mac Graw – Hill Companies. 4. K. R. Aneja. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.. New Delhi. India.
Course Outcomes	On completion of the course, students should be able CO1: Identify standard methods for the isolation and identification of microorganisms in food sample. CO2: Explain the application of rapid microbial analysis of food. CO3: Evaluate the data obtained and report accurately on the findings. CO4: Create microbial practical skills to produce fermented foods. CO5: Demonstrate practical skills in isolation of probiotics

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	2	2	2

Semester	**FOURTH**	Course Code	24GTPP00H1
Course Title	**HUMAN VALUES AND PROFESSIONAL ETHICS**		
No. of Credits	2	No. of contact hours per week	
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Modular Course		
Scope of the Course (may be more than one)			
Cognitive Levels addressed by the Course			
Course Objectives	**The Course aims** • to enable students to acquire basic knowledge and exposure to human values and professional ethics.		

	• to motivate the students to imbibe and practice values and ethics in their profession and social interactions.	
Unit	Content	No. of Hours
I	**Concept of Human values:** Need for values and ethics in human life, types of values: Personal and moral values: love, truth, tolerance, wisdom, sacrifice, sincerity, self-control, altruism and scientific vision - Social values: equality, humaneness, universal brotherhood, empathy, probity.	6
II	**Political and Constitutional values:** Democracy, socialism, secularism, equality, justice, liberty,freedom and fraternity - Religious values: faith, love, compassion, forgiveness, tolerance, equal respect for all religions, selflessness, awareness, nonattachment, character and virtues.	6
III	**Aesthetic values:** Appreciation of literature and fine arts and nature - Economic values: fairness, honesty, business integrity, eco-centric - Environmental values: respect and concern for nature and its fauna and flora - Professional values: quest for knowledge, competency, sincerity in profession, regularity, punctuality.	7
IV	**Ethics:** Meaning, domains of ethics, need for ethics, challenges to ethics, ethics and morality, role of ethics in work environment.	7
V	**Professional Ethics:** Pride in their work, trust with confidences, honesty, trust worthy, moral, corruption free and loyal, personal commitment to quality, sharing the burden - take responsibility, Ethical Intelligence**:** Do no harm, make things better, respect others, be fair (no bias / prejudice), be loving.	6
References	**Text Books:** 1. Kiruba Charles and V. Arul Selvi, 2016, Value Education, Neel kamal ; First edition, New Delhi. 2. Shiva and Balaji Loganathan, 2011, Value Education', Sree Gomathi Publications,Chennai. 3.Babu Muthuja and R. Usharani, 2009, 'Peace and Value Education', Centrum Press, New Delhi,. 4.Pushpam Kumar and B. Sudhakara Reddy, 2007, Ecology and Human Well Being', Sage Publications, New Delhi. 5.R.S. Naagarazan, 2006, A Textbook on Professional Ethics and Human Values', New Age International Publishers, New Delhi. 6.S. Srinivasan, 2005,Value Based Management', Jaico Books, Mumbai.	
	Reference Books 1. John Clammer, 2018, Cultural Rights and Justice: Sustainable Development, the Arts and the Body, Palgrave Macmillan,1st ed. 2019 edition, U.K. 2.Gregory R Maio,2016, The Psychology of Human Values, Routledge Publications, New York. 3.A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi. 4.A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi. 5.Justin Oakley, Dean Cocking, 2001, Virtue Ethics and Professional Roles, Cambridge University Press, United Kingdom.	
	E-Resources 1.Thich Nhat Hanh, 2008, Good Citizens: Creating Enlightened Society: http://archive.kdd.org/good_citizens_creating_enlightened_society_thich_nhat_hanh.pdf. 2.Thought of Human Value education According to Mahatma Gandhi management.nrjp.co.in/index.php/JSSMMS/article/download/155/294.	
Course Outcomes	On completion of the course, students should be able to Comprehend the significance and importance of values and their pervasiveness Gain knowledge on the different aspects of values and ethics Have exposure on the practical dimensions of professional ethics	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	2	2	2

Semester	**THIRD**	Course Code	**24MIBP03D1**
Course Title	**ELECTIVE - DISCIPLINE CENTRIC: MICROBIAL NANOTECHNOLOGY**		
No. of Credits	**3**	No. of contact hours per Week	**3**
New Course/ Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum20%)**	**30**
Category	Core Course		
Scope of the Course (may be more than one)	1. Students will be able to develop their skills on microbial nanotechnology 2. Students will be able to develop Employability in nanotechnology field		
Cognitive Levels addressed by the Course	**K-1**: Remember basics of nanotechnology and its development **K-2**: Understand importance of synthesis of nanoparticles and its vast applications **K-3**: Apply nanoparticles in different fields **K-4**: Analyze different types and characterization methods for nano particles **K-5**: Evaluate physical and chemical properties of nanoparticles **K-6**: Create knowledge on microbial nanotechnology		
Course Objectives (Maximum:5)	The Course aims to • To give an overview on basics of nanotechnology and its development. • To know the importance of synthesis of nanoparticles and its vast applications. • To impart in-depth information on different types and characterization methods for nano particles • To know about its physical and chemical properties. • To know the applications of nanoparticles		

UNIT	Content	No. of Hours
I	**Unit - I: Basics of nanotechnology and Biological Nanomaterials in Nature** Basics of nanotechnology, origin and conceptsNano and Nature: Nanoscopic colors (Butterfly Wings), Bioluminescence (Fireflies), tribiology (Geckos sticky feet, lotus leaf effect) - Introduction to hydrophilic and hydrophobic materials - Fundamentals of nanoscale self-assembly in Nucleic acid (DNA and RNA), Proteins, Enzymes- Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).	**12**
II	**Unit – II: Synthesis of Nanoparticles** Physical methods- Melt Mixing, Evaporation-Physical vapor deposition, Ionized cluster beam deposition, lazar vaporization and pyrolysis-Sputter deposition – Chemical methods -Colloidal, microemulsion, sol-gel, hydrothermal, sonochemical and microwave- Biological synthesis – Plant extracts, microorganisms, proteins, DNA, S-Layers, mechanism of microbial synthesis, biocompatibility issues of physical, chemical and biologically synthesized nanoparticles.	**9**
III	**Unit III Classification of Nanoparticles** Classification - based on origin, structural configuration/composition, the number of dimensions, pore dimensions, potential toxicity- Properties of nanoparticles, physical and chemical.	**9**

IV	**Unit - IV: Characterization of Nanoparticles** Characterization of nanoparticles using UV-Vis, FTIR spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD and nano particle size analyzer.	**9**
V	**Unit –V: Applications of Nanoparticles** Drug delivery-protein and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and protein microarrays. Uses of nanoparticles- Cancer therapy and manipulation of cell and biomolecules. Nanotechnology in health sectors. Toxicology in nanoparticles. Advantages and development of green chemistry – commercial viability of nanoparticles. Disadvantages – health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.	**9**
References	**Text books:** 1. Raton, Introduction to nanoscience and nanotechnology, 2008, CRC Press, Tylor and Francis Group. 2. Kuno, Introductory Nanoscience: Physical and Chemical Concepts, 2011, 1st edition, Garland Science. 3. Ibrahim K, Nanoparticles: Properties, applications and toxicities. 2017), Arabian Journal of Chemistry. 4. David SG. (2004). Bio nanotechnology, Lessons from nature, John Wiley & Sons Inc. publication 5. Parthasarathy BK. (2007). Introduction to Nanotechnology, Isha Publication.	
	Reference Books: 1. Bernd R. (2006). Microbial Bio nanotechnology: -. Horizon Scientific Press. 2. David ER and Joseph DB. (2009). Bio nanotechnology: Global Prospects. CRC Press. 3. Ehud G. (2013). Plenty of Room for Biology at the Bottom: An Introduction to Bio nanotechnology, World Scientific Publishers. 4. Silva GA and Parpura V. (2011). Nanotechnology for Biology and Medicine: At the building block level, Springer Science.	
	E-Resources: 1. https://www.igi-global.com/chapter/microbial-nanotechnology/165227	
Course Outcomes	On completion of the course, students should be able to do CO1: Understand the latest environmentally friendly research to human welfare. CO2: Understand different physical, chemical and biological methods used to synthesize nanoparticles. CO3: Understand the types and physical and chemical properties of nanoparticles. CO4: Understand analytical instruments use to characterize nanoparticles. CO5: Understand various applications of nanoparticles.	

Mapping of Cos with PSOs:

PSO / CO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	2	2	1	1
CO2	3	3	3	3	3
CO3	2	3		3	1
CO4	3	1	3	2	3
CO5	1	1	1	3	2

Semester	**THIRD**	Course Code	**24MIBP03D2**
Course Title	**ELECTIVE - DISCIPLINE CENTRIC: MICROBIOME BIOLOGY**		
No. of Credits	**3**	No. of contact hours per week.	**3**
New Course/ Revised Course	**New Course**	If revised, Percentage of Revision effected	--
Category	Core Course		
Scope of the Course	1. Understanding the microbiomes will pave the way for transforming microbiology to microbiome biology 2. Evolve techniques and approaches to exploit the benefits of microbiomes in general.		
Cognitive Levels addressed by the Course	**K-1** Ability to remember basic concepts in microbiome biology **K-2** Comprehensive knowledge on microbiome analysis **K-3** Assessment of human microbiome relationship **K-4** Newer approaches on microbiome and disease biology **K-5** Assessment of microbes in infectious diseases		
Course Objectives	The Course aims to: • Understand the basics of microbiome • Highlight the importance of approaches in microbiome analysis • To know the importance of human microbiome interaction • Impart information on microbiome and disease biology • Explain mechanisms of biofilm and infectious diseases		

UNIT	Content	No. of Hours
I	**Introduction to Microbiome** Microbiome – definition – uncultured majority – Candidatus, Status and phyla radiatus – definition, History of microbiome perspective, environmental genomics- microbiomes of oceans, lakes and terrestrial ecosystems, Microbiome ecology, the fungal and viral microbiomes, Microbiome evolution. Earth Microbiome project.	**9**
II	**Approaches in Microbiome analysis** Metagenomics (open and closed formats), Meta-transcriptomics, Pan-genomics, Epigenomics, Microfluidics technology to study the human microbiome, single cell genomics, Advance culturing techniques to study microbiomes. Metagenomics: – definition – principles – methods - whole genome shotgun cloning –metagenomic library production – high throughput screening - metagenomics of archealogical samples – Sargasso sea project – microbial phylogeography.	**10**
III	**Human microbiome** Biodiversity and major genera of human-microbiome, human-microbiome system as a "holobiont" or "superorganism", microbiome distributions in healthy individuals; composition of specific body sites' microbiome (nose, skin, oral, urogenital, etc.) - fecal transplants- designer probiotics, Symbiosis- Dysbiosis -Rebiosis, Dynamics microbiome changes from birth to death; pregnancy and the microbiome; personnel microbiome concepts.	**10**
IV	**Microbiome and disease biology** Gut-brain conversation, obesity and gut microbiome, infectious diseases and gut microbiome, non-infectious diseases and gut microbiome, phylogeography of epidemics, microbiome's role in diseases such as Inflammatory bowel disease (IBD), colitis, obesity, diabetes; effects of diet on microbiome; interactions with the immune system and resistance to pathogens; Drug delivery using microbes engineered to secrete peptides, Microbes as neuromodulators.	**9**
V	**Biofilm biology** Biofilm – definition, cell-cell communication, extracellular polymeric substances (EPS), Formation stages – Development, Dispersal, Habitats - dental plaque, diversity and eDNA, biofilm Infectious diseases - Pseudomonas aeruginosa and Staphylococcus epidermidis, Staphylococcus aureus, Streptococcus mutans, Candida. Uses in medicine, industry, Food industry, aquaculture. Eukaryotic biofilms, biofilm as model of microbiome.	**10**

References	**Text Books:** 1. Angela E. Douglas (2018). Fundamentals of Microbiome Science – how microbes shape animal biology, Princeton University Press, New Jersey, United States. 2. Rob DeSalle and Susan L. Perkins (2015). Welcome to the microbiome. getting to know the trillions of bacteria and other microbes in, on, and around you. Yale University Press. 3. Rodney Dietert (2016). The Human Superorganism: how the microbiome is revolutionizing the pursuit of a healthy life, Dutton. **Reference Books:** 1. Justin Sonnenburg and Erica Sonnenburg (2014). The good gut: taking control of your weight, your mood, and your long-term health. Penguin Press. 2. Emeran Mayer (2016). The Mind-Gut Connection: How the Astonishing Dialogue Taking Place in Our Bodies Impacts Health, Weight, and Mood. eBook, Harper Wave Books. 3. Martin J. Blaser (2014). Missing Microbes: How the Overuse of Antibiotics Is Fuelling Our Modern Plagues. Harper Collins Publishers. Toronto. 4. Diana Marco (2014). Metagenomics of the Microbial Nitrogen Cycle: Theory, Methods and Applications Book: 978-1-908230-48-5. ebook: 978-1-908230-60-7, Caister Academic Press. 5. Pilar Francino, M (2012). Horizontal Gene Transfer in Book: 978-1-908230-10-2. ebook: 978-1-908230-72-0, Caister Academic Press. **Web resources:** 1. https://www.genome.gov/genetics-glossary/Microbiome. 2. https://bio.libretexts.org/Bookshelves/Human_Biology/Human_Biology_(Wakim_and_Grewal)/20%3A_Immune_System/20.7%3A_Human_Microbiome
Course Outcomes	On completion of the course, students should be able to: **CO1**: Outline the introduction to microbiome **CO2**: Discuss the different approaches in microbiome analysis **CO3**: Acquire knowledge on human microbiome **CO4**: Understands the microbiome and disease biology **CO5**: Describe the aspects microbes in infectious diseases

Mapping of Cos with PSOs:

PSO / CO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**THIRD**	Course Code	**24MIBP03D3**
Course Title	**ELECTIVE - DISCIPLINE CENTRIC: MARINE MICROBIOLOGY**		
No. of credits	**3**	No. of contact hours per week	**3**
New Course Revised Course	New Course	If revised, percentage of Revision effected	-
Category	Core Course		
Scope of the Course (May be more than one)	1. Basic understanding on the morphology and functions of the structures of the marine microorganisms 2. Students can execute projects on the marine microbiology 3. Creates employability scope in marine microbiological laboratories / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember historical and developments in marine ecosystem K-2 Grasp the comprehensive knowledge on marine microorganisms K-3 Use microbiological tools for better understanding of microbial structures and their functions K-4 Capacity to analyse factors influencing marine microbial growth		

	K-5 Make new techniques to rapid diagnosis of contamination in sea foods K-6 Assessment and monitoring of extremophilic microorganisms in marine	
Course Objectives	• The course aims to: • enhance the student's knowledge in marine ecosystem • acquire an overall knowledge on the morphology and functions of the structures with marine microorganisms and its uses • develop knowledge in diagnosis of contamination in sea foods • make the students to gain knowledge on microbiology of aquatic environments and associated biogeochemical cycles • give an overview on microbial ecology-microbial habitats, their interactions and extremophilic microorganism	
UNIT	**Content**	**No. of Hours**
I	**Introduction to marine microbial ecosystem** Marine environment, Seawater, Habitats for marine microorganisms. Marine microbial communities–Bacteria, fungi, protozoa. Microbial interactions – Endosymbionts and Ectosymbiont	13
II	**Marine extremophiles:** Mechanism of survival at extreme environments – Adaptive mechanisms in thermophilic, alkalophilic, osmophilic, barophilic, psychrophilic, hyperthermophilic and halophilic microorganisms – Importance in biotechnology.	13
III	**Dynamics of Marine Microbes:** Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming – Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization–phosphorus cycle. Decomposition of organic matter. Bioleaching and bio-deterioration of natural and synthetic materials.	13
IV	**Marine Microbial Diseases:** Aqua culture pathogens & Water borne pathogens - *Aeromonas, Vibrio, Salmonella, Pseudomonas, Leptospira, Corynebacteria* and viral diseases. Rapid diagnosis of contamination in sea foods and aquaculture products.	13
V	**Applications of Marine Microbial Biotechnology:** Production and applications of marine microbial products – Enzymes, Antibiotics, Organic acids, Toxins, Biosurfactants and Pigments. Sea food preservation methods. Probiotic bacteria and their importance in aquaculture.	12
References	**Text Books:** 1. Munn C. B. (2019). Marine Microbiology: Ecology and Applications. (3rd Edition). CRC Press. 2. Bhakuni, D.S. and Rawat D.S. (2005). Bioactive Marine Natural Products. Anamaya Publishers, New Delhi. 3. Brock T.D. (2011). Thermophilic Microorganisms and Life atHigh Temperatures. Springer. 4. Nybakken, J. W. (2001). Marine Biology. (5thEdition). Benjamin Cummings.Veena. Understanding marine biology. Discovery Publishing. 5. Extremophiles: Microbial Life in Extreme Environments by Horikoshi and Grant, Published by Wiley (1998). **Web resources:** 1. https://link.springer.com/content/pdf/bfm%3A978-0-387-23709-1%2F1 2. https://www.researchgate.net/publication/285931262_Bioactive Marine Natural 3. http://link.springer.com/content/pdf/bfm%3A978-3-642-03470-1%2F1.pdf 4. https://link.springer.com/book/10.1007/b102184	

Course Outcomes	On completion of the course, students should be able to: CO1: Apply the knowledge on marine microbial communities and their interactions. CO2: Evaluate the mechanisms employed by the extremophiles to survive in extreme environments CO3: Illustrate the role of marine microorganisms in biogeochemical cycles. CO4: Identify the diseases affecting marine organisms and its diagnosis. CO5: Evaluate the marine microorganisms as a resource for novel microbial products

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	1	1
CO2	3	2	1	1	1
CO3	3	3	2	1	2
CO4	3	2	2	1	2
CO5	3	3	3	3	3

Semester	**THIRD**	Course Code	**24MIBP03M1**
Course Title	**MODULAR COURSE: ADVANCED MOLECULAR TECHNIQUES**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum20%)	20%
Category	Core Course		
Scope of the Course	1. Basic understanding on basic concepts in molecular techniques 2. Skill development for detection and analysis of nucleic acid 3. Creates employability scope in the forensic departments		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in molecular tools K-2 Comprehensive knowledge on electrophoresis techniques K-3 Use techniques for molecular sequencing and its applications K-4 Capacity to analyze the PCR techniques and its applications K-5 Make newer approaches to genome sequencing and K-6 Assessment of physical mapping		
Course Objectives(Maximum:5)	**The course aims to:** • give knowledge on working principle and applications of electrophoresis techniques • develop interest to acquire latest information on molecular sequencing and its applications • make knowledge on PCR techniques and its applications • impart in-depth knowledge on chromatographic and spectrophotometric techniques and their uses • create interest on the importance of genome sequencing and physical mapping analysis		

UNIT	Content	No. of Hours
I	**Chromatographic and Spectrophotometric techniques** Principle and applications of Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC). Principle and applications of Atomic Absorbance Spectra (AAS), Infra –red (IR) Spectra and LC-MS technique.	7
II	**Electrophoresis:** Principle and application: paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE) and Immunoelectrophoresis	7

III	**Molecular Sequencing** Amino acid sequencing and analysis -MALDI-TOF, DNA sequencing –Enzymatic & chemical methods and new generation sequencing – 16S & 18S rRNA sequencing. Blotting techniques – Southern, northern, western and Dot blots. Microarray techniques – oligonucleiotide array and cDNA array and its applications.	6
IV	**PCR techniques** Principle and applications- types of PCR - enzymology- primer types-methods. PCR amplification for Detection of mutation, monitoring cancer therapy, detect bacterial & viral infections, sex determination of prenatal cells, linkage analysis in sperm cells and studies on molecular evolution.	7
V	**Molecular mapping of genome** Physical mapping and map -based cloning – choice of mapping population & simple sequence repeat loci – southern and fluorescence in situ hybridization for genome analysis - chromosome microdissection and microcloning - molecular markers in genome analysis (RFLP, RAPD, and AFLP analysis) – molecular markers linked disease resistance genes – application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, varietal analysis, animal trafficking and poaching - germplasm maintenance and taxonomy. Molecular mapping of genome.	7
References	**Text Books:** 1. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. 2. James. D.Watson, Michael Gilman, Jan Wit Koeski and Mark Zuller, 2001. Recombinant DNA. IInd Ed. Scientific American Book, New York. 3. B. Lewin 2000. Genes VII Oxford University Press. 4. E.J. Gardener1991. Principles of Genetics (8th Ed.) John Wiley & Sons, New York. **Reference Books:** 1. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani. 2. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 3. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press. 4. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore 5. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India. **Web resources** 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html	
Course Out comes	**Upon completion of this course, students should be able to:** **CO1**: Outline the working principle and applications of electrophoresis techniques **CO2**: Explain molecular sequencing techniques **CO3**: Discuss PCR techniques and their applications **CO4**: Uses of chromatographic and spectrophotometric techniques **CO5**: Demonstrate methods involved for genome sequencing and physical mapping	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	2
CO2	2	2	1	2	2
CO3	2	3	1	2	2
CO4	2	2	1	2	2
CO5	3	2	1	2	2

Semester	**THIRD**	Course Code	**24MIBP03M2**
Course Title	**MODULAR COURSE: BIOINFORMATICS**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected	20%
Category	Core Course		
Scope of the Course	1. Basic understanding on basic concepts in molecular techniques 2. Skill development for detection and analysis of nucleic acid 3. Creates employability scope in the forensic departments		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in bioinformatics K-2 Comprehensive knowledge on computational biology K-3 Use techniques to explain the tools used in Bioinformatics K-4 Capacity to analyze the genome sequence and protein analysis K-5 Make newer approaches used in microbial genomics K-6 Assessment of Bioinformatic tools and its applications		
Course Objectives (Maximum:5)	**The course aims to:** • study on Bioinformatics, microbial genomics, and proteomics • understand genome analysis, sequence analysis and protein analysis • explain the tools used in Bioinformatics • impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations • know computational biology		

UNIT	Content	No. of Hours
I	**Whole genome analysis** Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing.	6
II	**Sequence analysis** Computational methods, homology algorithms (BLAST) for proteins and nucleic acids. PROSITE, PEAM, and Profile Scan.	6
III	**Databases Analysis** Use of internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB).	6
IV	**DNA microarray and general Analysis** DNA microarray printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expressions using fluorescent labeled DNA or end labelled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.	7
V	**Protein analysis and Proteomics** Sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays. Introduction to docking.	7
References	**Text Books** 1. Read, TD., Nelson, KE., Fraser, CH. 2004. Microbial Genomics. Humana Press Inc., USA. 2. Rashidi, H.H. and Buchler, L.K. 2002 Bioinformatics Basics: Applications in Biological Science and Medicines, CRC Press, London 3. Stephen P. Hont and Rick Liveey (OUP) 2000. Functional Genomics, A practical Approach. 4. Perysju, Jr. abd Peruski 1997. The Internet and the New Biology: Tools for Genomic and molecular Research. 5. Mark Schena (OUP). DNA Microarrays, A practical approach. **Web resources:** 1.https://www.bioinformatics.org 2.bioinformaticsonline.com 3. www.ii.uib.no/~inge/list.html	

Course Outcomes	On completion of the course, students should be able CO1: Evaluate whole genome analysis methods CO2: Apply the computational tools used for sequence analysis tools CO3: Demonstrate the use of internet in data analysis CO4: Acquire knowledge on DNA microarray techniques CO5: Familiar with the different methods of protein analysis

Mapping of Cos with PSOs:

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**FOURTH**	Course Code	**24MIBP04M1**
Course Title	**MODULAR COURSE: INTELLECTUAL PROPERTY RIGHTS**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	20
Category	Core Course		
Scope of the Course (may be more than one)	1. Understand the importance of Intellectual property Rights 2. Acquire the knowledge on Copyright, Trademarks and Registration of patents for innovations 3. Understand the Process of patentability and IPR opportunities in life sciences		
Cognitive Levels addressed by the Course	K1- Inculcate the importance of IPR K2- Examination of copyright and Trademarks and Registration of IPRs K3- Implement the process of patent application K4- Motivate the innovations to get copyrights K5- Create awareness among the people on patent application process		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge on Intellectual property Rights • To understand the Copyright and Trademarks and Registration of IPRs • To evaluate the process of Patents & Patentability • To analyze the details of various process of IPR in Life Sciences		

UNIT	Content	No. of Hours
I	**Introduction to IPRs.** Basic concepts and need for Intellectual property- Patents, Copyrights, Geographical Indications, Nature of Intellectual Property, Industrial Property, technological Research. Introduction to Intellectual property – Invention and Creativity – Importance – Protection of IPR	6
II	**Copyright and Trademarks and Registration of IPRs:** Copy right – definition, protection, Related Rights, Distinction between related rights and copyrights. Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings. Trade mark – definition, rights, kind of signs, types of trademarks, protection and registration.	6
III	**Patents:** Introduction to Patents – Patentability criteria - Novelty, Non-Obviousness and industrial applicability - The Patent Act, 1970 – Inventions not patentable – Patent Specifications: Provisional and complete - Types of patent applications – compulsory licensing – Patent application Forms and fees –Patent search- Types. Patents:	7

IV	**Patents & Patentability;** Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties	7
V	**IPR in Life Sciences:** Patentability of Biotechnology Inventions - Protection of Genetic Resources - Patenting of seeds Moral Issues in Patenting Biotechnological Inventions – case studies on biotechnology patents Legal protection of Biotechnological inventions. Patenting of Basmati Rice in USA, case study of Glyphosate tolerance, betaine production and revocation of Neem and Turmeric patents.	6
References	1. Deborah E. Bouchoux-Intellectual:The Law of Trademarks, Copyrights, Patents and Trade secrets, Cengage Learning. Third Edition, 2012 2. Prabuddha Ganguli Intellectual Property Rights: Unleashing the knowledge Economy. McGraw Hill Education, 2011 3. Edited by Derek Bosworth and Elizabeth Webster. The Management of Intellectual Property. Edward Elgar Publishing Ltd.,2013. 4. Baine. (2007). Biotechnology from A to Z, Agrobios, New Delhi. 5. Barum. (2006). Biotechnology, Thompson Publishers, New Delhi. 6. Chawla, H.S. (2007). Introduction to Plant Biotechnology. Oxford and IBH publishing Co (P) Ltd.New Delhi. 7. Das,H.K. (2010). Textbook of Biotechnology. Wiley India (P) Ltd. New Delhi. 8. Dubey, R.C. (2010). Textbook of Biotechnology, S. Chand and Co. Ltd., Ramnagar, New Delhi. 9. Prabuddha Ganguli (2017). Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education **E-resources:** 1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in /cells/ipr/ docs/ipr-eng-ebook.pdf 2. World Intellectual Property Organization. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs /en/intproperty/489/wipo_pub _489.pdf **Reference Journal:** 1. Journal of Intellectual Property Rights (JIPR): NISCAIR Useful Websites: 1. Cell for IPR Promotion and Management (http://cipam.gov.in/) 2. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/) 3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)	
	On completion of the course, students should be able to CO1: gain the knowledge on Intellectual property Rights CO2: understand the Copyright and Trademarks and Registration of IPRs CO3: evaluate the process of Patents & Patentability CO4: analyse the details of various process of IPR in Life Sciences	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	2	3	3	2	3
CO3	3	3	3	3	3
CO4	2	2	2	3	3
CO5	2	3	2	2	2

Semester	**SECOND**	Course Code	**24MIBP02G1**
Course Title	**ELECTIVE –GENERIC FOOD MICROBIOLOGY**		
No. of Credits	**3**	No. of contact hours per Week	**3**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum	**25%**

		20%)	
Category	Core Course		
Scope of the Course	1. Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products 2. Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food quality analysis K-4 Capacity to analyze the role of government organizations involved in food quality control K-5 Make new techniques to study food spoilage organisms and Food borne diseases K-6 Assessment of quality and safety assurance in the food industry		
Course Objectives (Maximum:5)	The Course aims to: • Ontroduce the scope and development of food microbiology • Highlight fermentation technologies in the food processing industry. • Create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control. • Give an overview on food spoilage organisms- Food borne diseases- to understand infection process and food borne outbreaks. • Impart knowledge on quality and safety assurance in the food industry.		

UNIT	Content	No. of Hours
I	**Microbiology of Foods** History - Importance of food microbiology- Factors influencing the microbial growth in food. (Intrinsic and Extrinsic parameters). Sources of food borne microorganisms found in food.	**10**
II	**Food poisoning and Food-borne diseases** Food infection and Food intoxication. Food borne diseases: Salmonella spp., Staphylococcus spp., and Clostridium spp., infections and mycotoxins, viral and parasitic food borne diseases. - Microflora of milk and sources of contamination.	**10**
III	**Microbial fermentations** Alcoholic Beverages- wine and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented food - Sauerkraut preparations, Fermented milk products: Buttermilk, Yogurt, Cheese and Kafir. -Single cell protein.	**10**
IV	**Food processing and preservation (Source NPTEL course)** Aseptic handling, pasteurization of milk. Methods of food preservation - Physical: radiation, irradiation, drying, chilling and freezing, high pressure. Chemicals: organic acids, nitrates, nitrites & cresols; Biological: Probiotics and bacteriocins.	**10**
V	**Quality and safety assurance** Quality and safety assurance in food and dairy industry. Good manufacturing practice, FDA, BIS, WHO, FSSAI, Hazard Analysis and Critical Control Point (HACCP) concept.	**9**
References	**Text Books:** 1. Carl, A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press, London. 2. Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd., New Delhi. 3. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 4. Jay, J.M.2000 Modern Food Microbiology 6th Ed. Aspen Publication, USA. 5. Joshi V. K and Ashok Pandey. 1999. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. (VOL II).	

	Reference Books: 1. Britz, T.J. and Robinson, R.K.2008 Advanced Dairy Science and Technology Blackwell publ.,U.K. 2. Hobbs, B.C.and Roberts,D. 1993.Food Poisoning and Food Hygiene, Edward Arnold (A Division of Hodder and Sloughton), London. 3. Salle, AJ. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill, Publishing Co. Ltd., New York. pp: 710-793. 4. Robinson, R.K. 1990. Dairy Microbiology, Elsevier Applied Sciences, London Banwart,GJ.Basic Food Microbiology, CBS Publishers and Distributors.
	Web resources: 1. http://www.microbes.info 2. http://www.fsis.usda.gov/ 3. http://www.cdc.gov. 4. http://www.microbes.info/ resource/food microbiology 5. http://www.binewsonline.com/1/what is food microbiology.html
Course Outcomes	On completion of the course, students should be able CO 1: Explain the role of microorganisms in food (beneficial as well as harmful) and the factors influencing their growth. CO2: Discuss and demonstrate processing and preservation of perishable food products and understand the microbial hazards involved CO3: Assess the techniques/processes used in microbial products using fermentation technology. CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	3	2	1
CO2	3	3	3	3	3
CO3	3	3	3	3	1
CO4	2	3	2	1	3
CO5	3	1	1	3	2

Semester	**SECOND**	Course Code	**24MIBP02G2**
Course Title	**ELECTIVE –GENERIC INDUSTRIAL MICROBIOLOGY**		
No. of Credits	**3**	No. of contact hours per Week	**3**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum20%)	**25%**
Category	Core Course		
Scope of the Course	1. Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries 2. Students can execute Projects on the microbial fermentations		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in Industrial microbiology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives (Maximum:5)	The Course aims to: • understand industries involving microbial technology • make knowledge on production of various industrial microbial products. • know the various techniques used in industries. • impart the functioning of bioreactors • create a comprehensive knowledge on upstream and downstream processing		

UNIT	Content	No. of Hours
I	**History and Fermentor (source NPTEL)** Introduction- Fermentor -Structure, and components - Agitator, Aerator and Stirrer. Measurement Parameters Temperature, Pressure, pH, DO. Fermentor - types - mode of operation. Fermentation process- upstream and downstream.	**10**
II	**Screening methods for Industrial microbes** Industrially important microbes. Strain selection and improvement - mutation and recombinant, DNA technique for strain development. Growth cycle.	**10**
III	**Fermentation media** Production media – Formulation strategies of production media. Raw material, screening for production media. Pure culture method - plating method. Maintaining culture	**10**
IV	**Types of Fermentation & Product recovery** Submerged fermentation - Batch, Fed-Batch and continuous fermentation - Biomass separation by centrifugation, filtration and other recent developments. Recovery and purification of intracellular and extracellular products.	**10**
V	**Rules and regulation** Newer Approaches to Industrial waste and sewage treatment and disposal. Institutional Biosafety Committee.	**9**
References	**Text Books:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi. 4. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 5. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited	
	Reference Books: 1. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed., Pergamon Press. 2. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 3. Casida, L.E. 1986. Industrial Microbiology, Eastern Limited, New York.	
	E-Resources: 1. www.rmit.edu.au/courses/034150 2. microbiologyonline.org 3. https://www.omicsonlineorg/industrial-microbiology-journals-articles-ppt-list.php 4. www.nature.com/nrmicro/series/applied and industrial	
Course Outcomes	On completion of the course, students should be able CO1: Discuss historical aspects of industrial microbiology and fermfermentation techniques: Compare screening methods for Industrial microbes CO3: Explain the biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial microbiology	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	3	2
CO2	3	3	3	3	3
CO3	3	1	3	3	3
CO4	2	3	2	3	3
CO5	3	2	3	1	3

Semester	**SECOND**	Course Code	**24MIBP02G3**
Course Title	**ELECTIVE – GENERIC BIOFERTILIZERS AND MUSHROOM TECHNOLOGY**		
No. of Credits	**3**	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	20%
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concepts biofertilizers and Mushroom production 2. Utilize the various methodologies of biofertilizers and Mushroom for income generation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists		
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of biofertilizers and Mushroom production K2- realize the various techniques involved in biofertilizers and Mushroom cultivation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of biofertilizers and Mushroom cultivation K5- Motivate the people to become biofertilizers and Mushroom cultivation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge and techniques of Biofertilizers • To understand the various processing technologies of Azolla cultivation • To evaluate the process of information about mushroom biology: • To validate the importance of tropical mushroom cultivation technology • To identify Nutrient profile of Mushrooms		

Unit	**Content**	**No. of Hours**
I	**Introduction Biofertilizers** Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers. Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Rhizobium and Azospirillum.	**12**
II	**Mass cultivation of Azolla, Phosphobacteria and Mycorrhiza** Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla. Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Biochemistry of Phosphate solubilization and mobilization. Mycorrhizal fungi as biofertilizers.	**15**
III	**Introduction to mushroom biology:** characteristics, importance of mushrooms - as food, tonics and medicines. Different parts of a typical mushroom. Key to differentiate edible from poisonous mushrooms. phases of mushroom technology - pure culture, spawn, preparation of compost, mushroom development	**10**
IV	**Prospects of tropical mushroom cultivation technology**: Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, postharvest technology. Mushroom farming and prospects.	**14**
V	**Nutrient profile of Mushrooms;** Protein, aminoacids, calorific values, carbohydrates, fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus. Health benefits: Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect,haematological value, cardiovascular and renal effect.	**13**
References	**Reference Books** 1. Kannaiyan, S., Kumar, K. and Govindarajan, K., 2010. Biofertilizers Technology. Scientific Publishers.	

	2. Kumar, R., Kumawat, N. and Sahu, Y.K., 2017. Role of biofertilizers in agriculture. Popular kheti, 5(4), pp.63-66. 3. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin. 4. Niir Board, 2004. The Complete Technology Book on Bio Fertilizer and Organic Farming, National Institute of Industrial Research, Delhi. 5. Reddy, G.C., Goyal, R.K., Puranik, S., Waghmar, V., Vikram, K.V. and Sruthy, K.S., 2020. Biofertilizers toward sustainable agricultural development. Plant microbe symbiosis. Springer, Cham, pp.115-128. 6. Dudeja, S.S., Singh, N.P., Sharma, P., Gupta, S.C., Chandra, R., Dhar, B., Bansal, R.K., Brahmaprakash, G.P., Potdukhe, S.R., Gundappagol, R.C. and Gaikawad, B.G., 2011. Biofertilizer technology and pulse production. In Bioaugmentation, biostimulation and biocontrol (pp. 43-63). Springer, Berlin, Heidelberg. 7. Tripathi, D.P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 8. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore.	
Course Outcomes	On completion of the course, students should be able to CO1: Evaluate Knowledge and techniques of Biofertilizers CO2: Understandthe various processing Technologies of Azolla cultivation CO3: Evaluate the process of information about mushroom biology: CO4: Validate the importance of tropical mushroom cultivation technology CO5: Identify Nutrient profile of Mushrooms	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2

Semester	**SECOND**	Course Code	**24MIBP0VA1**
Course Title	**VALUE ADDED COURSE RURALENTREPRENEURSHIP**		
No. of Credits	**3**	No. of contact hours per Week	**3**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum20%)	20%
Category	Core Course		
Scope of the Course	1. Basic understanding on basic concepts in rural biotechnology 2. Skill development for mushroom culture and *Spirulina* cultivation technology 3. Creates employability scope		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in rural biotechnology K-2 Comprehensive knowledge on biogas technology K-3 Use techniques for composting K-4 Capacity to analyze the Spirulina cultivation technology K-5 Make newer approaches to mushroom culture technology K-6 Assessment of Ornamental Fish culture technology		

Course Objectives (Maximum:5)	**The course aims to:** • to create interest on the fundamentals of biogas technology • to expose the technologies related to composting • to impart information on scope of mushroom culture technology • to impart knowledge on *Spirulina* cultivation technology • to know Ornamental Fish culture technology

UNIT	Content	No. of Hours
I	**Biogas technology** Introduction and history – anaerobic digestion – microbes involved – factors influencing methane production – Stages of methane generation – Wastes used in methanogenesis – various bioreactors used for methane generation – Advantages and disadvantages.Visit to biogas production units with field demonstration.	7
II	**Composting technology** Historical background – waste availability – factors influencing – methods- biomaturity-enrichment of Compost and crop productivity. Vermiculture Technologies: History – species – life cycles – methods – different types of waste suitable for vermicomposting. Utilization of vermicompost for crop production. Visit to vermicompost industries with field demonstration.	7
III	**Mushroom technology** Bioconversion of organic wastes into protein - Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, post-harvest technology. Mushroom farming and prospects. Visit to mushroom farms with field demonstration.	6
IV	**Spirulina cultivation technology** Biology of *Spirulina* - cultivation methods, post-harvest technology and single cell protein formulation. Visit to *Spirulina* industries with field demonstration.	6
V	**Ornamental Fish culture** National and international status-Importance-Selection of ornamental fishes-Commercially important fresh water and marine ornamental fishes- Setting and maintenance of aquarium tanks-Kinds of feeds and feeding methods- – breeding techniques of egg layers – gold fish, angel fish, fighter and barbs – live bearers – guppy, molly, platy and sword tail – economics. Visit to ornamental fish farms with field demonstration.	6
References	**Text Books:** 1. Tripati, G. 2003. Vermiresources technology, 1st Ed., Discovery Publication House, New Delhi. 2. Anita Saxena, 2003. Aquarium management. Daya Pub. House, New Delhi. 3. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt.Ltd., New Delhi. 4. Kumar, H.D., 1991. A Textbook on Biotechnology, II Edition, East-west Press Pvt. Ltd., New Delhi. 5. Chawla O.P. 1986. Advances in Biogas Technology, ICAR, New Delhi. **References:** 1. Srivastava, C.B.L, 2002. Aquarium fish keeping. Kitab Mahal, Allhabad. 2. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by 3. Improved Methods, 1st print, ICAR, New Delhi. 4. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 5. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 6. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 7. Bahl, N. 1988. Handbook on mushrooms. Oxford &IBH Publishing Co., Pvt. Ltd., New Delhi.	
Course Outcomes	**Upon completion of this course, students should be able:** CO1: Evaluate the different aspects of biogas production technology CO2: Discuss the different types of composting technologies and how to establish a composting unit CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: Immerse Spirulina cultivation by low-cost method CO5: To culture different ornamental fish and establish an aquarium farm	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	2	2
CO2	3	1	1	2	2
CO3	3	1	1	2	2
CO4	3	1	1	2	2
CO5	3	1	1	2	2

Semester	**SECOND**	Course Code	**24MIBP0VA2**
Course Title	**VALUE ADDED COURSE FOOD MICROBIOLOGY**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum 20%)	**25%**
Category	Core Course		
Scope of the Course	❖ Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products ❖ Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food quality analysis K-4 Capacity to analyze the role of government organizations involved in food quality control K-5 Make new techniques to study food spoilage organisms and Food bornediseases K-6 Assessment of quality and safety assurance in the food industry		
Course Objectives (Maximum:5)	The Course aims to: • introduce the scope and development of food microbiology • highlight fermentation technologies in the food processing industry. • create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control. • give an overview on food spoilage organisms- Food borne diseases- to understand infection process and food borne outbreaks. • impart knowledge on quality and safety assurance in the food industry.		

UNIT	Content	No. of Hours
I	**Microbiology of Foods** History - Importance of food microbiology- Factors influencing the microbial growth in food. (Intrinsic and Extrinsic parameters). Sources of food borne microorganisms found in food.	**7**
II	**Food poisoning and Food-borne diseases** Food infection and Food intoxication. Food borne diseases: Salmonella spp., Staphylococcus spp., and Clostridium spp., infections and mycotoxins, viral and parasitic food borne diseases. - Microflora of milk and sources of contamination.	**7**
III	**Microbial fermentations** Alcoholic Beverages- wine and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented food - Sauerkraut preparations, Fermented milk products: Buttermilk, Yogurt, Cheese and Kafir. -Single cell protein.	**7**
IV	**Food processing and preservation (Source NPTEL course)** Aseptic handling, pasteurization of milk. Methods of food preservation - Physical: radiation, irradiation, drying, chilling and freezing, high pressure. Chemicals: organic acids, nitrates, nitrites & cresols; Biological: Probiotics and bacteriocins.	**7**

V	**Quality and safety assurance** Quality and safety assurance in food and dairy industry. Good manufacturing practice, FDA, BIS, WHO, FSSAI, Hazard Analysis and Critical Control Point (HACCP) concept.	**6**
References	**Text Books:** 1. Carl, A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press, London. 2. Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd., New Delhi. 3. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 4. Jay, J.M.2000 Modern Food Microbiology 6th Ed. Aspen Publication, USA. 5.Joshi V. K and Ashok Pandey. 1999. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. (VOL II).	
	Reference Books: 1. Britz, T.J. and Robinson, R.K.2008 Advanced Dairy Science and Technology Blackwell publ., U.K. 2. Hobbs,B.C. andRoberts. 1993.Food Poisoning and Food Hygiene, Edward Arnold (A Division of Hodder and Slough ton), London. 3. Salle, AJ. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill, Publishing Co. Ltd., New York. pp: 710-793. 4. Robinson, R.K. 1990. Dairy Microbiology, Elsevier Applied Sciences, London Banwart,GJ.Basic Food Microbiology, CBS Publishers and Distributors.	
	Web resources: 1. http://www.microbes.info 2. http://www.fsis.usda.gov/ 3. http://www.cdc.gov. 4. http://www.microbes.info/ resource/food microbiology 5. http://www.binewsonline.com/1/what is food microbiology.html	
Course Outcomes	On completion of the course, students should be able CO 1: Explain the role of microorganisms in food (beneficial as well as harmful) and the factors influencing their growth. CO2: Discuss and demonstrate processing and preservation of perishable food products and understand the microbial hazards involved CO3: Assess the techniques/processes used in microbial products using fermentation technology. CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	2	3	2
CO2	3	3	3	3	3
CO3	3	2	1	3	3
CO4	3	3	3	3	3
CO5	2	3	3	2	1

Semester	**SECOND**	Course Code	**24MIBP0VA3**
Course Title	**VALUE ADDED COURSE BIOFERTILIZERS AND MUSHROOM TECHNOLOGY**		
No. of Credits	**2**	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20%
Category	Core		
Scope of the Course	1. Understand the concepts biofertilizers and Mushroom production		

(may be more than one)	2. Utilize the various methodologies of biofertilizers and Mushroom for income generation. 3. Comprehend the information on the techniques and motivate the students to become Entrepreneur and Industrialists
Cognitive Levels addressed by the Course	K1- Inculcate the advancement of biofertilizers and Mushroom production K2- realize the various techniques involved in biofertilizers and Mushroom cultivation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of biofertilizers and Mushroom cultivation K5- Motivate the people to become biofertilizers and Mushroom cultivation Entrepreneur and Industrialists
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate Knowledge and techniques of Biofertilizers • To understand the various processing technologies of Azolla cultivation • To evaluate the process of information about mushroom biology: • To validate the importance of tropical mushroom cultivation technology • To identify Nutrient profile of Mushrooms

Unit	Content	No. of Hours
I	**Introduction Biofertilizers** Introduction, scope. A general account of plant growth promoters and regulators – Cyanobacterial Biofertilizer: Algalization – mass cultivation of cyanobacterial biofertilizers. Nitrogen fixing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Rhizobium and Azospirillum.	12
II	**Mass cultivation of Azolla, Phosphobacteria and Mycorrhiza** Structure and Morphology – Mass cultivation method and Application. Economic and Ecological importance of Azolla. Phosphate solubilizing Bacteria: Isolation, characterization, identification, mass cultivation and inoculation method of Phosphobacteria. Biochemistry of Phosphate solubilization and mobilization. Mycorrhizal fungi as biofertilizers.	15
III	**Introduction to mushroom biology:** characteristics, importance of mushrooms - as food, tonics and medicines. Different parts of a typical mushroom. Key to differentiate edible from poisonous mushrooms. phases of mushroom technology - pure culture, spawn, preparation of compost, mushroom development	10
IV	**Prospects of tropical mushroom cultivation technology**: Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, postharvest technology. Mushroom farming and prospects.	14
V	**Nutrient profile of Mushrooms;** Protein, aminoacids, calorific values, carbohydrates, fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus. Health benefits: antiviral value, antibacterial effect, antifungal effect, anti-tumour effect,haematological value, cardiovascular and renal effect.	13

References

Reference Books

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	Biofertilizers toward sustainable agricultural development. Plant microbe symbiosis. Springer, Cham, pp.115-128. 8. Dudeja, S.S., Singh, N.P., Sharma, P., Gupta, S.C., Chandra, R., Dhar, B., Bansal, R.K., Brahmaprakash, G.P., Potdukhe, S.R., Gundappagol, R.C. and Gaikawad, B.G., 2011. Biofertilizer technology and pulse production. In Bioaugmentation, biostimulation and biocontrol (pp. 43-63). Springer, Berlin, Heidelberg. 10. Tripathi, D.P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 11. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 12. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd., New Delhi. 13. Bahl, N. 1988. Handbook on mushrooms. Oxford &IBH Publishing Co., Pvt. Ltd., New Delhi.
Course Outcomes	On completion of the course, students should be able to CO1: evaluate Knowledge and techniques of Biofertilizers CO2: understand the various processing Technologies of Azolla cultivation CO3: evaluate the process of information about mushroom biology: CO4: validate the importance of tropical mushroom cultivation technology CO5: identify Nutrient profile of Mushrooms

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2

Semester	**SECOND**	Course Code	**24MIBP0VA4**
Course Title	**VALUE ADDED COURSE INDUSTRIAL MICROBIOLOGY**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course/ Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum20%)	**20**
Category	Core Course		
Scope of the Course	1. Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries 2. Students can execute Projects on the microbial fermentations		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in Industrial microbiology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives (Maximum:5)	The Course aims to: • understand industries involving microbial technology • make knowledge on production of various industrial microbial products. • know the various techniques used in industries. • impart the functioning of bioreactors • create a comprehensive knowledge on upstream and downstream processing		

UNIT	Content	No. of Hours
I	**History and Fermentor *(source NPTEL)*** Introduction- Fermentor -Structure, and components - Agitator, Aerator, Valves, Steam traps and Stirrer. Measurement Parameters Temperature, Pressure, pH, DO. Fermentor - types - design - mode of operation. Fermentation process- upstream and downstream.	13
II	**Screening methods for Industrial microbes** Detection and assay of fermentation products - Fermentation types - batch, fed batch, continuous and solid state. Strain selection and improvement - mutation and recombinant DNA technique for strain development.	13
III	**Biology of Industrial important Microorganisms** Large scale cultivation of Industrially important microbes - Bacillus, *Penicillium and Streptomyces.* Fermentation media - media formulation strategies - carbon, nitrogen, vitamin and mineral sources, role of buffers, precursors, and antifoams agents.	13
IV	**Industrial production** Recovery and purification of intracellular and extra cellular fermented products – cell disruption, centrifugation, filtration, precipitation, solvent extraction and drying. Microbiological assay of antibiotics and vitamins. Antigens, antibodies, vaccine, insulin, toxin, toxoid.	13
V	**Rules and regulation** Newer Approaches to Industrial waste and sewage treatment and disposal. Institutional Biosafety Committee.	12
References	**Text Books:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi. 4. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 5. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited	
	Reference Books: 1. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed., Pergamon Press. 2. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 3. Casida, L.E. 1986. Industrial Microbiology, Eastern Limited, New York.	
	E-Resources: 1. www.rmit.edu.au/courses/034150 2. microbiologyonline.org 3. https://www.omicsonlineorg/industrial-microbiology-journals-articles-ppt-list.php 4. www.nature.com/nrmicro/series/applied and industrial	
Course Outcomes	On completion of the course, students should be able CO1: Discuss historical aspects of industrial microbiology and fermentation techniques CO2: Compare screening methods for Industrial microbes CO3: Explain the biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial microbiology	

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	3
CO2	3	3	3	3	3
CO3	1	3	3	2	3
CO4	3	2	3	3	3
CO5	3	2	3	3	2