M.Sc., MICROBIOLOGY PROGRAMME
SCHEME OF EXAMINATION

S. No	Sem.	Course Code	Course Title	Nature of the Course	C	L	P	E	CFA	ESE	Total Marks
1.1	I	21MIBP0101	General Microbiology	Major	4	4	-	3	40	60	100
1.2		21MIBP0102	Microbial Taxonomy and Diversity	Major	4	4	-	3	40	60	100
1.3		21MIBP0103	Biochemistry	Major	4	4	-	3	40	60	100
1.4		21MIBP0104	Molecular Biology	Major	4	-	4	3	40	60	100
1.5		21MIBP0105	Practical-1: General Microbiology, Microbial Taxonomy and Diversity	Major	2	-	4	3	60	40	100
1.6		21MIBP0106	Practical-2: Biochemistry and Molecular Biology	Major	2	4	-	3	60	40	100
1.7		21GTPP0001	Gandhi in Everyday Life	-	2	2	-	-	50	-	50
				Total	**22**	**18**	**08**				
2.1	II	21MIBP0207	Microbial Physiology and Development	Major	4	4	-	3	40	60	100
2.2		21MIBP0208	Environmental and Agricultural Microbiology	Major	3	3	-	3	40	60	100
2.3		21MIBP0209	Virology	Major	3	3	-	3	40	60	100
2.4		21MIBP0210	Biostatistics	Major	4	4	-	3	40	60	100
2.5		21MIBP0211	Practical -3: Microbial Physiology & Development	Major	2	-	4	3	60	40	100
2.6		21MIBP0212	Practical - 4: Environmental and Agricultural Microbiology	Major	2	-	4	3	60	40	100
2.7		-	Elective: Generic	Generic Elective	3	3	-	3	40	60	100
2.8		21ENGP00C1	Communication and Soft Skills	Soft Skills	2	2	-	-	50	-	50
2.9		21MIBP0213	Summer Internship / Mini Project (15 to 30 days during II -Semester Break)	Major	1	-	-	-	50	-	50
				Total	**24**	**19**	**08**				
3.1	III	21MIBP0314	Bioinstrumentation and Research Methods	Major	4	4	-	3	40	60	100
3.2		21MIBP0315	Immunology &Immunotechnology	Major	4	4	-	3	40	60	100
3.3		21MIBP0316	Medical Microbiology	Major	4	4	-	3	40	60	100
3.4		21MIBP0317	Practical -5: Bioinstrumentation	Major	2	-	4	3	60	40	100
3.5		21MIBP0318	Practical -6: Immunology and Medical Microbiology	Major	2	-	4	3	60	40	100
3.6		21MIBP03DX	Elective : Discipline Centric	Discipline Centric Elective	3	3	-	3	40	60	100
3.7		21MIBP03MX	Modular Course	Modular	2	2	-	-	50	-	50
3.8		21MIBP03 F1	Field visit /Industrial Visits	Major	1	-	2	-	50	-	50
3.9		21EXNP03V1	Village Placement Programme	VPP	2	-	-	-	50	-	50
				Total	**24**	**17**	**10**				
4.1	IV	21MIBP0419	Food Microbiology	Major	4	4	-	3	40	60	100
4.2		21MIBP0420	Industrial Microbiology	Major	4	4	-	3	40	60	100
4.3		21MIBP0421	Microbial Biotechnology and Genetic Engineering	Major	4	4	-	3	40	60	100
4.4		21MIBP0422	Practical -7: Food, Industrial Microbiology and Microbial Biotechnology	Major	2	-	4	3	60	40	100
4.5		21MIBP04MY	Modular Course	Modular	2	2	-	-	50	-	50
4.6		21MIBP0423	Dissertation	Major	6	-	10	-	75	75^{*+} 50^{**}	200
4.7		21GTPP00H1	Human Values and Professional Ethics	-	2	2	-	-	50	-	50
				Total	**24**	**16**	**14**				
			Grand Total Credits		**94**						

PROGRAMME EDUCATIONAL OBJECTIVES(PEO)

PEO 1: To gain technical aptitude and in-depth knowledge in the relevant discipline
PEO2: To independently carry out practicals, research and interpret the results scientifically
PEO 3: To utilize the skills developed for gainful employment
PEO 4: 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.
PEO 6: To preserve, add to and transmit knowledge.

PROGRAMME OUTCOME (PO)

PO 1: Become knowledgeable in the subject and apply the principles of the same to the needs of the subject of the Employer/Institution/Enterprise/Society.
PO 2: Gain analytical skills in the field.
PO 3: Be able to design/ conduct investigations and develop solutions to solve problems usingappropriate tools.
PO 4: Use knowledge gained from public health and safety, cultural, societal and environmental needs which are friendly and sustainable.
PO 5: 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 ofM.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**	**2021**
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**	

#Courses may be offered under MOOC/NPTEL based on availability online and the syllabus will be modified as perMOOC/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)**
21MIBP03D1 Microbial Nanotechnology	21MIBP03M1 Advanced Molecular Techniques	21BIOP02G1 Food Microbiology
21MIBP03D2 Microbial Genetics	21MIBP03M2 Bioinformatics	21BIOP02G2 Industrial Microbiology
21MIBP03D3 **G**enetic Engineering and Applications	21MIBP04M1 Rural Biotechnology	21BIOP02G3 Biofertilizer and Mushroom technology
--	21MIBP04M2 Intellectual Property Rights	21BIOP02G4 Rural Biotechnology

VALUE ADDED COURSE (21MIBP0VA)

Course Code	**Course Title**	**Credit**
21MIBP0VA1	Rural Biotechnology	2
21MIBP0VA2	Food Microbiology	2
21MIBP0VA3	Biofertilizer and Mushroom technology	2
21MIBP0VA4	Advanced Molecular Techniques	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 and Applications	--
4. Biochemistry	8. Biomathematics	--

Semester	**FIRST**	Course Code	**21MIBP0101**
Course Title	**GENERAL 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%)**	20%
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 culture techniques ❖ Creates employability scope in microbiological laboratories / hospitals / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember historical and recent developments in microbiology 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 and monitoring of Extremophilic microorganisms		
Course Objectives	The course aims to: • enhance the student's knowledge in historical aspects and microscopic techniques • acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes. • develop knowledge in microbial control techniques • make the students knowledgeable on the various cultural techniques involved in the microbiological lab • give an overview on microbial ecology-microbial habitats, their interactions and extremophilic microorganisms		

UNIT	Content	No. of Hours
I	**History and Microscopy** Historical and recent developments -Scope of microbiology- Spontaneous generation and germ theory of disease - Major contribution of scientists– – Leeuwenhoek, Edward Jenner, and Alexander Fleming, Joseph Lister, Robert Koch and Louis Pasteur. Modern Microbiology - Landmark achievements in 20th century –Microscopy: Simple, Compound, Dark field, Phase contrast, Fluorescence and Electron microscopy.	13
II	**Prokaryotic and Eukaryotic Cell *(Source NPTEL course)*** Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Cilia, flagella, cytoskeleton, cytomembrane systems, mitochondria and chloroplast Comparison of Prokaryotic and Eukaryotic cell.	13
III	**Microbiological Techniques I** Microbial control – Physical methods - Heat, (Low & High temperatures), Filtration, high pressure, Osmotic pressure, Radiation, and Desiccation. Chemical methods – chemical agents, types and mode of action- Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value).	13
IV	**Microbiological Techniques II *(Source NPTEL course)*** Cultural techniques: pure culture techniques, types of media - media preparation - preservation of cultures - aerobic and anaerobic culture techniques - growth of bacteria: batch and synchronous culture - factors influencing growth - pH, temperature, substrate and osmotic condition. Growth curve-Microbial nutrient -macro nutrients, micronutrients, growth factors and sources of nutrients- Methods to study microbial morphology - wet mount and hanging drop method. Staining techniques - Gram's, acid fast, spore and capsule staining.	13

V	**Microbial Ecology** Microbial habitat- An overview, the niche, aquatic habitats (marine and fresh water)-soil habitats-subsurface and atmospheric. Microbial Interactions- neutralism, mutualisms, commensalisms, competition, amensalisms, parasitism, predation, antagonism, syntrophism and symbiotic associations. Extremophilic microorganisms – physiology and molecular adaptations in thermophilic, alkaliphilic, acidophilic, osmophilic, Piezophilic and psychrophilic microbes. Applications of extremophilic microorganisms.	12
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. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 2. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi.. 3. Hans G. Schlegel. 2012(Reprint). General Microbiology. VII Ed. Cambridge University Press. UK. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 5. John L. Ingrahm and Catherine Ingrahm.. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA. 6. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed. WCB/McGraw Hill Company. 7. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms: Milestones in Microbiology. Prentice-Hall International Inc. London. 8. Talaro, K and Talaro, A. 1996. Foundations in Microbiology, 2en Ed., Wm. C. Brown publishers, Toronto. 9. Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press. **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 thehistorical aspect CO2: Identify key organelles and their functions in both eukaryotes and prokaryotes CO3: Describe how to control microorganism and the factors affecting the growth of microbes. CO4: Demonstrate the different cultural techniques in microbiology CO5: Explain the interactions and characteristics of 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	**21MIBP0102**
Course Title	**MICROBIAL TAXONOMY AND DIVERSITY**		
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 (May be more than one)	• Students will be able to develop their skills on taxonomy and diversity of different microorganisms. • Students can execute field projects on the diversity of microorganisms		
Cognitive Levels addressed by the course	K-1: Remember taxonomy of microorganisms K-2: Understand methods of classification K-3: Apply in the field study K-4: Analyze characteristics of different groups of microorganisms K-5: Evaluate applications of diversified microorganisms K-6: Create knowledge on microbial taxonomy and diversity		
Course Objectives	The course aims to: • make the students to understand the taxonomy of microorganisms. • make the students understand the various classification types. • make the students knowledgeable on the different aspects of the classification of Prokaryotes and Eukaryotes and diversity of microbes. • in-depth an on knowledge on the different groups and species of microbes • understand the importance of different microbes		

UNIT	Content	No. of Hours
I	**Microbial Taxonomy &General Classification** ***(Source NPTEL course)***Introduction to microbial taxonomy – morphological taxonomy, biochemical taxonomy, molecular taxonomy, numerical taxonomy – basic concepts of taxonomy. Types of rRNA, Importance of 16S rRNA in microbial identification and taxonomy. Positive and negative aspects of each taxonomical method. Generalprinciplesofclassificationofmicroorganisms–Haekel'sthreekingtomconcept – Whittaker'sfivekingdomconcept–threedomainconceptofCarlWoese.Evolutionarymethods in classification - International codes of nomenclature - Phylogentic tree construction–Briefoutlineon metagenomics.	13
II	**Virology** Salient features and classification of viruses. Nature and properties in relation to classification. Structure and in-depth study of T4, TMV, M13 and HIV. Brief outline on Satellite, Satellites virus, Virusoids, Viroids and Prions.	13
III	**Bacteriology** Salientfeaturesandclassificationofbacteria - Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists-Classification based on Bergey‟s manual (Determinative & Systematic Bacteriology). *In-depth study of E. coli, Rhizobium sp., Rhodomicrobium sp., Methanobacteriasp., and Cyanobacteria.*Economicimportanceofbacteria.	13
IV	**Phycology and Mycology** Classification and salient features of algae – nutrition, thallus characteristics and reproduction. Characteristics of green algae, diatoms, euglenoids, brown Rhodophyta, pyrrophyta. Economic importance of algae. Classification and salient features of fungi: *Myxomycetes, Ascomycetes*, *Basidiomycetes, Deuteromycetes, Zygomycetes,* Acrasiomycetesand *Oomycetes*. Economic importance of fungi.	14
V	**Protozology** Principles and outline classification of protozoa: Sarcodina, Mastigophora, Ciliata and Sporozoa. Structure and in-depth study of *Entamoeba histolytica and Plasmodium vivax.*	11
References	**Text Books:** 1. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig. (2000). Microbiology. V Ed. Tata McGraw Hill Book Company. 2. Alexopoulos, C.J. and Mims, C.W. (1979). Introductory Mycology, John Wiley, New York. 3. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed. WCB/McGraw Hill Company. pp: 335 to 553. 4. John G. Holt. 1994. Bergey's Manual of Determinative Bacteriology. Lippincott Williams and Wilkins. Pp: 351-352; 597-724. 5. Dubey H. C. 1978. A Textbook of Fungi, Bacteria and Viruses. Vikaas Publishing House Ltd. Ltd. Pp: 1-341. **Reference Books:** 1. Jeffery C. Pommerville (2016). Alcamo's Fundamentals of Microbiology (Third Edition). Jones and Bartlett Learning. LLC, Burlington, MA 01803. 2. HansG. Schlegel. 2012. General Microbiology. VII Ed. Cambridge University Press. UK. 3. S. Biwasis and Amita Biswas. 1998. An Introduction to Viruses. Vikaas Publishing House Pvt. Ltd. Pp: 1-17; 209 – 224.	

	4. Chatterjee, K. D. 1981. Parasitology. Chatterjee Medical Publishers. Pp: 1-106. 5. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms: Milestones in Microbiology. Prentice-Hall International Inc. London. **Web resources:** 1. http://www.microbiologyonline.org.uk/links.html 2. http://www.bac.wise.edi/microtextbook/index.php 3. http://www.microbeworld.org.uk 4. http://www.staff.ncl.ac.uk/n.y.morris/lectures/class2007.html
Course Outcomes	**On completion of the course, students should be able to:** CO 1: Outline the classification of prokaryotes and eukaryotes CO2: Evaluate the basic principles and methods hsed for theclassificationofvirusesand an in-depth knowledge on T_4, λ, M_{13} and HIV CO3:Assess the basic principles and methods for the classification of bacteria and an in-depth knowledge on *E. coli, Rhizobium* sp.,*Rhodomicrobium*sp.,*Methanobacteria*sp.*, and* Cyanobacteria CO4: Explain the basic principles and methods of classification of algae and fungi an an in-depth knowledge on *Aspergillus* sp.*, Candida* sp.*, Mucor* sp.,and*Agaricus*sp.*,* green algae, diatoms, euglenoids, brown rhodophyta and pyrrophyta. CO5: Discuss the basic principles and methods of classification of protozoa and an in-depth knowledge on *Entamoeba histolytica and Plasmodium vivax.*

Mapping of COs with PSOs:

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

Semester	**FIRST**	Course Code	**21MIBP0103**
Course Title	**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%)**	100%
Category	• Core Course		
Scope of the Course (May be more than one)	❖ Basic understanding on the various biological molecules and their importance ❖ Skill development for analysis of enzymatic reaction ❖ 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 analyse 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 • highlight the salient feature on the structural and chemical properties of various biological molecules • 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	**Introduction** Chemical elements – Structure of atoms, molecules and chemical bonds, chemical reactions. Water – structure, physical and chemical properties. Composition of living matter, biochemistry of bacterial, animal and plant cell. Structure and function of cellular constituents. Applications of biochemistry in medicine, nutrition and agriculture.	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 – aminoacids;, 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. Structural features and chemistry of antibiotics, pigments and other secondary metabolites	13
III	**Enzyme classification and catalysis** Enzymes as biocatalysts, enzyme classification, 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, kinetic analysis of allosteric enzymes, principles of allosteric regulation.	13
IV	**Cellular metabolism and regulation** Cell metabolism: Basic principles – anabolism and catabolism. Hormone regulation of metabolism. Biosynthesis of macromolecules: synthesis of carbohydrates, nucleic acids (salvage and de novo pathway), protein and lipids (Triglyceride synthesis). Break down of carbohydrates (Glycolysis, Pentose – Phosphate pathway, Krebs cycle), lipids (β – oxidation), proteins (aminoacid oxidation, Glucogenic, ketogenic, urea synthesis) and nucleic acids., vitamins and their role as coenzymes.	14
V	**Bioenergetics** Bioenergetics and strategy of metabolism: flow of energy through biosphere, strategy of energy production in the cell, oxidation — reduction reactions, coupled reactions and group transfer, ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction, G, Go, G and equilibrium, 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. **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 StryerStryer (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. 5. 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	**21MIBP0104**
Course Title	**MOLECULAR BIOLOGY**		
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)	❖ Basic understanding on the molecules of life ❖ Developing skills to for analysis mutagenesis ❖ Creates employability scope in the molecular screening laboratories		
Cognitive Levels addressed by the course	K-1 Ability to remember historical developments of molecular biology K-2 Comprehensive knowledge on molecules of life K-3 Use molecular techniques for better understanding of structures of DNA, RNA and Proteins K-4 Capacity to analyse mutagenesis and molecular recombination 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 molecular biology and molecules of life • 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 Molecular Biology** Introduction and historical development - Central dogma of Molecular biology. The Logic of molecular biology – the efficient argument, examination of models and strong inference. Molecules of life – DNA world – RNA world and protein world. Prokaryotic and Eukaryotic Chromosome organization. Genes – definition, types and functional organization. Fine structure of gene - Benzers classical studies on rII locus. Structure of DNA -primary, secondary and different forms (A, B & Z). Gene transfer mechanism- bacterial transformation, conjugation and transduction.	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, plant mutants and animal mutants. Recombination at the molecular level. Crossing over during cell divisionbreakage 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.bacteriophageλ; 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 Ø174 DNA replication- DNA damages – DNA repair mechanism – photoreactivation, excision repair, recombinant repair and DSOS function.	13
IV	**Transcription** Basic factors of RNA Synthesis - RNAploymerases – 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 structure and capping -biochemistry of ribozyme (hammerhead, hairpin, and other ribozyme) – strategies for designing ribozymes – applications of antisense and ribozyme technologies.	13
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, ara, and his operons; global nutrient (carbon, nitrogen) status sensing mechanisms – link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene	12

	expression. Functional genomics, Validation of gene function. Gene silencing, PTGS, RNai, Antisense technology, Applications. Molecular Pharming. Genome Editing tools- ZFNs, TALENs and CRISPR-Cas9.	
References	**Text Books** 1. David Freifelder, 2020, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 2. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017. Lewin's Genes XII Oxford University Press. 3. Lansing M. Prescott, John P. Harley and Donald A. Klein(2008). Microbiology(7th Ed.). Mc Graw Hill companies. 4. H.D. Kumar, 1993, Molecular Biology & Biotechnology, Vikas publishing house Pvt. Ltd., New Delhi. **References** 1. R.F. Weaver and P.W. Hedrick 1992, Genetics Wh.C. Brown publishers, Dubuque. 2. E.J. Gardner, M.J. Simmons, D.P. Snustad, 2006. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York. 3. Buchanan, Gruissum and Jones, (2000). Biochemistry and Molecular Biology of Plant; ASPP, USA. 4. David Rawn(2012). Biochemistry. Panima Publishers. 5. Richard Calendar (2005). The Bacteriophages, 2nd Edition, Oxford University Press. 6. Alberts et al., Molecular Biology of the Cell, Garland Publications, (2012). **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	FIRST	Course Code	21MIBP0105
Course Title	PRACTICAL-1: GENERAL MICROBIOLOGY, MICROBIAL TAXONOMY AND DIVERSITY		
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%)**	20%
Category	Core course		
Scope of the Course (May be more than one)	❖ Basic knowledge on the important aspects of microorganisms ❖ Developing skills in the isolation and handling of microorganisms ❖ 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 analyse 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.	a) Safety measures and rules of conduct to be followed in a microbiological laboratory. b) Cleaning of Glassware c) Handling and Care of Microbiological Instruments	4
2.	a) Microscopic Examination of Living Organisms – Demonstration of Motility (Hanging drop method). b) Measurement of Microorganisms using Micrometry.	4
3.	Staining Techniques – Grams staining, capsular staining, endospore staining and acid fast staining	4
4.	Preparation of Culture Media for Microorganisms. Preparation and sterilization.	4
5.	Demonstration techniques for pure culture of microorganisms- serial dilution technique, pour plate, spread plate and streak plate technique.	4
6.	Methods of culture preservation and maintenance- maintenance by sub culturing	4
7.	Enumeration and isolation of Bacteria, Fungi and actinomycetes from soil using serial dilution and plating technique.	4
8.	Isolation and identification of AM spores from soil- wet –sieving and decanting technique	4
9.	Isolation of bacteriophage from sewage sample	4
10.	Enumeration of microorganisms from Air using Air sampler	4
11.	Quality analysis of milk- Methylene blue reductase and standard plate count method	4
12.	Standard Qualitative Analysis of Water by MPN test	4
13.	Isolation of anaerobic bacteria	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. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).

Course Outcomes

On completion of the course, students should be able to:

CO 1: 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: Evaluate the microbial load in soil and food samples
CO5: Examine the microbial quality of air and water

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	21MIBP0106
Course Title	**PRACTICAL-1: BIOCHEMISTRY AND 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**(Minimum 20%)**	--
Category	Core course		
Scope of the Course (May be more than one)	❖ Basic knowledge on the measurement: criteria of reliability, precision, accuracy, sensitivity, specificity ❖ Developing skills in estimation of protein, carbohydrates, and lipids ❖ 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 albumin, bile salts and sugar in urine K-5 Make use of techniques to demonstrate antibiotic resistance mechanism K-6 Assessment of Haemoglobin, blood sugar, blood glucose and serum cholesterol		
Course Objectives	The course aims to: • impart a practical knowledge on estimation of protein, carbohydrates, and lipids • acquire practical knowledge on estimation of albumin, bile salts and sugar in urine • develop art of practical skills to estimate Haemoglobin, blood sugar, blood glucose and serum cholesterol • develop skills to demonstrate antibiotic resistance mechanism • develop skills to isolate chromosomal and plasmid DNA		

Practical	Topics covered	Hours
1.	Measurement: criteria of reliability, precision, accuracy, sensitivity, specificity	4
2.	Estimation of carbohydrates - Anthrone method	4
3.	Estimation of Proteins - Folin Lowry's method	4
4.	Estimation of lipids - Van Handel's method	4
5.	Estimation of albumin, bile salts and sugar in urine	4
6.	Estimation of Haemoglobin, blood sugar, blood glucose and serum cholesterol	4
7.	Estimation of blood urea by diacetyl monoxime (DAM) method	4
8.	Estimation of serum uric acid by Caraway method	4
9.	Estimation of vitamin - Ascorbic acid	4
10.	Isolation of chromosomal DNA from *E. coli.*	4
11.	Plasmid DNA isolation and restriction digestion.	4
12.	Estimation of DNA by spectrophotometry	4
13.	Estimation of Nucleic acids	4
14.	Spontaneous and induced mutations-isolation of antibiotic resistant and auxotrophic mutants	4

References

References:

1. Keith Wilson and John Walker. Principles and Techniques of Practical
2. Biochemistry, 4th edition, Cambridge University press, Britain. 1995.
3. Shawn O' Farrell and Ryan T Ranallo. Experiments in Biochemistry: A
4. Hands on Approach-A manual for the undergraduate laboratory, Thomson
5. Learning, Inc., Australia. 2000.
6. Strolv BA, Makavora VC. Laboratory manual in Biochemistry. MIR
7. Publisher, Moscow. 1989.
8. Oser BL Hawks. Physiological Chemistry, TATA Mc Graw Hill. 1965.
9. Short course in bacterial genetics.J.H.Miller. 1992.CSHLaboratories.
10. Methods for General and molecular bacteriology. 1994. Murray et.al. ASM Press.
11. ExperimentswithGeneFusions.1994.T.Silhavy. Cold Spring Har bourLab.Press.
12. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India.
13. Breed and Buchanan2003. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) .

Course Outcomes

On completion of the course, students should be able to:

CO1: Discuss the concepts of infection and epidemiology of communicablediseases.
CO2: Outline the diseases transmitted through Faecal-oral route.
CO3: Explain various diseases of respiratory tract.
CO4: Discuss the causative agents, symptoms, treatment, and prevention of sexuallytransmitted diseases.
CO5: Describe the causes, symptoms, treatment and control of vector borne diseases

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	**21GTPP0001**
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 • To understand and appreciate the principles and practices of Gandhi and their relevance in the contemporary times. • 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 (SarvadharmaSamabhava) - 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.
Richard Attenborough, Gandhi.

	Syam Benegal, Making of The Mahatma. Anupam P. Kher, Mein Gandhi Ko Nahin Mara. 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	21MIBP0207
Course Title	MICROBIAL PHYSIOLOGY 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)	❖ Basic understanding on the microbial physiology ❖ develop skills on microbial metabolism and its functions. ❖ 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 analyzespecial 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 and quorum sensing in different bacterial species		

UNIT	Content	No. of Hours
I	**Metabolism (source NPTEL course)** Introduction to metabolism – Anabolism versus Catabolism - specific functions – Metabolic pathways – Linear, irreversible and branched metabolic pathways – Mechanisms and the role of ATP and precursor metabolites in metabolism. ETC components – NAD, NADP, FAD, FMN, Coenyme-Q. Mechanism of ETC – Oxidative phosphorylation – chemiosmotic hypothesis and conformational change hypothesis.	13
II	**Respiration and bioenergetics** 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 - Gluconeogenesis and Calvin–Benson cycle. Basic aspects of bioenergetics – entropy – enthalpy – electron carriers – artificial electron donors – inhibitors – uncouplers – energy bond – phosphorylation.	13
III	**Special fermentations** ATP regeneration by fermentation – Starter cultures – role of starter cultures. 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** Introduction to photosynthesis – PS1 and PS2 –Factors affecting photosynthesis- Phototropic bacteria – purple sulphur bacteria, non-sulphur purple bacteria, green sulphur bacteria and cyanobacteria – Localization of the pigments – regulation of pigment. Metabolism of phototropic bacteria – CO_2 fixation, hydrogen donors, dark metabolism, photoproduction of hydrogen, Nitrogen fixation and nif genes. – Elementary processes of photosynthesis – anoxygenic photosynthesis – oxygenic photosynthesis – photosynthesis in halobacteria.	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 – Introduction, Types of Autoinducers, Acyl Homoserine Lactone Molecules, Synthesis of Autoinducers, Peptide Pheromones-Autoinducers In Gram-Positive Bacteria, Bioluminescence as a Phenotype of Quorum Sensing- The Lux System. Bioluminescent bacteria and its importance – Luciferin - Luciferase along with the lux operon (genes). Other Phenotypes in Quorum Sensing Systems.	12
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. Roger Y. Stanier., John L.Ingraham., Mark L.Wheelis., Page R.Painter., 1987. General Microbiology, V Ed., MacmillanPress Ltd., London. 4. Salle, A.J. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York. 5. Gottschalk, G. 1986. Bacterial Metabolism. II Ed. Heidelberg, Springer.	

	References 1. David L. Nelson and Michael M. Cox(2017). Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York 2. Charu Gera and S. Srivastava(2006). Quorum- sensing: The phenomenon of microbial communication, Current science. 90: 666-676. 3. Jeremy M Berg, John L Toymoczko and Lubert StryerStryer (2006). Biochemistry VI Edition. W.H. Freeman and Company, New York 4. Albert G. Moat, John W. Foster and Michael P. Spector (2002) Microbial Physiology, 4th Edn. Wiley Liss. 5. Lansing M. Prescott, John P. Harley and Donald A. Klein (2002). Microbiology. V Ed. WCB/McGraw Hill Company. 6. Fuqua W C, Winans S C and Greenberg E P (1994). Quorum sensing in bacteria: the LuxR-LuxI family of cell density-responsive transcriptional regulators, Journal of bacteriology. 176(2): 269–275.
	E-Resources: 1. http://www.microbiologyonline.org.uk/links.html 2. http://www.bac.wise.edi/microtextbook/index.php 3. http://www.microbeworld.org.uk 4. http://www.staff.ncl.ac.uk/n.y.morris/lectures/class2007.html
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 principle mechanisms of aerobic and anaerobic respiration in microorganisms. CO3: Explain the special fermentation types in specific group of microbes. CO4: Apply the principle 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	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**SECOND**	Course Code	**21MIBP0208**
Course Title	**ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**		
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%)**	--
Category	Core Course		
Scope of the Course (may be more than one)	Students will be able to develop their skills on microbes in environment and agriculture 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 andbiopesticides		
Course Objectives (Maximum: 5)	The Course aims to • To impart in-depth information on ecosystems and microbial transformations of minerals • TomakethestudentsunderstandMicrobial analysis of drinking water Waste management & Sewage Treatment &Aeromicrobiology • TogiveanoverviewonBioremediation& Microbial leaching Biosafety & Environmental monitoring • Toknowtheimportanceof Symbiotic and Non-Symbiotic nitrogen fixation and Bioinoculants production • Plantpathogenicmicroorganisms and Biopesticides		

UNIT	Content	No. of Hours
I	**Ecosystems and Microbialtransformationsofminerals** Composition of Lithosphere, Soil-Structure, Types, Physical and Chemical properties, Soil Microbiology. Factorsinfluencing soil microbial population. Rhizosphere, R:S ratio. Biogeochemicalcycles-Carbon,Nitrogen,Phosphrous,Sulphur.	13
II	**Microbial analysis of drinking water Waste management & Sewage Treatment &Aeromicrobiology** 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 organismsfor 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,*Azotobacter*sp and *Azospirillum*sp and theirfunctions - Cyanobacteria (BGA) and theirassociations in Nitrogen fixation. genetics and Biochemistryofnitrogenfixation-Factorsinfluencingnitrogenfixation – Importanceofnitrogenfixation. Bioinoculants- Phosphate solubilizing microbes. Mycorhizae and plant growthpromotingrhizobacteria(PGPR).Roleofbiofertilizers.Qualitycontrol(BISspecification).	13
V	**Plantpathogenicmicroorganisms and Biopesticides** Algal, bacterial, fungal, mycoplasma, Nematodeand viral, diseases and symptoms.DefinitionandHistoryofBiopesticides–Viral(NPV,CPV&GV),bacterial(*Bacillusthuringiensis, B.popillae& Pseudomonas* sp.), Fungal (*Entomophthora musca, Beaveria*sp.,*Metarrhizium*sp.&*Verticillium*sp.),Protozoan(*Mattesia*sp.,*Nosema*sp.,*Octosporamuscaedomesticae&Lambornella* sp.).	12

References

TextBooks:

1. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2nd edition, NewDelhi.
2. NeelimaRajvaidya and Dilip Kumar Markandey. (2006). Agricultural Applications of Microbiology, Nangia S.B. and A.P.H. publishing corporation, New Delhi
3. Gupta,S.K.2014Approachesandtrendsinplantdiseasemanagement.Scientificpublishers,Jodhpur,India.
4. Jamaluddin*etal*2013Microbesandsustainableplantproductivity.ScintificPublishersJodhpur,India. G

	5. SubbaRao,N.S.1997.BiofertilizersinAgricultureandForestry,IIIEd.,Oxford&IBHPublishingCo.Pvt.Ltd.,NewDelhi.
	Reference Books: 1.Gaur,A.C.,1999.MicrobialtechnologyforCompostingofAgriculturalResiduesbyImprovedMethods, 1st print,ICAR,NewDelhi. 2.Kannaiyan. S. (2002), Biotechnology of Biofertilizers, Alpha science international, 1stedition. 3.Glick,B.R.ANDPasternak,J.J1994.MolecularBiotechnology,ASMPress,WashingtonDC. 4.Purohit,S.S.,Kothari,P.R.andMathur1993.BasicandAgriculturalBiotechnology,AgrobotanicalPublishers (India). Bikaner. 5.Newton, W.E and Orme, Johnson, W.H.1980. Nitrogen fixation vol II: SymbioticAssociationsandCyanaobacteria.UniversityparkPressBaltimore,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 IntroductiontoPlantDisease.ELBSandJohnWileyandSons,Ltd. 8.SubbaRao,N.S.1995.Soilmicroorganismsandplantgrowth.Oxford&IBHPublishingCo.Pvt.Ltd.NewDelhi. 9.MartinAlexander1983. IntroductiontoSoilMicrobiology,Wileyeastern Ltd.,NewDelhi. 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 4.microbiologyonline.org
Course Outcomes	On completion of the course, students should be able to do CO1: UnderstandtheComposition 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 plantpathogenicmicroorganisms and biopesticides

Mapping of COs with PSOs:

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

Semester	SECOND	Course Code	21MIBP0209
Course Title	VIROLOGY		
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%)**	--
Category	Core Course		
Scope of the Course (may be more than one)	Students will be able to develop their skills on virology Students will be able to develop Employability in clinical field		
Cognitive Levels addressed by the Course	K-1: Remember Concept and scope of virology and immunology K-2: Understand Emerging viruses and challenges K-3: Apply to know immunodiagnosis of viruses K-4: Analyze newly emerging and life threatening diseases and control measures K-5: Evaluate plant, animal and bacterial viruses K-6: Create knowledge on virology		
Course Objectives (Maximum: 5)	The Course aims • The students will learn about Concept and scope of virology • The student will able to learn immunodiagnosis of viruses • The student will able to learn the basic concepts Emerging virus and challenges. • The students will learn about characterization and identification of plant viruses • The student will able to learn assay for animal and bacterial viruses		

UNIT	Content	No. of Hours
I	**Concept and scope of virology** Discovery of virus and recent development in virology. Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and enzymes. Cultivation and detection of viruses: Animal Inoculation, Inoculation into embryonated egg and Cell Culture.	13
II	**Immunodiagnosis of viruses** Hemagglutination and hemagglutination inhibition test, compliment fixation, neutralization, western blot, flow cytometry. Nucleic acid based diagnosis: nucleic acid hybridization, RTPCR, qRT, Microarray and nucleotide sequencing.	13
III	**Emerging virus and challenges** Promises and problems- Evolutionary importance of viruses: Antigenic shift, antigenic drift. Newly emerging and life threatening diseases – Ebola, Marburg, MachupoNepha, Hendra, SARS, Corona viruses, sources and causes of emergent virus diseases. The threat of bioterrorism, viruses as therapeutic agents, viruses for gene delivery, using viruses to destroy other viruses, viruses and nanotechnology.	13
IV	**Propagation, purification, characterization and identification of plant viruses:** General methods of propagation of plant viruses; purification using electrophoresis techniques. Methods employed in identification of plant viruses. Detection and diagnosis of Plant Viruses	13
V	**Infectivity assay for animal and bacterial viruses**: Plaque assay, Transformation assay, Fluorescent focus assay, Infectious centre assay, end point dilution methods, LD50, ID50, EID50, TCID50.	13

References

Text Books:

1. Martinez J. Hewlett (2018). Basic Virology, 4th Edition. Wiley, USA.
2. Dimmock, N.J., Easton, A.J., and Leppard, K.N. (2016). Introduction to Modern Virology. 7th Edition. Blackwell publishing, USA.
3. Carter J. and Saunders V. (2013). Virology: Principles and Applications, 2nd Edition. Willy, USA.
4. Flint S.J., Racaniello V.R., Enquist L.W., Rancaniello V.R., Skalka. A.M. (2015) Principles of Virology, 4th Edition, 2 Vol. American Society for Microbiology, USA.
5. Dimmock. N.J and Primrose. S.B. (1994). Introduction to Modern Virology. IV edition. Blackwell Scientific Publications, Oxford

Reference Books:

1. John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications, John Wiley & Sons, west Susscex ,England.
2. Nigel Dimmock, Andrew Easton, Keith Leppard, (2009), Introduction to Modern Virology, 6th Edition,Wiley-Blackwell.
3. John. B.C and Venetia. A.S. (2007). Virology, Principles and Applications. John Wiley and Sons limited. England.
4. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
5. Understanding Immunology (Cell and Molecular Biology in Action). (2006).; Peterwood, Pearson Education Ltd
6. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003).
7. Molecular Toxicology; Nick Plant, Garland Science (2003).
8. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 585-620.
9. Lansing. Prescott, John. P. Harley and Donald. A. Klein 1999. Microbiology. WCB McGraw

	– Hill Company. pp: 605-676. 10. Kuby, J. 1994. Immunology 2nd Ed., W.H. Freeman and Company, New York. 11.Alan J. Cann (2011) Principles of Molecular Virology, 5th edition, Elsevier 12.Kuby Immunology- 7th edition. (2013). Publisher W. H. Freeman & Company. 13.Roitt, I.M.. 1998. Essential Immunology, Blackwell Scientific Publishers.
	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 Discovery of virus and recent development in virology CO2: Understand the immunodiagnosis of viruses CO3: Understand the Promises and problems- Evolutionary importance of viruses CO4: Understand the Propagation, purification, characterization and identification of plant viruses CO5: Understand the Infectivity assay for animal and bacterial viruses

Mapping of COs with PSOs:

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

Semester	Second	Course Code	21APRP0204
Course Title	**BIOSTATISTICS**		
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. Differentiate plant and animal cells 2. Inculcate the structural organization of genes 3. Learn the Mendelian principles and inheritance of characters		
Cognitive Levels addressed by the Course	K1- Understanding basic concepts in Biostatistics K2- Comprehending statistical measures in the biological data analysis K3- Ability to interpret the statistical inference		
Course Objectives	The Course aims • to familiar with statistics and its applications in biology • to solve problems quantitatively using appropriate statistical measures • to create and interpret visual representations of quantitative information • to understand and critically assess data collection and its representation • to enhance the understanding of various rates, ratios and odds ratio.		

Unit	Content	No. of Hours
I	**Introduction to Biostatistics** Development of Biostatistics and its applications - Sources of biological data - Secondary and Primary sources - Classification and tabulation of data - frequency distribution -Diagrammatic and Graphical representation of statistical data.	12
II	**Sampling Techniques** Meaning - Advantages, concept of parameter and statistics, sample size, sampling error, sampling frame. Types of samples – Probability sampling – simple, systematic, stratified, cluster, multi-stage sampling. Non-probability sampling – Purposive, Convenience, Judgment and snowball techniques.	13
III	**Descriptive Statistics** Measures of central tendency - Mean, Median, Mode - Measures of Dispersion: –Range, Quartile Deviation, Mean Deviation, and Standard Deviation. Absolute and relative measures of dispersion. Skewness and kurtosis measures.	13
IV	**Correlation and Regression Analysis** Definition, uses, types of correlation, Regression Lines – Properties of regression lines and coefficients; Introduction to probability and its applications – Theoretical Distributions – Binomial, Poisson, and Normal distributions; Properties, uses and applications.	13
V	**Inferential Statistics and Biological Measures** Hypothesis testing and Tests of significance - Test of attributes, small and large sample tests - Analysis of variance – one-way and two-way classifications; Measurement of risk, odds ratio and Bioassay and dose responses.	13

References	
	Text Books 1. Veer Bala Rastogi, Biostatistics, Medtech publication, (3rd revised Edition), 2017. 2. Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008. 3. Sampath Kumar V.S; Bio-Statistics, ManomaniamSundaranar University Publication, Tirunelveli, 1997. 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. W.G.Cochran, Sampling Techniques, Wiley Eastern Ltd, New Delhi, (1985).
	Reference Books 1. Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020. 2. Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017. 3. Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012. 4. Rohatgi, V. K. and A. K. md.EhsanesSaleh(2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi. 5. Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004.
	E-Resources 1. https://www.biostat.washington.edu/about/biostatistics 2. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics 3. https://www.edx.org/course/biostatistics-0
Course	On completion of the course, students should be able to

Outcomes	CO1:	Get acquainted with basic concepts of statistics and its relevance with thecore subject.
	CO2:	Visualization of biological data using diagrams, charts and graphs.
	CO3:	Analyze the different sample characteristics using descriptive statistics.
	CO4:	Observe and interpret the relationship between various biological parameters.
	CO5:	Calculate and interpret regression estimates made on biological data.

Mapping of Cos with PSOs

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

Semester	**SECOND**	Course Code	**21MIBP0211**
Course Title	**PRACTICAL -3: MICROBIAL PHYSIOLOGY ANDDEVELOPMENT**		
No. of Credits	2	No.ofcontacthoursperWeek	4
New Course/ Revised Course	RevisedCourse	Ifrevised,PercentageofRevisioneffected**(Minimum20%)**	20%
Category	• CoreCourse		
ScopeoftheCourse	❖ Basic understanding on the microbial physiology ❖ develop skills on microbial metabolism and its functions. ❖ Creates employability scope in fermentation and pharmaceutical industries.		
Cognitive LevelsaddressedbytheCourse	K-1 Ability to remember basic concepts in microbial growth K-2 Comprehensive knowledge on effects of environmental factors on growth of bacteria K-3 Use biochemical and cultural techniques to study microbial identifications K-4 Capacity to analyze antimicrobial studies K-5 Make new techniques to produce microbial enzyme K-6 Assessment of spore germination		
Course Objectives(Maximum:5)	The course aims • to impart a practical knowledge on how to measure bacterial growth curve and calculate generation time • to demonstrate through experiments the effects of environmental factors on growth of bacteria • to identify unknown bacteria and fungi based on biochemical and culture characteristics • to perform antimicrobial assay to estimate and quantify various biomolecules		

UNIT	**Content**	**No.ofHours**
1	Study and plot the of growth curve of bacteria (*E.coli*) by turbidometric and also standard plate count techniques	4
	Direct cell/spore counting by Haemocytometer.	4
	Effect of temperature on growth of *E. coli*	4
	Effect of pH on growth of *E. coli*	4
5	Effect of carbon and nitrogen sources on growth of *E.coli*	4
6	Effect of UV light & heavy metals on the growth of*E.coli*	4
7	Demonstration of TDP and TDT of an organism E.coli	4
8	Genus identification of unknown bacterial strains using the Bergey's Manuals: 8.1. IMVIC test for enteric bacteria 8.2. H_2O_2 production by catalase and Oxidase activity 8.3. Urease production and Gelatin hydrolysis bybacteria. 8.4. Nitrate Reductase activity. 8.5. Triple Sugar Iron agar test. 8.6. Carbohydrate fermentation	4
9	Test for antimicrobial property [Kirby-Bauer method] by disc diffusion method Determination of MIC of an antibiotic.	4
10	Genus Identification of an unknown fungi and measurement of fungal growth by centrifugal method	4
11	Production of amylase by *Bacillus* Sp.	4
12	Spore germination study	4

References	**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. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
CourseOutcomes	Upon completion of this practical course, students should be able to: CO 1: Explain bacterial growth curve and generation time CO 2: Demonstrate the effects of environmental factors on growth of bacteria CO 3: Identify unknown bacteria and fungi based on biochemical and culture characteristics CO 4: Assess the antimicrobial property CO5: Estimate and quantify various biomolecules following standardProcedures.

Mapping of COs with PSOs:

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

Semester	SECOND	Course Code	21MIBP0212
Course Title	PRACTICAL -5: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY		
No. of Credits	2	No.ofcontacthoursperWeek	4
New Course/ Revised Course	New Course	Ifrevised,PercentageofRevisioneffected **(Minimum20%)**	--
Category	CoreCourse		
ScopeoftheCourse(maybemorethanone)	• Students will be able to develop their skills on environmental and agricultural microbiology • Students can execute FieldProjects on the environmental pollution and agriculture		
Cognitive Levelsaddressedbythe Course	• K-1:Rememberisolationandcharacterizationofmicrobesimportantin environment and agriculture • K-2:Understandtheenvironmental pollution and plant-pathogeninteraction • K-3:(Apply potentialbiofertilizers 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)	TheCourseaims • To understand the microbes present in different environment • To understand the role of microbes in environmental pollution management • Toprovidepracticalknowledgeintheisolationandcharacterizationofmicrobesimportantin agriculture. • Tounderstandtheplant-pathogeninteraction • Tobeabletoisolateorganismsthathavepotentialasbiofertilizers		

S. No.	Content	No.ofHours
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.	DemonstrationofWinogradskycolumn	6
7.	Isolation of Rhizobium from soil and root nodules and authenticationofbybiochemicalandbyplantinfectiontest(tubesandLeonardjarexperiment)	6
8.	Isolation of bioinoculants from soil a.*Azotobacter* sp. b.*Azospirillum* sp. c.AM Fungi d.Cyanobacteria e.Phosphobacter	6
9.	Studythegrowthresponseofcropsduetobioinoculantsapplication.	3
10.	Compostmaking-testingthequalityofcompostmade,Fortificationofcompostbyinoculatingbeneficial microbes Androckphosphate.	6
11.	Studyonplantpathogens,collection,identificationandsubmission.	6
12.	Mass propagation of *Azolla-Anabaena* for bioinoculants.	3

References

TextBooks:

1. Dubey,R.CandMaheswari,D.K.2002.PracticalMicrobiology,1st Ed.,ChandandCompanyLtd.,India.
2. K.R.Aneja.1993.ExperimentsinMicrobiology,PlantPathologyandTissueCulture.WishwaPrakashan.. NewDelhi.India.
3. Sadasivam,SandManikam,A.1992.Biochemicalmethodsforagriculturalsciences.WileyEasternLtd., NewDelhi.

4.Aaronson S. (1970). Experimental Microbial Ecology, Academic Press, New York.

5.Darshan Dharajiya, Hitesh Jasani, (2015). EnvironmentalMicrobiology and Biotechnology - A Practical Manual

ReferenceBooks:

1. Collins CH, Lyne PM. (1985). Microbiological methods. Butterworths, 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-b-d&q=1.+Demonstration+of+Winogardsky+coloumn.

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

CourseOutcomes	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:Beabletounderstandtheimportanceofmicrobesinagriculture CO4: Beabletoknowthemethodsofisolation,identificationandmassproductionof Bioinoculants CO5: Beabletoknowthemethodstoidentifyplantpathogens

MappingofCOswithPSOs:

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

Semester	SECOND	Course Code	21ENGP00C1
Course Title	COMMUNICATION AND SOFT SKILLS		
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	Soft Skills		
Course Objectives	The Course aims • To help the students improve their communication and life and soft skills; and • To enhance their personality and employability skills.		

Unit	Content	No. of Hours
I	Basics of Communication Barriers to Communication	3
II	Communication and Language Skills Communicating in a Global Language	3
III	Resumes and Cover Letters Group Discussions	3
IV	Business communication Intercultural Communication	3
V	Professional Communication Interviews	3
References	**Text Books** Krishnaswamy, Dhariwal and Krishnaswamy. *Mastering Communication Skills and Soft Skills*. Blomsbury, 2015.	

Semester	THIRD	Course Code	21MIBP0314
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 course		
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 of 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 presention • To learn the article publication, ethics and IPR.		

Unit	Content	No. of Hours
I	**Microscopy, pH and Buffer** Microscopy- Principle and Applications- Light, phase contrast, Confocal and Fluorescence – Electron Microscopy - SEM and TEM(Source: NPTEL) - pH basic principles – pH electrodes- Principles, application and preparation of common buffers- Citrate, acetate, tris and phosphate	11
II	**Isolation and Separation** Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes- Homogenization- Manual, mechanical and sonication- Centrifugation techniques- Basic principles, Different types of Centrifuges, Analytical and preparative ultracentrifugation methods (Source: NPTEL) – Chromatography- Paper, thin layer, Ion-exchange, column- separation of amino acids and sugars- Gas liquid chromatography, GC-MS, HPLC.	13
III	**Electrophoresis, Colorimetry and Calorimeter** Electrophoresis- General Principles Horizontal & Vertical gel electrophoresis and immune electrophoresis (Source: NPTEL) -Electrophoresis of proteins and nucleic acids- Spectroscopic techniques- UV-Visible and FT-IR – Flame photometer, Bomb calorimeter, AAS, Mass Spectra, NMR – Principle and applications.	13
IV	**Research, Thesis writing and Presentation** Research- Definition, objectives, types and importance- Research methods in Biological Sciences- Research	13

	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	
V	**Article Publication, Ethics and Intellectual Property Rights** Writing scientific paper- Organization of scientific paper- Publication in research journals-Standards of Research journals- Peer review-Types- Impact factor- citation index,h-index,i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Plagiarism checking-Use of plagiarism softwares – Preparation of Research proposal and funding agencies and Research fellowships- 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. L.Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai. pp.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, New Delhi. 4. N. Gurumani 2010 Research Methodology for Biological Sciences. MJPPublishers, Chennai. 5. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani
	Reference Books 1. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 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. AddisonWesley Longman Pte. Ltd, Indian Branch, Delhi,India.
	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 ofdifferent 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	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
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	THIRD	Course Code	21MIBP0315
Course Title	IMMUNOLOGY AND IMMUNOTECHNOLOGY		
No. of Credits	4	No.ofcontacthoursperWeek	4
New Course/ Revised Course	NewCourse	Ifrevised,PercentageofRevisioneffected**(Minimum20%)**	--
Category	CoreCourse		
ScopeoftheCourse(maybe morethanone)	• Students will be able to develop their skills on immunology and immunotechnology • Students will be able to develop Employability in clinical field		
Cognitive LevelsaddressedbytheCourse	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 structuralfeaturesofthecomponentsoftheimmunesystem) K-5:(Evaluate functionsandresponsiveness 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 Immunohaematology,Tumor immunology & Vaccines		

UNIT	Content	No.ofHours
I	**Basics and types of Immunity** History of Immunology. Types of Immunity (Innate &Acquired immunity), Innate immunity components-physical, physiological defenses. Acquired immunity: (specific) natural, artificial, active and passive immunity. Humoral immunity and cell mediated immunity.	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 (Thymus, Bone marrow, lymph node, spleen, MALT, GALT, BALT – Immune tolerance.	13
III	**ImmunogensandImmunoglobulins** Immunogen - types. Haptens, adjuvants, carriers, Bacterial, Viral and Tumour antigens, autoantigens, blood group antigens and Rh factors. Immunoglobulin types, structure and function.	13
IV	**Immunological Techniques and Hypersensitivity** Antigen - antibody reaction, *Invitro* methods: Agglutination - precipitation, complement fixation, Immunoflurescense,ELISA,RIA.*Invivo*method-Immunecomplextissuedemonstration.Theoriesof antibody production. Hypersensitivity reactions- Antibodymediated - TypeIanaphylaxis-TypeIIAntibodydependentcellcytotoxicity-TypeIII Immunecomplex reactions-TypeIVhypersensitivityreactions.	13
V	**Immunohaematology,Tumorimmunology&Vaccines** Immunohaematology of blood groups, forensic serology - ABO and Rh incompatibility.Transplantation.HLAtissuetyping–majorhistocompatibilitycomplex- MHC restriction-antigen presentation (Organisation & inheritance of MHC, MHC molecules & genes), Role of Antigen presenting cells (APCs)- Immune suppression.Tumor immunology - Tumor antigens - Immunotherapy ofmalignancy - Autoimmune disease. Principles underlying the preparation of live, attenuatedvaccinesandrecombinantvaccine.Recent advances in the production of monoclonal antibodies and their applications.	12
References	**TextBooks:** 1. Martinez J. Hewlett (2018). Basic Virology, 4th Edition. Wiley, USA. 2. Dimmock, N.J., Easton, A.J., and Leppard, K.N. (2016). Introduction to Modern Virology. 7th Edition. Blackwell publishing, USA. 3. Carter J. and Saunders V. (2013). Virology: Principles and Applications, 2nd Edition. Willy, USA. 4. Flint S.J., Racaniello V.R., Enquist L.W., Rancaniello V.R., Skalka. A.M. (2015) Principles of Virology, 4th Edition, 2 Vol. American Society for Microbiology, USA. 5. Dimmock. N.J and Primrose. S.B. (1994). Introduction to Modern Virology. IV edition. Blackwell Scientific Publications, Oxford	

	ReferenceBooks: 1. John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications, John Wiley & Sons, west Susscex ,England. 2. Nigel Dimmock, Andrew Easton, Keith Leppard, (2009), Introduction to Modern Virology, 6th Edition,Wiley-Blackwell. 3. John. B.C and Venetia. A.S. (2007). Virology, Principles and Applications. John Wiley and Sons limited. England. 4. Antibodies–A LaboratoryManual;E.D.Harlow, DavidLane,2ndEdn.CSHLPress(2014). 5. Understanding Immunology (Cell and Molecular Biology in Action). (2006).; Peterwood,PearsonEducationLtd 6. Microbiology;Prescott,HarleyandKlein,McGraw-Hill(2003). 7. MolecularToxicology;NickPlant,GarlandScience(2003). 8. Stanier,Y.Roger,JohnL.Ingrahm,MarkL.WheelisandPageR.Painter.2003.GeneralMicrobiology.VEd.MacMillanPressLtd. NewJersey. pp: 585-620. 9. Lansing.Prescott,John.P.HarleyandDonald.A.Klein1999.Microbiology.WCBMcGraw–HillCompany.pp:605-676. 10. Kuby,J.1994. Immunology2nd Ed.,W.H.FreemanandCompany,NewYork. 11.Alan J. Cann (2011) Principles of Molecular Virology, 5th edition, Elsevier 12.Kuby Immunology- 7th edition. (2013). Publisher W. H. Freeman & Company. 13.Roitt,I.M..1998.Essential Immunology,BlackwellScientificPublishers.
	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:Understandvaccine,immunohematologyandtumorimmunology.

MappingofCOswithPSOs:

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

Semester	THIRD	Course Code	21MIBP0316
Course Title	MEDICAL MICROBIOLOGY		
No. of Credits	4	No.ofcontacthoursperWeek	4
New Course/ Revised Course	RevisedCourse	Ifrevised,PercentageofRevisioneffected**(Minimum20%)**	
Category	CoreCourse		
ScopeoftheCourse(maybemorethanone)	❖ students gain the knowledge of common medically important microorganism and the diseases ❖ Learn diagnostic approaches for microbial pathogens and various control measures		
Cognitive Levelsaddressed bytheCourse	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)	TheCourseaimsto • 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.ofHours
I	**Introduction to medical microbiology** Introduction to medical microbiology, Historical background, Classification of medically important microorganisms, Disease cycle, transmission of pathogen and its routes. Host parasite relationship, pathogenicity and virulence in relation with bacteria, Virus, fungi and parasites. Epidemiology and Public Health: Epidemiological principles in prevention and control of diseases; Endemic, epidemic, pandemic and sporadic diseases; Concepts of mortality/ morbidity rates, incidence and prevalence;	13
II	**Infection and its types** Infections: types of infection, sources of infection, reservoirs and vectors of infection, predisposing factors. Host-parasite relationship governing the infection and establishment of disease. Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, respiratory tract, gastrointestinal tract, urogenital tract, concept of probiotics; Mode of spread of infection; Respiratory, skin, wound & burn infection, venereal infections, alimentary tract infection, blood born infection and nosocomial infection.	12
III	**Bacterial diseases and Protozoan diseases** Classification of medically important microorganisms; Classification of pathogenic bacteria. Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium, Vibrio, Yersinia, Haemophilus, Mycobacterium, Spirochetes, Bordetella, Rickettsiae, Chlamydia.Protozoan diseases: Causative agents, Symptoms, mode of transmission, prophylaxis and control: Malaria, Kala-azar.	14
IV	**Viral and Fungal diseases** General properties of viruses Host interactions: Pox viruses; Herpes virus, Hepatitis viruses Picorna viruses, Orthomyxo viruses and Human Immunodeficiency viruses (HIV) Fungal diseases of man, Epidemiology. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis, treatment. Superficial mycoses, subcutaneous mycoses, systemic mycoses.	13
V	**Antimicrobial agents** Antimicrobial agents: Antibiotics, Antifungal and Antivirals. Antibiotic and chemotherapeutic agents: Sulfur drugs, Antibiotics and their classification, Mode of action, chemical nature of different antibiotics. Antibiotic assay and sensitivity test. Antiviral drugs-Antibiotic/Drug resistance – origin, cause, and clinical implication with special references of multidrug resistant bacteria. Superbugs.	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. Bergeys Manual of determinative Bacteriology
	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: Describethe measures in prevention and control of microbial diseases

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	3	2	2	2
CO5	3	3	2	2	2

Semester	THIRD	Course Code	21MIBP0317
Course Title	**BIOINSTRUMENTATION– PRACTICAL**		
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%)	**20%**
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,FT-IR,SEM,AAS and NMR. 3. Enhance the potential to handle the bioinstuments		
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 bioinstuments K4- Implementation of Experimental protocols K5- Assessment of experimental results		
Course Objectives (Maximum:5)	The Course aims to: • know the preparation of buffers and determination of pH. • separate amino acids and sugars using chromatography and electrophoresis • separate gas and organic acids using GC and HPLC • estimate proteins, sugars, nucleic acids, chlorophyll, sodium, potassium, calcium and magnesium using different equipments. • know the protocols involved in the estimation of biological samples using SEM,FT-IR,AAS and NMR.		

Practicals	**Content**	**No. of Hours**
1.	Preparation of buffers.	**3**
2.	Determination of pH in water and soil samples.	**3**
3.	Separation of amino acids and sugars using paper chromatography (2D)	**3**
4.	Separation of amino acids and sugars using thin layer chromatography	**3**
5.	Separation of pigments by column chromatography	**3**
6.	Differential centrifugation of samples	**3**
7.	Separation of gas and organic acids using GC and HPLC (Demonstration)	**6**
8.	Separation of proteins using vertical gel electrophoresis	**6**
9.	Estimation of Protein using Spectrophotometer	**3**
10.	Estimation of sodium, potassium, calcium and magnesium using Flame photometer	**3**
11.	Estimation of calorific value of feed/ fire wood samples	**3**
12.	Demonstration of Biological samples using SEM, FT-IR, AAS, NMR	**6**
	Chemicals preparation	**10**
	CFA	**4**
	Record Work	**3**

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.
Course Outcomes	On completion of the course, students should be able to
	CO1: Prepare buffers of desired pH CO2: Separate amino acids and sugars using paper and thin layerchromatography CO3: Estimate proteins,sodium,potassium,calcium and magnesium usingspectrophotometer and flame photometer. CO4: Separate proteins using vertical gel electrophoresis CO5: Know the biological applications of SEM, FT-IR, AAS and NMR

MappingofCOswithPSOs:

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

Semester	THIRD	Course Code	21MIBP0318
Course Title	**PRACTICAL - 6: VIROLOGY, IMMUNOLOGY AND 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 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 analyseclinical 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 infectivity titre of a T4 phage using Plaque assay	3
3.	Study of virus infected plant samples	3
4.	Identification of Viral agents by PCR (Demonstration)	3
5.	Selection, collection, and transport of specimens, blood samples, sera for microbiological and immunological examinations	3
6.	Isolation and enumeration of Anaerobic bacteria from wound specimen.	3
7.	Isolation and identification of Human pathogenic fungi and other opportunistic organisms.	3
8.	Fixation of Smears for microscopy and different staining techniques a) Ziehl –Neelsen method for AFB b) Leishman's staining c) Albert's staining d) Giemsa's staining	3+3
9.	ABO Blood grouping and Rh typing	3
10.	Agglutination tests a) WIDAL b) VDRL Test (RPR). c) RA d) ASO (Anti streptolysin 'O' Test). e) HBs Ag Test	3+3
11.	Precipitation Tests a) Immuno - diffusion test b) Immunoelectrophoresis	3
12.	Demonstration of ELISA (HIV & HBs Ag)	3
13.	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

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	3	2	2	2
CO5	3	3	2	2	2

Semester	**FOURTH**	Course Code	**21MIBP0419**
Course Title	**FOOD MICROBIOLOGY**		
No. of Credits	**4**	No.ofcontacthoursperWeek	**4**
New Course/ Revised Course	**RevisedCourse**	Ifrevised,PercentageofRevisioneffected(Minimum 20%)	**25%**
Category	CoreCourse		
ScopeoftheCourse	❖ 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 LevelsaddressedbytheCourse	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)	TheCourseaims 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.ofHours
I	**Microbiology of Foods** History - Importance of food microbiology- Factors influencing that affect microbial growth in food. (Intrinsic and Extrinsic parameters). Sources of food borne microorganisms found in food.	13
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 of contamination - methods of minimizing contamination.	13
III	**Microbial fermentations** Alcoholic Beverages- alcohol, wine, brandy and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented food preparations - Sauerkraut preparations and natural Vinegar. Fermented milk 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 course*) 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 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. Microbial criteria and standards for various products.	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, PHLLearning 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,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
CourseOutcomes	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 usingfermentation technology. CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.

MappingofCOswithPSOs:

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

Semester	FOURTH	Course Code	21MIBP0420
Course Title	INDUSTRIAL MICROBIOLOGY		
No. of Credits	4	No.ofcontacthoursperWeek	4
New Course/ Revised ourse	RevisedCourse	Ifrevised,PercentageofRevisionef fected(Minimum20%)	25%
Category	CoreCourse		
ScopeoftheCourse	❖ Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries ❖ Students can executeProjects on the microbial fermentations		
Cognitive LevelsaddressedbytheCourse	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)	TheCourseaimsto: • 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.ofHours
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 hrs

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: Comparescreening methods for Industrial microbes CO3: Explain thebiology of Industrial Microorganisms CO4: Evaluate theIndustrial production of various products CO5: Apply the rules and regulation of industrial microbiology

MappingofCOswithPSOs:

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

Semester	FOURTH	Course Code	21MIBP0421
Course Title	MICROBIAL BIOTECHNOLOGY AND GENETIC ENGINEERING		
No. of Credits	4	No.ofcontacthoursperWeek	4
New Course/ Revised Course	NewCourse	Ifrevised,PercentageofRevisioneffected(Minimum20%)	--
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in microbial biotechnology ❖ Skill development for biotransformation and production of useful compounds ❖ Creates employability scope in the biotechnology industries		
Cognitive Levelsaddressedbytheourse	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. 4. Kumar H.D., 1991. A text book on Biotechnology 2nd Ed, East-west Press Private Ltd., New Delhi. Pg.1-250; 411-472; 534-555. 5. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. **Reference Books** 1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S.Chand&Company Ltd., New Delhi. 2. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. 3. Kumar, H.D. 1993. Molecular Biology & Biotechnology, Vikas Publishing House Pvt., Ltd., New Delhi. 4. Kumar, H.D. 1991 Biotechnology, 2nd Ed., East – West Press Private Ltd., New Delhi. 5. Trevan, M.D, Boffey, S., Goulding, K.H. and Stanbury, P. 1990. Biotechnology- The basic Principles. Tata McGraw Hill, New Delhi. 6. Demain, A.L., Solomon, N.A. 1986. "Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington. 7. Robert F. Weaver, 2012Molecular Biology; McGraw Hill 8. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. 9. 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

MappingofCOswithPSOs:

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 -7: FOOD, INDUSTRIAL MICROBIOLOGY AND BIOTECHNOLOGY		
No. of Credits	2	No.ofcontacthoursperWeek	4
New Course/ Revised Course	NewCourse	Ifrevised,PercentageofRevisioneffected(Minimum20%)	--
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in food, industrial and biotechnology ❖ Skill development for biotransformation and production of useful compounds ❖ Creates employability scope in the Food and biotechnology industries		
Cognitive Levelsaddressedbythe 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)	TheCourseaimsto • 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.ofHours
1	Direct microscopic count and standard plate count from milk and dairy products.	4
2	Assessment of milk quality by methylene blue reduction test	4
3	Performance of phosphatase test for pasteurized milk.	4
4	Wine production by *Saccharomyces cerevisiae.* and analysis of physiochemical properties of wine	4
5	Role of yeasts in fermented food – Bread and some traditional fermented foods.	4
6	Enumeration of anaerobic bacteria from canned foods.	4
7	Enumeration of microbial load in fruit pulp, carbonated beverages and ice creams	4
8	Detection of aflatoxin from food sample by TLC	4
9	Detection and assay of bacteriocin by probiotic lactic acid bacteria.	4
10	Preservation of potato and onion by UV radiation	4
11	Production of Alkali Protease by submerged fermentation	4
12	Production of Cellulase by solid state fermentation	4
13	Production of bioethanol using Immobilization techniques	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. WishwaPrakashan.. 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

MappingofCOswithPSOs:

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

Semester	FOURTH	Course Code	21GTPP00H1
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, trustworthy,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, Neelkamal ; 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

Semester	THIRD	Course Code	18MIBP03D1
Course Title	ELECTIVE -DISCIPLINE CENTRIC: MICROBIAL NANOTECHNOLOGY		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	NewCourse	Ifrevised,PercentageofRevisioneffected**(Minimum20%)**	--
Category	• MajorElective		
ScopeoftheCourse(maybemorethanone)	• Students will be able to develop their skills on microbial nanotechnology • Students will be able to develop Employability in nanotechnology field		
Cognitive Levelsaddressed bytheCourse	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)	TheCourseaimsto • Togiveanoverviewon basics of nanotechnology and its development. • To know the importance of synthesis of nanoparticles and its vast applications. • Toimpartin-depthinformationon 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.ofHours
I	**Unit - I: Basics of nanotechnology** Basics of nanotechnology, origin and concepts – applications in Life Sciences. Terminologies – nanotechnology, microbial nanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles. Present status and future prospects of microbial nanotechnology.	**9**
II	**Unit – II: Synthesis of Nanoparticles** Physical methods- Melt mixing-Evaporation-Physical vapour deposition, Ionized cluster beam deposition, lazar vaporization and pyrolysis-Sputter deposition –Chemical-Colloidal, microemulsion, soil-gel, hydrothermal, sonochemical and microwave –Biological-Molecular nanotechnology-nanomachines and collagen-Microbial synthesis of nanoparticles- mechanism	**9**
III	**Unit III Types of Nanoparticles** Nanoparticles-types structure and functions, Physical and chemical properties of nanoparticles. carbon nanotubes.	**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. Ibrahim K, Khalid S and Idrees K. (2017). Nanoparticles: Properties, applications and toxicities. Arabian Journal of Chemistry.
2. David SG. (2004). Bionanotechnology, Lessons from nature, John Wiley & Sons Inc. publication
3. Parthasarathy BK. (2007). Introduction to Nanotechnology, Isha Publication.

Reference Books:

1. Bernd R. (2006). Microbial Bionanotechnology: -. Horizon Scientific Press.
2. David ER and Joseph DB. (2009). Bionanotechnology: Global Prospects. CRC Press.
3. Ehud G. (2013). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology, 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

CourseOutcomes	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.

MappingofCOswithPSOs:

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

Semester	THIRD	Course Code	18MIBP03D2
Course Title	ELECTIVE -DISCIPLINE CENTRIC: MICROBIAL GENETICS		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	60%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in microbial genetics ❖ Skill development for detection and analysis of mutation ❖ Creates employability scope in the forensic departments and vaccine industries		
Cognitive LevelsaddressedbytheCourse	K-1 Ability to remember basic concepts in microbial genetics K-2 Comprehensive knowledge on plasmid biology K-3 Use techniques for detection of mutations K-4 Capacity to analyze the importance of gene transfer mechanisms K-5 Make newer approaches to design of vaccine K-6 Assessment of phage genetics		
Course Objectives(Maximum:5)	TheCourseaimsto • understand the genetics of microorganisms • highlight the importance of gene transfer mechanisms and design of vaccine • know the importance of bacteriophage • impart information on plasmids and their utility • explain mechanisms viz., transformation, transduction and conjugation		

UNIT	Content	No. of Hours
I	**Introduction to Microbial Genetics** Gene as unit of mutation and recombination. Molecular nature of mutations; mutagens. Spontaneous mutations – origin. Mutations: Introduction-Types, causes and detection of mutations; mutagens; Mutant types; Isolation and Characterization of mutants: Sugar utilizing auxotrophs, amino acid utilizing auxotrophs, mutant enrichment. Reversions versus suppression, Ames test; Complementation tests	9
II	**Plasmid biology and Transposable elements:** Plasmid types, Replication and Incompatibility. Control of copy number and segregation. Colicins and col factors. Transposable elements –Discovery of Transposons, Insertion sequences. Types of bacterial transposons. Transposition-duplication of target sequence at an insertion site, Deletion and inversion caused by transposons. Transposable elements in yeast. phages as transposons; Transposon mutagenesis	9
III	**Gene transfer and genetic recombination mechanisms:** Transformation – competence cells, regulation, general process and Efficiency. Transduction – general and specialized; transduction frequency. Conjugation: Discovery, F+ , F- and Hfr cells; F^+& F^- and Hfr& F^- genetic crosses. Mechanism of conjugation. conjugational transfer of colicinogenic and resistance transfer factors. Genetic mapping of T4 phage.	9
IV	Phage Genetics Bacteriophages, classification of Bacteriophages, Lytic phages – T7 and T4 . Lysogenic phages I and Pl. M13 and Φ x 174 Life cycle, and their uses in microbial genetics	9
V	**Microbial genetics and design of vaccines** Historical perspectives-Vaccine development-evaluation and standardization-progress and challenges in modern vaccinology. Recent advances in vaccine development- impact of vaccine development-computer prediction of T-cell epitopes- identification of B- and T-cell epitopes through structural characterization and peptide technology.	9

References

Text Books:

1. Myron M. Levine, Graeme C. Woodrow, James B. Kaper and Gary S. Cobon. 1997. New Generation Vaccines. II Ed. Marcel Dekker, Inc. New York.
2. Stanley R. Maloy, John. E. Cronan, Jr. and David Freifielder. 1994. Microbial Genetics. II Ed. Jones & Bartlett Publishers. London.

Reference Books:

1. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company. pp: 227-260.
2. Lansing M. Prescott, John P. Harley and Donald A. Klein. 1999. Microbiology. 4th Ed. WCB/McGraw Hill Company. pp: 255 to 309.
3. S. Biwasis and Amita Biswas. 1998. An Introduction to Viruses. Vikaas Publishing House Pvt. Ltd. pp: 175-208.
4. Glick, B.R. AND Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. pp: 207-232.

Web resources:

1.webresources.articles411.com/tag/genome-bacterial/
2.microbiologyonline.org
3. https://www.sciencedirect.com/topics/biochemistry- genetics...biology/microbial-genetics

Course Outcomes	On completion of the course, students should be able CO1: Outline the genes and mechanisms of mutation CO2: Discuss the different gene transfer mechanisms CO3: Explainplasmids and their applications CO4: Acquire knowledge on bacteriophages CO5: Designing of vaccines

MappingofCOswithPSOs:

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	THIRD	Course Code	21MIBP03D3
Course Title	ELECTIVE -DISCIPLINE CENTRIC: GENETIC ENGINEERINGAND APPLICATIONS		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in microbial genetics ❖ Skill development for detection and analysis of mutation ❖ Creates employability scope in the forensic departments and vaccine industries		
Cognitive LevelsaddressedbytheCourse	K-1 Ability to remember basic concepts in genetic engineering K-2 Comprehensive knowledge on microbial biotechnology K-3 Use techniques for detection of right clones K-4 Capacity to analyze the importance of gene transfer mechanisms K-5 Make newer approaches to gene therapy K-6 Assessment of molecular cloning		
Course Objectives(Maximum:5)	The course aims to: • gain knowledge on the basic principles of genetic engineering • introduce the different protocols for molecular cloning strategies • understand the various applications of genetic engineering • know the basic concepts of gene transfer in bacteria plants and animals • study the future challenges of gene therapy		

UNIT	Content	No. of Hours
I	Role of genes within cells, genetic code, genetic elements that control gene expression, Method of creating recombinant DNA molecules, Types, biology and salient features of vectors in recombinant DNA technology–I: Plasmids, Phages, Cosmids, Fosmids, Phagemids, and Artificial chromosomes.Design of vectors and uses - Selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, protease cleavage sites and enzymes.	9
II	Enzymes in genetic engineering: Restriction nucleases: exo& endo nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase and their mechanism of action, Enzymes in modification- Methylases and phosphatases and their mechanism of action, Enzymes in modification- Polynucleotide kinase, Ligases, RNase and their mechanism of action.	9
III	Methods of nucleic acid detection, Polymerase chain reaction (PCR) and its applications, Variations in PCR and their applications, Methods of nucleic acid hybridization, Probe and target sequences, Nucleic acid mutagenesis in vivo and in vitro.Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.	9
IV	Gene transfer techniques: biological methods, Gene transfer techniques: chemical methods, Gene transfer techniques: physical or mechanical methods, *Agrobacterium*- mediated gene transfer in plants, Chloroplast transformation. Transgenic science in plant improvement, Biopharming - plants as bioreactors, Transgenic science for animal improvement**,** Biopharming- Animals as bioreactor for recombinant protein, Gene mapping in plants and animals, Marker-assisted selection for plant breeding and livestock improvement.Experiments using model systems - *E.coli*, Yeast, *Baculovirus*, *Agrobacterium tumefaciens.*	9
V	Microbial biotechnology: Genetic manipulation, Engineering microbes to produce antibiotics and enzymes, Engineering microbes for the production of insulin, growth hormones, monoclonal antibodies. Purification of expressed proteins - Determination of purity and activity of over expressed proteins. Engineering microbes for clearing oil spills.Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges and future of gene therapy. Safety guidelines for recombinant DNA research, Control of spills and mechanism of implementation of biosafety guidelines.	9
References	**Web resources:** 1. https://www.edx.org/learn/biotechnology 2. https://blog.feedspot.com/genetics-blogs/ 3. learn.genetics.utah.edu/ 4. http://bmcbiotechnol.biomedcentral.com	
Course Outcomes	On completion of the course, students should be able CO1: Explain the various vectors and enzymes used in genetic engineering CO2: Acquire knowledge on various methods employed in genetic engineering CO3: Evaluate the applications of genetic engineering CO4: Outline the applications of microbial biotechnology	

	CO5: Apply the challenges and future of gene therapy

MappingofCOswithPSOs:

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

Semester	THIRD	Course Code	21MIBP03M1
Course Title	**MODULAR COURSE: ADVANCED MOLECULAR TECHNIQUES**		
No. of Credits	**2**	No.ofcontacthoursperWeek	**2**
New Course/ Revised Course	**Revised Course**	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in molecular techniques ❖ Skill development for detection and analysis of nucleic acid ❖ Creates employability scope in the forensic departments		
Cognitive LevelsaddressedbytheCourse	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 spectrophometric techniques and their uses • create interest on the importance of genome sequencing and physical mapping analysis		

UNIT	Content	No.of Hours
I	**Chromatographic and Spectrophometric 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 Immunoelctrophoresis	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. Gardener*et al.,*. 1991. 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 spectrophometric techniques CO5: Demonstrate methods involved for genome sequencing and physical mapping

MappingofCOswithPSOs:

PSO / CO	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	THIRD	Course Code	21MIBP03M2
Course Title	MODULAR COURSE: BIOINFORMATICS		
No. of Credits	2	No.ofcontacthoursperWeek	2
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in molecular techniques ❖ Skill development for detection and analysis of nucleic acid ❖ Creates employability scope in the forensic departments		
Cognitive LevelsaddressedbytheCourse	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 labeled 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	**References:** 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	

MappingofCOswithPSOs:

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

Semester	FOURTH	Course Code	21MIBP04M1
Course Title	MODULAR COURSE:RURAL BIOTECHNOLOGY		
No. of Credits	2	No.ofcontacthoursperWeek	2
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in rural biotechnology ❖ Skill development for mushroom culture and *Spirulina* cultivation technology ❖ Creates employability scope		
Cognitive LevelsaddressedbytheCourse	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** Present status and importance – popular varieties – artificial and live feeds – 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 Improved Methods, 1st print, ICAR, New Delhi. 3. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific,Singapore. 5. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 6. 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 acomposting units CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: ummerise*Spirulina* cultivation by low cost method CO5: to culture different ornamental fish and establish an aquarium farm	

MappingofCOswithPSOs:

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	**FOURTH**	Course Code	**21MIBP04M2**
Course Title	**MODULAR COURSE:INTELLECTUAL PROPERTY RIGHTS**		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Modular		
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 analyse 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
10. R. Radhakrishnan and S. Balasubramanian (2008). Intellectual Property Rights: Text and Cases. Excel books
11. B.L. Wadehra (2016) Law relating to Intellectual Property, 2011. Universal Law Publishing – An imprint of LexisNexis, 5th Edition
12. Verma, S.K and Mohit Verma, (2010). Textbook of Plant Physiology, Biochemistry and Biotechnology. S.Chand and Co. New Delhi.
13. P. Narayanan(2010).Law of Copyright and Industrial Designs; Eastern law House, Delhi,
14. T. M Murray and M.J. Mehlman, (2000). Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons/
15. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN:

	Cengage Learning India Private Limited. 16. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited. Reference book: 1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis. **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 Organisation. (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	

MappingofCOswithPSOs:

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	**21MIBP02G1**
Course Title	**FOOD MICROBIOLOGY**		
No. of Credits	**3**	No.ofcontacthoursperWeek	**3**
New Course/ Revised Course	**RevisedCourse**	Ifrevised,PercentageofRevisioneffected(Minimum 20%)	**25%**
Category	CoreCourse		
ScopeoftheCourse	❖ 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 LevelsaddressedbytheCourse	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)	TheCourseaims 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.ofHours
I	**Microbiology of Foods** History - Importance of food microbiology- Factors influencing that affect microbial growth in food. (Intrinsic and Extrinsic parameters). Sources of food borne microorganisms found in food.	13
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 of contamination - methods of minimizing contamination.	13
III	**Microbial fermentations** Alcoholic Beverages- alcohol, wine, brandy and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented food preparations - Sauerkraut preparations and natural Vinegar. Fermented milk 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 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. Microbial criteria and standards for various products.	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. 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,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 asharmful) 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 usingfermentation technology. CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.

MappingofCOswithPSOs:

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

Semester	SECOND	Course Code	21MIBP02G2
Course Title	INDUSTRIAL MICROBIOLOGY		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	RevisedCourse	Ifrevised,PercentageofRevisioneffected(Minimum20%)	25%
Category	CoreCourse		
ScopeoftheCourse	❖ Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries ❖ Students can executeProjects on the microbial fermentations		
Cognitive Levelsaddressed bytheCourse	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)	TheCourseaims 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.ofHours
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 hrs

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

CourseOutcomes	On completion of the course, students should be able CO1: Discuss historical aspects of industrial microbiology and fermentation ***techniques*** CO2: Comparescreening methods for Industrial microbes CO3: Explain thebiology of Industrial Microorganisms CO4: Evaluate theIndustrial production of various products CO5: Apply the rules and regulation of industrial microbiology

MappingofCOswithPSOs:

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

Semester	SECOND	Course Code	21MIBP02G3
Course Title	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%)	-
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	**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. Mechanism of nitrogen fixation (free-living and symbiotic) - Biochemistry and molecular basis of nitrogen fixation.	12
II	**Azollacultivation** 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 - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	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. Rao, N.S., 1982. Biofertilizers. Interdisciplinary science reviews, 7(3), pp.220-229. 4. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin. 5. Subba Rao, N.S. (1982). Advances in Agricultural Microbiology. Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi. 6. Niir Board, 2004. The Complete Technology Book On Bio Fertilizer and Organic Farming, National Institute Of Industrial Research, Delhi. 7. 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. 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. 9.https://www.biologydiscussion.com/essay/bio-fertilizers-types-and-importance-of-bio-fertilizers/1901 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	21MIBP 04G4
Course Title	MODULAR COURSE:RURAL BIOTECHNOLOGY		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in rural biotechnology ❖ Skill development for mushroom culture and *Spirulina* cultivation technology ❖ Creates employability scope		
Cognitive LevelsaddressedbytheCourse	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** Present status and importance – popular varieties – artificial and live feeds – 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. 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 units CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: ummerise*Spirulina* cultivation by low cost method	

	CO5: to culture different ornamental fish and establish an aquarium farm

MappingofCOswithPSOs:

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	21MIBP0VA1
Course Title	MODULAR COURSE:RURAL BIOTECHNOLOGY		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	Revised Course	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in rural biotechnology ❖ Skill development for mushroom culture and *Spirulina* cultivation technology ❖ Creates employability scope		
Cognitive LevelsaddressedbytheCourse	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** Present status and importance – popular varieties – artificial and live feeds – 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 units CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: ummerise*Spirulina* cultivation by low cost method CO5: to culture different ornamental fish and establish an aquarium farm	

MappingofCOswithPSOs:

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	21MIBP0VA2
Course Title	FOOD MICROBIOLOGY		
No. of Credits	3	No.ofcontacthoursperWeek	3
New Course/ Revised Course	RevisedCourse	Ifrevised,PercentageofRevisioneffected(Minimum 20%)	25%
Category	CoreCourse		
ScopeoftheCourse	❖ 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 LevelsaddressedbytheCourse	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)	TheCourseaims 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.ofHours
I	**Microbiology of Foods** History - Importance of food microbiology- Factors influencing that affect microbial growth in food. (Intrinsic and Extrinsic parameters). Sources of food borne microorganisms found in food.	13
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 of contamination - methods of minimizing contamination.	13
III	**Microbial fermentations** Alcoholic Beverages- alcohol, wine, brandy and beer. Microbes involved in fermentation: Starter lactic acid cultures. Fermented food preparations - Sauerkraut preparations and natural Vinegar. Fermented milk 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 course*) 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 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. Microbial criteria and standards for various products.	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. 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,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: 5. http://www.microbes.info 6. http://www.fsis.usda.gov/ 7. http://www.cdc.gov. 8. 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 usingfermentation technology. CO4: Apply the different aspects of food preservation CO5: Evaluate the quality assurance of foods especially by HACCP.

MappingofCOswithPSOs:

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

Semester	**SECOND**	Course Code	**21MIBP0VA3**
Course Title	**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%)	-
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	**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. Mechanism of nitrogen fixation (free-living and symbiotic) - Biochemistry and molecular basis of nitrogen fixation.	12
II	**Azollacultivation** 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 - Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions.	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. Rao, N.S., 1982. Biofertilizers. Interdisciplinary science reviews, 7(3), pp.220-229.
4. Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin.
5. Subba Rao, N.S. (1982). Advances in Agricultural Microbiology. Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Niir Board, 2004. The Complete Technology Book On Bio Fertilizer and Organic Farming, National Institute Of Industrial Research, Delhi.
7. 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.
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. 9.https://www.biologydiscussion.com/essay/bio-fertilizers-types-and-importance-of-bio-fertilizers/1901 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	THIRD	Course Code	21MIBP0VA4
Course Title	**MODULAR COURSE: ADVANCED MOLECULAR TECHNIQUES**		
No. of Credits	2	No.ofcontacthoursperWeek	2
New Course/ Revised Course	**Revised Course**	Ifrevised,PercentageofRevisioneffected(Minimum20%)	20%
Category	CoreCourse		
ScopeoftheCourse	❖ Basic understanding on basic concepts in molecular techniques ❖ Skill development for detection and analysis of nucleic acid ❖ Creates employability scope in the forensic departments		
Cognitive LevelsaddressedbytheCourse	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 spectrophometric techniques and their uses • create interest on the importance of genome sequencing and physical mapping analysis		

UNIT	Content	No.of Hours
I	**Chromatographic and Spectrophometric 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 Immunoelctrophoresis	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. Gardener*et al.,*. 1991. Principles of Genetics (8^{th} Ed.,) John Wiley & Sons, New York. **5. Reference Books:** 6. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani. 7. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 8. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press. 9. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore 10. 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 spectrophometric techniques CO5: Demonstrate methods involved for genome sequencing and physical mapping

MappingofCOswithPSOs:

PSO / CO	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