B.Sc., MICROBIOLOGY

SYLLABUS

(Revised syllabus effects from 2021 -2022)

DEPARTMENT OF BIOLOGY
THE GANDHIGRAM RURAL INSTITUTE
(Deemed to be University)
Gandhigram - 624 302
Dindigul District
Tamil Nadu

OBE ELEMENTS FOR
B.Sc., MICROBIOLOGY PROGRAMME

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To gain technical aptitude and in-depth knowledge in the respective field

PEO2: To independently carry out practical, project 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 in the respective discipline.

PROGRAMME OUTCOME (PO)

PO 1: Become knowledgeable in the respective discipline 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 respective discipline.

PO 3: Be able to design/ conduct investigations and develop solutions to solve problems using appropriate 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 of B.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 and develop communication skills - written, oral and visual communication.

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. Work effectively with others-to connect choices, actions and ethical decision making. Have a social responsibility.

B.Sc., MICROBIOLOGY PROGRAMME 2021-2022

OBE Template

Name of the Programme	**B.Sc., MICROBIOLOGY PROGRAMME**										
Year of Introduction	2019				**Year of Revision**				**2021**		
Semester-wise Courses and Credit distribution	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**Total**
No. of Courses	**9**	**10**	**10**	**9**	**9**	**7**	**--**	**--**	**--**	**--**	**54**
No. of Credits	**21**	**22**	**23**	**21**	**23**	**21**	**--**	**--**	**--**	**--**	**131**

SCHEME OF EXAMINATION

Course Code	Title of the Course	Credits	Hours		Max Marks		
			Theory	Practical	CFA	ESE	Total
FIRST SEMESTER							
21TAMU0101/ 21HIDU0101/ 21MALU0101/ 21FREU0101	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
21ENGU01F1	Foundational English -I	3	3	-	40	60	100
21MIBU0101	Fundamentals of Microbiology	4	4	-	40	60	100
21MIBU0102	Practical I: Fundamentals of Microbiology	1	-	3	60	40	100
21CHEU01A1/ 21BIOU01A1	Allied Chemistry- I / Allied Biochemistry- I	3	3	-	40	60	100
21CHEU01A2 21BIOU01A2	Allied Practical- I: Allied Chemistry- I/ Allied Biochemistry- I	1	-	3	60	40	100
21NSSU0001/ 21FATU0001/ 21SPOU0001	NSS/ Fine Arts/ Sports	1	-	1	50	-	50
21YOGU0001	Yoga	1	-	1	50	-	50
21EVSU0101	Environmental Studies	3+1	3	2	24+24	36+16	100
	Total	**21**	**16**	**10**			

SECOND SEMESTER

21TAMU0202/ 21HIDU0202/ 21MALU0202/ 21FREU01202	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
21ENGU02F2	Foundational English -II	3	3	-	40	60	100
21CTAU0001/ 21CHIU0001/ 21CMLU0001	Core Tamil/ Core Hindi/ Core Malayalam	2	2	-	20	30	50
21MIBU0203	Microbial Diversity	3	3	-	40	60	100
21MIBU0204	Practical II: Microbial Diversity	1	-	3	60	40	100
21CHEU02A3/ 21MIBU02A3	Allied Chemistry- II / Allied Biochemistry- II	3	3	-	40	60	100
21CHEU02A4/ 21MIBU02A4	Allied Practical II: Allied Chemistry- II/ Allied Biochemistry- II	1	-	3	60	40	100
21GTPU0001	Gandhi's Life, Thought and Work	2	2	-	20	30	50
21EXNU0001	Extension Education	2	2	-	20	30	50
21ENGU00C1	Soft Skills	2	2	-	20	30	50
	Total	**22**	**20**	**6**			

THIRD SEMESTER

21TAMU0303/ 21HIDU0303/ 21MALU0303/ 21FREU01303	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
21ENGU03F3	Advanced English	3	3	-	40	60	100
21CTAU0002/ 21CHIU0002/ 21CMLU0002	Core Tamil/ Core Hindi/ Core Malayalam	2	2	-	20	30	50
21MIBU0305	Molecular Biology	4	4	-	40	60	100
21MIBU0306	Practical III: Molecular Biology	1	-	3	60	40	100
21APRU03A1/ 21BIOU03A1	Allied Biostatistics- I / Allied Biology: Botany –I	3	3	--	40	60	100
21APRU03A2/ 21BIOU03A2	Allied Practical: Allied Biostatistics- I / Allied Biology: Botany –I:	1	-	3	60	40	100
21CSAU03A1	Computer Course	3	3	-	40	60	100
21SHSU0001	Shanthi Sena	1	2	-	50	-	50
21EXNU03V1	VPP	2	-	-	50	-	50
	Total	**23**	**20**	**6**			

FOURTH SEMESTER							
21MIBU04DX	Elective : Discipline Centric	3	3	-	40	60	100
--	Elective : Generic	3	3	-	40	60	100
21MIBU0407	Microbial Physiology	3	3	-	40	60	100
21MIBU0408	Immunology and Virology	3	3	-	40	60	100
21MIBU0409	Medical Microbiology	3	3	-	40	60	100
21MIBU0410	Practical IV: Microbial Physiology, Immunology, Virology and Medical Microbiology	1	-	3	60	40	100
21APRU04A3/ 21BIOU04A3	Allied Biostatistics- II / Allied Biology: Zoology-II	3	3	-	40	60	100
21APRU04A4/ 21BIOU04A4	Allied Practical: Allied Biostatistics- II / Allied Biology: Zoology -II	1	-	3	60	40	100
21GTPU00H1	Human Values and Professional Ethics	1	-	1	50	-	50
	Total	**21**	**18**	**7**			
FIFTH SEMESTER							
21MIBU04DY	Elective : Discipline Centric	3	3	-	40	60	100
--	Elective : Generic	3	3	-	40	60	100
21MIBU0511	Food and Dairy Microbiology	4	4	-	40	60	100
21MIBU0512	Industrial Microbiology	4	4	-	40	60	100
21MIBU0513	Agricultural Microbiology	4	4	-	40	60	100
21MIBU0514	Practical V: Food, Dairy &Industrial Microbiology	1	-	3	60	40	100
21MIBU0515	Practical VI: Agricultural Microbiology	1	-	3	60	40	100
21MIBU05SX	Skill Based Elective	2	2	-	40	60	100
21MIBU05F2	Field Visit /Industrial Visit	1	-	-	50	-	50
	Total	**23**	**20**	**6**			
SIXTH SEMESTER							
21MIBU06MX	Modular Course- 1	2	2	-	50	-	50
21MIBU06MY	Modular Course- 2	2	2	-	50	-	50
21MIBU0616	Applied Environmental Microbiology	4	4	-	40	60	100
21MIBU0617	Microbial Technology	4	4	-	40	60	100
21MIBU0618	Bioinstrumentation	4	4	-	40	60	100
21MIBU0619	Practical VII: Applied Environmental Microbiology, Microbial Technology and Bioinstrumentation	1	-	3	60	40	100
21MIBU0620	Project	4	-	8	40	40+20*	100
	Total	**21**	**16**	**11**	-	-	-
	Grand Total	**131**					

*40 for External evaluation and 20 for concurrent viva- voce evaluation

LIST OF DISCIPLINE CENTRIC ELECTIVES

Course Code	Course Title	Credit
Fourth semester (21MIBU04DX)		
21MIBU04D1	Microbial Genetics	3
21MIBU04D2	Medical Parasitology and Entomology	3
Fifth Semester (21MIBU04DY)		
21MIBU05D1	Bioprocess and Fermentation Technology	3
21MIBU05D2	Communicable Disease and Prevention	3

MODULAR COURSE OFFERED (21MIBU06MX)

Course Code	Course Title	Credit
21MIBU06M1	Micro algal Technology	2
21MIBU06M2	Molecular Techniques	2
21MIBU06M3	Recombinant DNA Technology	2
21MIBU06M4	Bioinformatics	2

SKILL BASED ELECTIVE OFFERED (21MIBU05SX)

Course Code	Course Title	Credit
21MIBU05S1	Mushroom Technology	2
21MIBU05S2	Clinical Lab Technology	2
21MIBU05S3	Sanitation Microbiology	2
21MIBU05S4	Composting Technology	2

GENERIC ELECTIVE COURSES OFFERED

Course Code	Course Title	Credit
21MIBU00G1	Dairy Microbiology	3
21MIBU00G2	Biofertilizer and Biopesticides Production	3
21MIBU00G3	Food Microbiology	3
21MIBU00G4	Industrial Microbiology	3

VALUE ADDED COURSE (21MIBU0VA)

Course Code	Course Title	Credit
21MIBU0VA1	Mushroom Technology	2
21MIBU0VA2	Clinical Lab Technology	2
21MIBU0VA3	Sanitation Microbiology	2
21MIBU0VA4	Composting Technology	2
21MIBU0VA5	Biofertilizer and Biopesticides Production	2
21MIBU0VA6	Dairy Microbiology	2
21MIBU0VA7	Food Microbiology	2
21MIBU0VA8	Industrial Microbiology	2

LIST OF ALLIED COURSES

Course Code	Course Title	Credit
	First Semester	
21BIOU01A1	Allied Biochemistry –I	3
21BIOU01A2	Allied Practical –I: Allied Biochemistry-I	1
	Second Semester	
21BIOU02A3	Allied Biochemistry –II	3
21BIOU02A4	Allied Practical –II: Allied Biochemistry-II	1
	Third Semester	
21BIOU03A1	Allied Biology :Botany –I	3
21BIOU03A2	Allied Practical III: Allied Biology : Botany –I	1
	Four Semester	
21BIOU04A3	Allied Biology :Zoology – II	3
21BIOU04A4	Allied Practical IV: Allied Biology : Zoology – II	1

Possible Online Courses to be introduced in I to VI 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	**21MIBU0101**
Course Title	**FUNDAMENTALS OF MICROBIOLOGY**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	Core Course		
Scope of the Course	• Students will be able to develop their skills on fundamentals of Microbiology • Students will be able to develop Employability in various microbiological fields		
Cognitive Levels addressed by the Course	K-1: Remember Concept and scope of microbiology K-2: Understand Emerging viruses and challenges K-3: Apply to know microbial growth, microscopy, staining, and sterilization techniques K-4: Analyze microbial culture techniques K-5: Evaluate prokaryotic and eukaryotic cell structure K-6: Create knowledge on fundamentals of microbiology		
Course Objectives	The Course aims to: • enhance the students' knowledge on the historical aspects and development of microbiology • know about the scope of microbiology • give an overview on microscopy and microbial growth • make the students knowledgeable on the various microbial techniques involved. • acquire an overall knowledge on the morphology and functions of the structures within the prokaryotes and eukaryotes.		

UNIT	Content	No. of Hours
I	**History and Scope of Microbiology** Introduction- Scope and History of Microbiology- Theories of Spontaneous Generation, Biogenesis- Contribution of Anton Van Leevwenhoek, Louis Pasteur, Robert Koch and Edward Jenner - Applications of Microbiology in various fields- Industries, Food, Agriculture, Environment, Medical and Research.	10
II	**Microscopy and Staining** Microscopy- Principles and applications of Simple, Compound, Phase contrast, Fluorescent, SEM and TEM- Specimen preparations for Electron Microscope. Principles and types of staining- Simple, Differential (Gram's, Spore and Capsule).	09
III	**Organization of Prokaryotic and Eukaryotic Cells** Structure and Organization of Prokaryotic and Eukaryotic Cell-Size, Shape, Structure and organization of bacterial cell wall, Membrane, Ribosomes, Nucleoid, Slime layer, Capsule, Flagella, Spores, Cysts and Plasmids. Difference between Prokaryotic and Eukaryotic cells.	10
IV	**Sterilization Techniques** Sterilization, Principles types: Physical- Moist heat- Dry heat- Filtration (Membrane and HEPA), Radiations, Chemical agents- Mode of action.	09
V	**Microbial Growth and Culture Techniques** Microbial growth and nutritional requirements. Batch- Continuous-Synchronous culture- Growth curve. Isolation-Serial	10

	dilution techniques- Culture and media preparation-Types of media – Solid, Liquid Natural, Semi Synthetic, Synthetic, Enriched, Selective, Differential media-Pure culture techniques-Pour plate, Spread plate and Streak plate – Preservation.	
References	Text Books: 1. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2019. Prescott's Principle of Microbiology, 9th Ed., Mc Graw Hill, New York. 2. Dubey, R.C and Maheswari, D.K 2013. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 3. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2010. Microbiology. 5th Ed. Tata McGraw Hill Book Company, New Delhi.	
	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. VIIEd.Cambridge University Press. UK.. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 5. John L. Ingrahm and Catherine Ingrahm.. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA.	
	E-Resources: 1.http://www.bac.wise.edi/microtextbook/index.php 2.http://www.microbeworld.org.uk 3.http://www.microbiologyonline.org.uk/links.html	
Course Outcomes	On completion of the course, students should be able to: CO 1: Discuss important historical aspect CO2: Describe principles and applications of microscopy and staining techniques CO3: Identify key structures and their functions in both eukaryotes and Prokaryotes CO4: Perform sterilization techniques for microbial control CO5: Assess the microbial growth and demonstrate the different cultural techniques in microbiology	

Mapping of COs with PSOs:

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

Semester	**FIRST**	Course Code	**21MIBU0102**

Course Title	**PRACTICAL-I: FUNDAMENTALS OF MICROBIOLOGY**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on fundamentals of microbiology • Students will be able to develop Employability in various fields of microbiology		
Cognitive Levels addressed by the Course	K-1: Remember Concept basic microbiology K-2: Understand the isolation and handling of microorganisms and instruments K-3: Apply to know basic microbial techniques K-4: Analyze the principles of microscopes K-5: Evaluate the morphology and functions of the structures with the prokaryotes and eukaryotes K-6: Create knowledge on fundamentals of microbiology		
Course Objectives	The Course aims to: • enhance the student's knowledgeable and impress upon them the important aspects of microorganisms • understand the working procedure and principles of microscopes. • provide practical knowledge and skill in the isolation and handling of microorganisms and instruments • know pure culture techniques and methods of culturing of microorganisms • acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes		

UNIT	Content	No. of Hours
1.	Safety practices in microbiological laboratory	3
2.	Cleaning of glassware's and preparation of cleaning solutions	3
3.	Handling and maintenance of microscope	6
4.	Sterilization techniques - Handling of laboratory instruments and glass wares-Autoclave, Hot air oven, Laminar air flow pH meter, Petriplates	6
5.	Media preparation Liquid media-Nutrient broth, Solid media-Nutrient agar, Semisolid media-Nutrient semisolid medium, Differential media-Mac Conkey agar, Selective medium-EMB	6
6.	Isolation and enumeration of bacteria by serial dilution and plating and Total count (Haemocytometer count)	6
7.	Pure culture techniques-Pour plate, Spread plate and Streak plate	6
8.	Staining techniques-Simple, Differential, Spore and Capsular staining	6
9.	Determination of motility of bacteria-Hanging drop method	3
10.	Measurement of size of the microorganisms-Micrometry	3

	Total hours	**48**
References	1. James. G. Cappucino. And Natabe Sherman, 2014. Microbiology – A Laboratory Manual, X Ed., Pearson Education (Singapore) Pvt. Ltd., India. 2. Dubey, R.C and Maheswari, D.K. 2012. Practical Microbiology, 5 Ed., Chand and Company Ltd., New Delhi. 3. Aneja. K.R, 2017. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, 5 Ed. New Age International publishers (P) Ltd, New Delhi. 4. John G. Holt. 2000. Bergey's Manual of Determinative Bacteriology. 9 Ed. Lippincott Williams and Wilkins, USA. 5. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panama Publishing Corporation, New Delhi.	
	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 CO 1: Demonstrate standard methods for the isolation, identification and culturing of microorganisms CO2: Explain the staining techniques CO3: Identify the different groups of microorganisms CO4: Asses the principles and applications of microscope CO5: Examine the pureculture techniques	

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	**21MIBU0203**
Course Title	**MICROBIAL DIVERSITY**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	Core Course		
Scope of the Course	• 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 the concept of taxonomy and diversity of microorganisms K-2: Understand characteristics of different groups of microorganisms K-3: Apply in the field study K-4: Analyze methods of classification K-5: Evaluate the importance of microorganisms K-6: Create knowledge on Diversity of prokaryotic and eukaryotic microbes		
Course Objectives	The Course aims to: • highlight the different aspects of the classification of Prokaryotes and Eukaryotes. • enhance the students knowledge on the diversity of microbes. • help students have an in-depth knowledge on the different groups and species of microbes • make the students aware of the economical value of microorganisms • sensitize the students on critical thinking of the ill effects caused by microbes.		

UNIT	Content	No. of Hours
I	**Microbial Taxonomy** Introduction to microbial classification and Taxonomy-modern approaches-Numerical, molecular taxonomy and phylogeny. Hackel three kingdom and Whittaker's five kingdom concept.	10
II	**Bacterial Diversity** Bacteria-General characteristics and classification of Eubacteria and Archaebacteria. (Bergey's Mannual). *E. coli*, *Rhizobium* sp., *Methanobacteria* sp., Economic importance of Bacteria.	10
III	**Fungal Diversity** Fungi- General characteristics and classification (Alexopoulous, Ainsworth and G.W.Martin) of fungi. *Rhizopus* sp., *Aspergillus* sp., *Penicillium* sp. and *Agaricus* sp. Economic importance of Fungi.	10

IV	**Algal and protozoan Diversity** Algae- General characters, classification, mode of reproduction and economic importance of green algae , brown algae and pyrrophyta. Salient features of *Chlorella*. Protozoa - General characters, classification, and life cycle of *Plasmodium vivax***.** Importance of protozoa.	10
V	**Viral Diversity** Virus-morphology, general characters, classification (Baltimore classification). Life cycle and mode of reproduction of plant virus TMV, bacteriophage T4, insect virus PV and human virus HIV.	8
References	Text Books: 1. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2010. Microbiology. 5th Ed. Tata McGraw Hill Book Company, New Delhi. 2.Prescott L M, JP Haley and D A Lein. 2005. Microbiology, sixth edition, International edition, McGraw Hill, New York. 3. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2019. Prescott's Principle of Microbiology, 9th Ed., Mc Graw Hill, New York. 4.Alexopoulos, CJ, and Mims, C.W. 2007. Introductory Mycology, John Wiley, New York	
	Reference Books: 1. Hans G. Schlegel. 2012. General Microbiology. VII Ed. Cambridge University Press. UK. 2. S. Biwasis and Amita Biswas. 2006. An Introduction to Viruses.4 Revised Ed. Vikaas Publishing House Pvt. Ltd., New Delhi. 3. John G. Holt. 2000. Bergey's Manual of Determinative Bacteriology. 9 Ed. Lippincott Williams and Wilkins, USA 4. Chatterjee, K. D. 2019. Parasitology Protozoology and Helminthology 13Ed CBS Publishers & Distributors, New Delhi.	
	E-Resources: 1.http://www.bac.wise.edi/microtextbook/index.php 2.http://www.microbeworld.org.uk 3.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: Assess the basic principles and methods for the classification of Eubacteria and Archaebacteria . CO3: Explain the basic principles and methods of classification of fungi and algae CO4: Discuss the basic principles and methods of classification of protozoa's CO5: Evaluate the basic principles and methods used for the classification of viruses	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	1	1	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	**21MIBU0204**
Course Title	**PRACTICAL -2: MICROBIAL DIVERSITY**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on diversity of microbes • Students can execute Field Projects on the diversity of microorganisms		
Cognitive Levels addressed by the Course	• K-1: Remember characteristics of microorganisms • K-2: Understand microscopic observation of different microbes • K-3: Apply to know observation of microbes in the fiels • K-4: Analyze the methods of microbial observation • K-5: Evaluate the importance of taxonomy and microbial diversity • K-6: Create knowledge on Diversity of prokaryotic and eukaryotic microbes		
Course Objectives	The Course aims to: • provide practical knowledge on the cultural characteristics of microorganisms • make the modern technical capabilities to analyse the structures of prokaryotes and eukaryotes • encourage development of skills on observations of organisms • extend knowledge on diversity of microorganisms • give skills in the isolation various microorganisms		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Cultural characteristics of microorganisms, colony morphology, shape and margin	6
2.	Observation on a Gram positive bacteria.	3
3.	Observation of a Gram negative bacteria.	3
4.	Isolation and observation of an Archae bacteria.	6
5.	Microscopic observation of Algae - *Chlamydomonas, Nostoc* and *Anabaena*	6
6.	Microscopic observation of fungi and their spores - *Aspergillus*, *Penicillium*, *Mucor* and *Rhizopus*	3
7.	Observation of Yeast morphology and budding	3
8.	Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium.*	3
9.	Study of air microflora in the environment	3
10.	Visit to microbial rich environments like lakes and demonstrate the presence of distinct and conspicuous microorganisms.	12
	Total hours	**48**

References	1. Dubey, R.C and Maheswari, D.K. 2012. Practical Microbiology, 5 Ed., Chand and Company Ltd., New Delhi. 2. Aneja. K.R, 2017. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, 5 Ed. New Age International publishers (P) Ltd, New Delhi. 3. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panima Publishing Corporation, New Delhi. 4. Sundararaj T. 2005. Microbiology laboratory manual. Revised and published by Aswathy Sundararaj. No.5 First cross street, Thirumalai nagar, Perungudi, Chennai. 5. James. G. Cappucino. And Natabe Sherman, 2014. Microbiology – A Laboratory Manual, X Ed., Pearson Education (Singapore) Pvt. Ltd., India. 6. Harold J Benson, 2016. Microbiological Applications - Laboratory Manual in General Microbiology. 14 Ed., Me Grew-Hill, Boston.
	E-Resources: 1.https://www.google.com/search?q=cultural+characteristics+of+bacteria&client=firefox 2.https://www.google.com/search?q=isolation+of+archaebacteria&client=firefox
Course Outcomes	On completion of the course, students should be able to: CO1: Identify standard methods for the isolation and identification of microorganisms. CO2: Explain the application of microbes in various habitats. CO3: Evaluate the abundance of microbes . CO4: Create microbial practical skills on microbial isolation techniques. CO5: Demonstrate the presence of distinct and conspicuous microorganisms.

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	1	1	3	3
CO3	3	1	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**THIRD**	Course Code	**21MIBU0305**
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%)**	25%
Category	Core course		
Scope of the Course	❖ 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 understand molecular mechanism for replication, transcription, and translation K-5 Make new techniques to analyse mutagenesis 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 • make the student knowledgeable on concepts and mechanism of DNA replication process • expose the students on mechanisms of transcription and translation process in prokaryotes and eukaryotes. • give an in-depth knowledge on mutagenesis • enhance student's interest on bacterial genetics and gene transfer mechanisms.		

UNIT	**Content**	**No.of Hours**
I	**Basic concepts in Molecular Biology** Introduction and historical development - Central dogma of Molecular biology - Discovery of genetic material- Structure, organization and types of DNA and RNA– Extra chromosomal DNA(Plasmid) - molecular organization of chromosome and Genes.	13
II	**Mutations** Spontaneous and induced mutations, base pair changes, frame shifts, deletions, inversions and duplications, insertions, useful phenotypes (auxotrophic, conditional lethal, resistant), reversion vs suppression, Ames test.	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 and repair mechanisms.	13
IV	**Gene structure and expression** Organization of genes in prokaryotes & Eukaryotes. Molecular mechanism and Enzymology of Transcription in prokaryotes and	13

	Eukaryotes, Post transcriptional modifications, Genetic code, Molecular mechanism and Enzymology of Translation of proteins in prokaryotes and Eukaryotes, Post translational modifications. Regulation of gene expression in prokaryotes– Operon concept– lac & trp Operon.	
V	**Recombination and Gene Transfer mechanisms:** Genetic analysis and Molecular basis of recombination in bacteria. Gene transfer mechanisms-Transformation: natural transformation, competence, DNA uptake, roleof natural transformation, artificially induced competence, electroporation. Transduction (generalized and specialized). Conjugation**:**self-transmissible plasmids, F factor, *tra*genes, on T,F' and Hfr strains, steps in conjugation, chromosomemobilization, transfer systems in Gram Positive bacteria.	12
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. E.J. Gardner, M.J. Simmons, D.P. Snustad, 2006. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York. **References** 1. Lansing M. Prescott, John P. Harley and Donald A. Klein(2008). Microbiology(7th Ed.). Mc Graw Hill companies. 2. Buchanan, Gruissum and Jones, (2000). Biochemistry and Molecular Biology of Plant; ASPP, USA. 3. David Rawn(2012). Biochemistry. Panima Publishers. 4. Richard Calendar (2005). The Bacteriophages, 2nd Edition, Oxford University Press. 5. 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 Out comes	**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: Compare the differences of transcription & translation process in prokaryotes with eukaryotes CO5: Describe the mechanisms of gene transfer and recombination in bacteria	

Mapping of COs with PSOs:

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

Semester	**THIRD**	Course Code	**21MIBU0306**
Course Title	**PRACTICAL III: MOLECULAR BIOLOGY**		
No. of credits	1	No. of contact hours per week	3
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	40%
Category	Core course		
Scope of the Course	❖ Basic understanding on genetic marker ❖ 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 molecular techniques K-2 Comprehensive knowledge on mutants K-3 Use molecular techniques for better understanding of DNA K-4 Capacity to understand separation of DNA and protein K-5 Make new techniques to analyse mutagenesis K-6 Assessment of DNA amplification by PCR		
Course Objectives	**The course aims to:** • impart a practical knowledge on how to measure isolate single colony and checking genetic marker • demonstrate antibiotic resistance mechanism • conduct genetic mapping studies • determine transposon mediated mutagenesis • perform mutagenesis and isolate chromosomal and plasmid DNA		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Single colony isolation and checking genetic markers.	6
2.	Isolation of antibiotic resistant and auxotrophic mutants.	6
3.	Transformation in *E.coli*	6
4.	Isolation of chromosomal DNA from *E.coli / Yeast*	6
5.	Estimation of DNA by spectrophotometry	3
6.	Plasmid DNA isolation and	3
7.	Restriction digestion of genomic DNA	3
8.	Separation of plasmid and genomic DNA by agarose gel electrophoresis	3
9.	Separation of protein by PAGE and determination of molecular weight	6
10	DNA amplification by PCR	6
	Total Hours	48

References	1. Sambrook J and Russell DW (2001). Molecular cloning - A laboratory manual, Cold Spring Laboratory Press, New York, 3rd Edition. Vol. 1, 2, 3. 2. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd Edition; ASM press; 2007. 3. Methods for General and Molecular Bacteriology. 1994. R.G.E. Murray, Willis A. Wood, Noel R. Krieg,ASM Press. 4. Experiments with Gene Fusions.1994. T.Silhavy. Cold Spring Har bour Lab.Press. 5. Dubey, R.C and Maheswari, D.K. 2012. Practical Microbiology, 3 Ed Revised., Chand and Company Ltd., India. 6. Breed and Buchanan2003. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) . 7. Short course in Bacterial Genetics. J.H.Miller. 1992.CSHLaboratories. 8. Surzyeki S (2000). Basic Techniques in Molecular Biology, Springer.
Course Outcomes	**Upon completion of this practical course, students should be able to:** CO 1: Explain how to measure isolate single colony and checking genetic marker CO 2: Demonstrate the antibiotic resistance mechanism CO 3: Carry out mutagenesis and isolate chromosomal and plasmid DNA CO 4: Determine molecular weight of protein using PAGE CO5: Demonstrate PCR

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	**FOURTH**	Course Code	**21MIBU0407**
Course Title	**MICROBIAL PHYSIOLOGY AND METABOLISM**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	• Core Course		
Scope of the Course	• Students will be able to develop basic skills in microbial physiology • Students will be able to develop their skills on and microbial metabolism		
Cognitive Levels addressed by the Course	K-1: Remember bacterial morphology and ultra structure K-2: Understand motility and sporulation K-3: Apply to know microbial nutrition and growth K-4: Analyze newly emerging and life threatening diseases and control measures K-5: Evaluate photosynthesis, carbon assimilation and bacterial metabolism K-6: Create knowledge on microbial physiology and metabolism		
Course Objectives	The Course aims to: • make the students knowledgeable on bacterial morphology and cell wall composition • give an outline on the processes involved in motility, sporulation and quorum sensing • provide an in-depth knowledge on microbial nutrition and growth. • highlight photosynthetic pathways in different bacterial groups. • expose the students to the mechanisms of bacterial respiration and energy generation.		

UNIT	Content	No. of Hours
I	**Microbial nutrition and growth:** Nutritional types – autotrophs, heterotrophs, lithotrophs and organotrophs. Transport mechanisms –diffusion-active transport. Definition of growth, Growth curve, generation time and specific growth rate. Batch culture, Continuous culture– synchronous and asynchronous culture. Factors influencing microbial growth – pH, temperature, pressure, salinity, oxygen, etc.,	9
II	**Photosynthesis and Carbon assimilation:** Photosynthesis – Oxygenic and anoxygenic, photosynthetic and accessory pigments - chlorophyll - bacteriochlorophyll- rhodopsin- carotenoids-phycobiliproteins. Carbon dioxide fixation, Calvin cycle.	9
III	**Respiratory metabolism:** Embden Meyerhof pathway- Entner Doudroff pathway, alcoholic fermentation, TCA cycle, Gluconeogenesis - Pasteur effect, Glyoxalate cycle, Electron transport chain, Substrate level and Oxidative phosphorylation, Pentose phosphate pathway. Fermentation of Carbohydrates – homo and hetero-lactic fermentations	10
IV	**Bacterial cell structure formation and motility:** Composition and cell arrangement structure and biosynthesis of cell wall in Gram positive and Gram negative bacteria. Organs of locomotion- cilia, flagella, pili or fimbriae. Swarming motility, gliding motility and motility in spirochete – chemotaxis.	10
V	**Differentiation in bacterial cells and Quorum sensing:** Differentiation in bacterial cells- sporulation and morphogenesis-	10

	structure and properties of endospore - germination and outgrowth of bacterial endospores - Dormancy. Bacterial cell division, replication of bacterial chromosome, co-ordination of cell division with replication of chromosome, partitioning of chromosome into daughter cells. Microbial biofilms and quorum sensing.	

References

Text Books:

1. Byung Hong Kim and Geoffrey Michael Gadd. 2008. Bacterial Physiology and Metabolism. Cambridge University Press, UK.
2. Albert G. Moat, John W. Foster and Michael P. Spector, 2002. Microbial Physiology, 4th Edn. Wiley Liss.
3. Salle, A.J, 2007. Fundamental Principles of Bacteriology, VII Ed., Tata McGraw Hill Book Company, New Delhi.

Reference Books:

1. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 2012. Biochemistry VII Edition. W.H. Freeman and Company, New York
2. David L. Nelson and Michael M. Cox, 2017. Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York
3. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2010. Microbiology. 5th Ed. Tata McGraw Hill Book Company, New Delhi.
4. Roger Y. Stanier., John L. Ingraham., Mark L.Wheelis., Page R.Painter., 2003. General Microbiology, V Ed., Macmillan Press Ltd., New Jersey.
5. Charu Gera and S. Srivastava, 2006. Quorum- sensing: The phenomenon of microbial communication, Current science. 90: 666-676.
6. Lansing M. Prescott, John P. Harley and Donald A. Klein, 2002 Microbiology. V Ed. WCB/McGraw Hill Company.

E-Resources:

a. http://www.microbiologyonline.org.uk/links.html
b. http://www.edu.pe.ca/southernkings/microbacteria.htm
c. https://ocw.mit.edu/courses/biology/

Course Outcomes

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

CO1: Explain various microbial nutrition and growth curve.
CO2: Delineate the principle and mechanisms of bacterial photosynthesis and carbon assimilation.
CO3: Describe the pathways involved in bacterial respiration
CO4: Discuss the bacterial cell wall composition, morphology and replication.
CO5: Outline the principle mechanisms of motility and sporulation in microorganisms.

Mapping of COs with PSOs:

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

Semester	**FOURTH**	Course Code	**21MIBU0408**
Course Title	**IMMUNOLOGY AND VIROLOGY**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	40%
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on immunology and virology • Students will be able to develop Employability in clinical field		
Cognitive Levels addressed by the Course	• K-1: Remember Concept and scope of immunology and virology • K-2: Understand cells and organs of immune system Emerging viruses • K-3: Apply to know immunological techniques and diagnosis of viruses • K-4: Analyze structural features, functions and responsiveness of immune system • K-5: Evaluate principles underlying the preparation of vaccines • K-6: Create knowledge on immunology and virology		
Course Objectives	The Course aims to: • elaborate the structural features of the components of the immune system as well as their functions and responsiveness. • introduce the basics of antigen and antibody • impart basic knowledge hypersensitivity reactions and autoimmune diseases. • gain an in depth knowledge on bacteriophages, plant and animal viruses • give an insight on vaccines and monoclonal antibody production		

UNIT	Content	No. of Hours
I	**Introduction to Immunology:** Historical background, innate and acquired immunity, humoral and cell mediated immunity, organs and cells involved in immune response, identification and characterization of T and B cells, cell surface receptors, cellular cooperation, MHC restriction,	9
II	**Antigen and antibodies and Antigen – antibody reactions** Antigen characteristics, types of antigens, adjuvants, immunoglobulin structure properties, theories of antibody diversity, complement, complement Activation. *In-vitro* Methods - agglutination, precipitation, complement fixation, immunofluorescence, ELISA, Radio immunoassays; *In-vivo* Methods: skin tests and immune complex tissue demonstrations.	10
III	**Hypersensitivity reactions and autoimmune diseases:** Hypersensitivity reactions – Antibody mediated - Type I anaphylaxis – Type II Antibody dependent cell cytotoxicity – TypeIII Immune complex reactions - the respective disease and immune response - Lymphokines, cytokines - Type IV hypersensitivity reactions. Autoimmune diseases – Rheumatoid arthritis, Systemic lupus erythematosus, Multiple sclerosis. Types of grafts, graft rejection – properties and types of rejection; tissue typing, immunosuppressive therapy.	10

IV	**Virology: Bacteriophages and Plant Viruses:** Introduction to virology - Outline Classification and General characteristics. Bacteriophages – T4, λ phages, M 13 and ϕ x174. Plant viruses - TMV, sugar cane mosaic virus, peanut stunt virus, cauliflower mosaic virus.	9
V	**Animal viruses and Vaccines:** DNA containing animal viruses - Adeno viruses, Herpes viruses-type-I and type-II, Pox viruses – Variola virus. RNA containing animal viruses: Picorna virus, Rhabdo virus, Hepatitis viruses -A, B and C, Orthomyxo virus – Influenza H1N1, Paramyxovirus, Retroviruses – HIV, Rubella virus and Corona virus, Arbo virus – Dengue virus, Ebola virus, Prions. Principles underlying the preparation of live, attenuated vaccines and recombinant vaccine. Monoclonal antibody - production and application.	10
References	Text Books: 1. Judith A. Owen, Jenni Punt, Sharon A. Stanford, 2013. Kuby Immunology, 7th Edn. W. H. Freeman and Company, New York 2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2016. Essential Immunology, 13 Ed. Blackwell Scientific Publishers. USA. 3. Ananthanarayanan and Jayaram Panicker. 2016.Textbook of Microbiology, 7 Ed. Orient Blackswan, Hyderabad 4. Flint, S. J., Enquist, L. W., Racaniello, V. R., and Skalka, A. M. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, 2nd ed. 944 pp. ASM Press, Washington, DC, 2004.	
	Reference Books: 1. Dimmock. N.J and Eatson, A.J., Leppard, K.N. (2016). Introduction to Modern Virology. VII edition. Blackwell Scientific Publications, Oxford.7th Edition. 2. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2010. Microbiology. 5th Ed. Tata McGraw Hill Book Company, New Delhi. 3. David Greenwood, Richard Slack and John Peutherer. (2000). Medical Microbiology.15th edition, Church Hill Living stone Publication. 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. 3.Bailey and Scott‟s Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby 4.Essentials of Diagnostic Microbiology – Lisa Anne Shimeld, Anne T. Rodgers,	
	E-Resources: a) https://www.microbe.net/resources/microbiology/web-resources/ b) guides.emich/immunology http://oew.mit.edu/courses/.../hst-176-cellular-and molecular.Immunology -fall-2005 c) https://www.google.com/search?channel=nrow5&client=firefox-b-d&q=animal+viruses+and+diagnosis	

Course Outcomes	On completion of the course, students should be able to: CO1: Discuss the structural features of the components of the immune system as well as their functions and responsiveness. CO2: Explain the basics of antigen and antibody CO3: Understand the processes in hypersensitivity reactions and autoimmune diseases. CO4: Describe the structure of different viruses infecting bacteria and plants CO5: Distinguish DNA and RNA based viruses

Mapping of COs with PSOs:

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

Semester	**FOURTH**	Course Code	**21MIBU0409**
Course Title	**MEDICAL MICROBIOLOGY**		
No. of Credits	**3**	No. of contact hours per Week	**3**
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	20
Category	Core Course		
Scope of the Course	❖ students gain the knowledge of common medically important microorganism and the diseases ❖ Learn diagnostic approaches for microbial pathogens and various control measures		
Cognitive Levels addressed by the Course	K-1: Remember the basics of medical microbiology and Epidemiology K-2: Understand the mechanisms of pathogenesis K-3: Apply to know host parasite relationship and virulence factors associated with the pathogen. K-4: Analyze the 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	The Course aims to • introduce the history and basic concepts of medical microbiology • gain an in-depth knowledge on microbial pathogenesis • impart basic knowledge on bacterial diseases, prevalence and virulence factors associated with the pathogen. • give an insight on different viral and fungal diseases • provide outline on prevention and control of microbial diseases		

UNIT	Content	No. of Hours
I	**Introduction to medical microbiology** Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. Importance of Microbiology in Medicine. Epidemiology and Public Health: Classification of medically important microorganisms; Normal microbial flora of human body; role of the resident flora; normal flora and the human host	**9**
II	**Mechanisms of microbial pathogenesis:** Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response.	**10**
III	**Bacterial diseases:** Classification of pathogenic bacteria - mode of transmission, pathogenesis, Symptoms, laboratory diagnosis, treatment and prevention of the bacterial diseases caused by *Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium*, *Vibrio*, *Yersinia*, *Haemophilus*, *Mycobacterium*, Spirochetes, Bordetella, Rickettsiae, *Chlamydia*.	**10**
IV	**Viral and Fungal diseases:** General properties of pathogenic viruses - mode of transmission, pathogenesis, Symptoms, laboratory diagnosis, treatment and prevention of	**13**

	Pox viruses; Herpes virus, Hepatitis viruses, Human Immuno deficiency viruses (HIV), and Coronavirus. Fungal diseases of man, Epidemiology. Dermatophytes, dimorphic fungi. Superficial mycoses, Subcutaneous mycoses and Systemic mycoses. Opportunistic fungal pathogens.	
V	**Prevention of microbial infection and control:** Antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules. Emergence of multi drug resistant bacterial, fungal pathogens, extremely drug resistant (XDR) pathogens and superbugs	**12**
References	**Text Books:** 1. Jawetz, Melnick and Adelberg's (2013) Medical Microbiology 22nd edition McGraw Hill Medical Publication division 2. David Greenwood, Richard Slack and John Peutherer. (2000). Medical Microbiology.15th edition, Church Hill Living stone Publication. 3. Ananthanarayanan and Jeyaram Paniker. 2016. Textbook of Microbiology, 7th Edition, Orient Publication, New Delhi	
	Reference Books: 1. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg, 2010. Microbiology. TATA McGraw Hill, New Delhi. 2. Baron EJ, Peterson LR and Finegold SM Mosby, 2013. Bailey and Scott's Diagnostic Microbiology. 13 Ed. 3. 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 4. Hacker J and Dorbindt U. ed. 2006. Pathogenomics: Genome analysis of pathogenic microbes. Wiley- VCH. 5. Prescott, Harley and Klein. Microbiology; McGraw-Hill (2003). 6. Molecular Toxicology; Nick Plant, Garland Science (2003). 7. 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.	
	E-Resources 1. . https://www.microbe.net/resources/microbiology/web-resources/ 2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php	
Course Outcomes	On completion of the course, students should be able to: CO1: Understand the basic concepts of medical microbiology CO2: Explain the processes in microbial pathogenesis CO3: Familiar with bacterial diseases, epidemiology and virulence factors associated with the pathogen. CO4: Compare and contrast between different viral and fungal diseases CO5: Describe the measures in prevention and control of microbial diseases	

Mapping of COs with PSOs:

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

Semester	FOURTH	Course Code	21MIBP0410
Course Title	**PRACTICAL-IV: MICROBIAL PHYSIOLOGY, IMMUNOLOGY, VIROLOGY AND MEDICAL MICROBIOLOGY**		
No. of Credits	1	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	• Students will be able to develop basic skills in microbial physiology, clinical microbiology, virology and immunology • Students will be able to develop their skills on medical microbiological techniques		
Cognitive Levels addressed by the Course	K-1: Ability to remember the basic concepts in microbial physiology, clinical microbiology, virology and immunology techniques K-2: Understand measurement of microbial growth and Physiological characterization of bacteria K-3: Comprehensive knowledge on isolation of bacteriophages K-4: Capacity to analyse clinical samples to diagnose the disease condition K-5: Make new techniques to demonstrate ELISA K-6: Assessment of techniques in virology, immunology and medical microbiology		
Course Objectives	The Course aims to: • impart a practical knowledge on how to measure bacterial growth curve and calculate generation time • demonstrate through experiments, the effects of environmental factors on growth of bacteria • identify unknown bacteria and fungi based on biochemical and culture characteristics • 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		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Measurement of microbial growth- cell count, turbidity method, standard plate count and cell biomass	3
2.	Effect of pH, temperature and salinity on bacterial growth.	3
3.	Morphology of microorganisms: Morphological variations in algae (Diatoms, Chlamydomonas, & Volvox). Morphological variations in Cyanobacteria (*Oscillatoria, Nostoc, & Anabaena*), Morphological variations in fungi (*Mucor, Aspergillus, & Penicillium).*	3
4.	Physiological characterization of bacteria: IMViC test, H_2S, Oxidase, catalase, urease test, gelatin liquefaction, casein, starch hydrolysis. Carbohydrate fermentation.	3

5.	Selection, collection, and transport of specimens, blood samples, sera for microbiological and immunological examinations	3
6.	Isolation of Bacteriophages from sewage and natural environments	3
7.	Study of virus infected plant samples	3
8.	Isolation and enumeration of Anaerobic bacteria from wound specimen.	3
9.	Isolation and identification of Human pathogenic fungi and other opportunistic organisms.	3
10.	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
11.	ABO Blood grouping and Rh typing	3
12.	Agglutination tests a) WIDAL b) VDRL Test (RPR). c) RA d) ASO (Anti streptolysin 'O' Test). e) HBs Ag Test	3
13.	Precipitation Tests a) Immunodiffusion test b) Immunoelectrophoresis	3
14.	Demonstration of ELISA (HIV & HBs Ag)	3
15.	Visit to Diagnostic Labs and Hospitals	6
References	1. Dubey, R.C and Maheswari, D.K. 2012. Practical Microbiology, 5 Ed., Chand and Company Ltd., New Delhi. 2. Aneja. K.R, 2017. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, 5 Ed. New Age International publishers (P) Ltd, New Delhi. 3. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panima Publishing Corporation, New Delhi. 4. Sundararaj T. 2005. Microbiology laboratory manual. Revised and published by Aswathy Sundararaj. No.5 First cross street, Thirumalai nagar, Perungudi, Chennai. 5. James. G. Cappucino. And Natabe Sherman, 2014. Microbiology – A Laboratory Manual, X Ed., Pearson Education (Singapore) Pvt. Ltd., India. 6. Harold J Benson, 2016. Microbiological Applications - Laboratory Manual in General Microbiology. 14 Ed., Me Grew-Hill, Boston. 7. 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. 8. Turgeon, M.L., 1990. Immunology and serology in laboratory medicine, St.Louis, C.V. Mosby Co. 9. Talwar G.P and Gupta S.K(1992). A hand book of practical and clinical immunology. CBS Publication, New Delhi, India 10. E. D. Harlow, David Lane, 2014. Antibodies– A Laboratory Manual; 2nd Edn. CSHL Press	

	11. D. Harlow, David Lane (2014). Antibodies– A Laboratory Manual; 2nd Edn. CSHL Press 12. 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/ https://www.abpischools.org.uk/topic/diseases/
Course Outcomes	On completion of the 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: Enumerate and identify pathogenic bacteria and fungi from clinical samples CO5: Perform agglutination tests to diagnose diseases

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	1	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

Semester	**FIFTH**	Course Code	**21MIBU0511**
Course Title	**FOOD AND DAIRY 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%)	40%
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products • Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food and dairy microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food and dairy products 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 and dairy industries		
Course Objectives	The Course aims to: • introduce the scope and development of food microbiology • highlight fermentation technologies in the dairy and food processing industry. • create awareness among the students about the dairy and 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 and dairy industry		

UNIT	Content	No.of Hours
I	**Microbiology of Foods** Introduction - History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic & Extrinsic factors - pH, moisture, water activity, oxidation-reduction potential, nutrient contents.	13
II	**Food poisoning, Food-borne diseases and food preservation** Food infection and Food intoxication. Microbial contamination of foods –Food spoilage by microbes in meat, vegetables and canned food. Food borne infections – Bacterial, Fungal and viral infections. Methods of food physical preservations – drying, heat processing, chilling, and freezing, radiation - chemical methods – Nitrates, Nitrites.	13
III	**Dairy Microbiology** Introduction - Physical and chemical properties of milk. Processing of milk - homogenization, storage, and transportation. Judging and grading of milk and its products. Pasteurization and its types, Microbiological analysis of milk- DMC, SPC, MBRT, Resazurin test, Alkaline phosphatase test. Microbial contamination in milk - *Clostridium, Salmonella, Shigella, Staphylococcus* and *Campylobacter* and milk borne diseases.	13

IV	**Dairy and fermented Products** Fluid milk products and dried milk Products. Skimmed milk powder, other dairy products: Ice Cream, Butter, Whey. Milk Fermentation – Yoghurt, butter milk and Kefir.	13
V	**Quality Control and Standards** Food hygiene and sanitation - Food control agencies and their regulations - Food standards - GMP, HACCP, FSO, FSSAI, FDA, BIS Systems for food safety	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. BlackwellPublishers, UK. 4. Jay, J.M.2000 Modern Food Microbiology 6th Ed. AspenPublication, USA.
	Reference Books: 1. Carl,A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press,London. 2.Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgrawHill publishingCo., New Delhi. 3. Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd.,New Delhi. 4. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 5. Jay,J.M.2000 Modern Food Microbiology 6th Ed. Aspen Publication, USA. 6. Joshi V. K and Ashok Pandey. 1999. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. (VOL II).
	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 to:** CO1: Explain the role of microorganisms in food and factors influencing their growth. CO2: Discuss and demonstrate an overview on food spoilage organisms- Food borne diseases. CO3: Assess the techniques/processes used in microbial products using fermentation technology. CO4: Delineate the processes of sanitation in dairy industries CO5: Describe the aspects of quality assurance of milk especially HACCP and FDA

Mapping of Cos with PSOs:

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

Semester	**FIFTH**	Course Code	**21MIBU0512**
Course Title	**INDUSTRIAL MICROBIOLOGY**		
No.of Credits	4	No.of contact hours per Week	4
New Course / Revised Course	Revised Course	If revised ,Percentage of Revision effected (Minimum20%)	30%
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries • Students can execute field Projects on the microbial fermentations		
Cognitive Levels addressedby the Course	K-1 Ability to remember basic concepts in Industrial microbiology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives	The Course aims to: • understand industries involving microbial technology • make knowledge on production of various industrial microbial products. • know the various techniques used in industries. • impart the functioning of bioreactors • create a comprehensive knowledge on upstream and downstream processing		

UNIT	Content	No.of Hours
I	**Introduction to industrial microbiology** History and concept of industrial microbiology – principle, construction and design of fermenter, types - aseptic containment, control and monitoring variables - Agitator, Aerator, Pressure Gauge, pH, DO probe.	13
II	**Screening methods for Industrially important microbes** Isolation of industrially important microbes and Screening methods - Strain selection and improvement - mutation and recombinant DNA technology.	13
III	**Fermentation process** Fermentation - batch, fed batch and continuous. Upstream fermentation process- Principles of media formulations - Raw materials used in media production. Media formulation strategies - carbon, nitrogen, vitamin, mineral sources, and anti-foaming agent. Industrial sterilization methods - Concepts of inoculum development. Down-stream processing – recovery and purification of fermented products – cell disruption, solvent extraction, chromatography and drying.	13
IV	**Large scale cultivation of microbes and Industrial production** Large scale cultivation of industrially important microbes. Industrial products derived from microbes- intracellular and extra cellular -fermented products- production of beverages (wine & beer) - organic acids (vinegar, & lactic acid) - enzymes (amylase, & protease), antibiotics (penicillin & strptomycin), and single cell protein, - Importance and production of Single cell protein (SCP).	13

V	**Industrial waste disposal and its regulation** Novel approaches to industrial effluent treatment and disposal – EPA's Guide for Industrial Waste Management - Institutional Bio-safety committee.	12
References	**Text Books:** 1. Casida, L.E. 2015. Industrial Microbiology, New Age International Pvt, New Delhi 2. Stanbury, P.F., Whittaker, A. and Hali, S.J. 2017. Principles of FermentationTechnology, III Ed., Butterworth-Heinemann, Elsevier, UK 3. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi.	
	References: 1. V. K. Joshi and Ashok Pandey. 2009. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology, Vol -2. Educational Publishers & Distributors, Kochi, India. 2. Prescott and Dunn's. 2005. Industrial Microbiology. CBS publishers and Distributors. New Delhi 3. Patel A.H. 2011. Industrial Microbiology, Laxmi Publications, New Delhi 4. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.	
	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 to: CO1: Discuss historical aspects of industrial microbiology and fermentation techniques CO2: Compare screening methods for Industrial microbes CO3: Explain the biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial microbiology	

Mapping of Cos with PSOs:

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

Semester	**FIFTH**	Course Code	**21MIBU0513**
Course Title	**AGRICULTURAL 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%)**	
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on agricultural microbiology • Students will be able to develop Employability in agriculture		
Cognitive Levels addressed by the Course	K-1: Remember Concept of soil and microbes involved in agriculture K-2: Understand the importance of nitrogen fixation K-3: Apply to know the role of microbes in biogeochemical cycle K-4: Analyze the production of biofertilizers K-5: Evaluate the types and role of biopesticides K-6: Create knowledge on microbes in agriculture		
Course Objectives	The Course aims to: • impart in-depth information on soil and agriculture • make the students understand the role of microbes in agriculture • give an overview on plant microbe interaction. • make the students to know about various techniques involved in biofertilizers production • introduce the importance of biofertilizers and biopesticides		

UNIT	Content	No. of Hours
I	**Soil Microbiology:** Soil- formation, soil structure, soil types. Physical and chemical properties of soil. Microbes in soil – types, abundance, distribution, factors influencing microbial activity in soil.	13hrs
II	**Microbial transformations of minerals:** Biogeochemical cycles-Carbon, Nitrogen, Phosphorous and Sulphur cycles. Organic matter decomposition ,humus formation and C:N ratio.	13hrs
III	**Biological Nitrogen fixation:** Microorganisms in the Rhizosphere, Rhizoplane and Phylloplane-Biological nitrogen fixation, symbiotic and free living nitrogen fixation, nitrogenase- structure and function - Genetics of N_2 fixation- importance of nitrogen fixation.	13hrs
IV	**Types and production of Biofertilizers:** Biofertilizers – Importance and various types of Biofertilizer *Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla*, Phosphate solubilizing microorganism-Mycorrhizal biofertilizers, PGPR - *Pseudomonas* Sp. Biofertilizers production, quality control and BIS specification .	13hrs
V	**Plant pathogenic microorganisms and Biopesticides:** Characters of plant pathogens, symptoms and control measures of bacterial, fungal and viral diseases. Microbial pesticides-classification, mode of action of bacterial pesticides (*Bacillus thuringiensis*), fungal (*Trichoderma viride*) and viral pesticides (NPV).	12hrs

References	Text Books: 1. Subba Rao, N. S., 2019. Biofertilizers in Agriculture and Forestry, 4 Ed., Cbs Publ & Dist Pvt Ltd, New Delhi. 2. Subba Rao, N. S. 1995. Soil microorganisms and plant growth. Oxford & IBHPublishing Co.Pvt.Ltd. New Delhi. 3. Martin Alexander, 1983. Introduction to Soil Microbiology, Wiley eastern Ltd., NewDelhi.
	Reference Books: 1. Gupta, S.K., 2014 Approaches and trends in plant disease management. Scientific publishers, Jodhpur, India. 2. Jamaluddin *et al*., 2013 Microbes and sustainable plant productivity. Scintific Publishers Jodhpur, India. 3. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 4. Glick, B.R. AND Pasternak, J.J, 1994. Molecular Biotechnology, ASM Press, Washington DC. 5. Purohit, S. S., Kothari, P. R. and Mathur, 1993. Basic and Agricultural Biotechnology, Agrobotanical Publishers (India). Bikaner.
	E-Resources: 1.https://microbewiki.kenyon.edu/index.php 2.https://www.elsevier.com/books/advances-in-agricultural-microbiology/subba-rao/ 3.https://en.wikipedia.org/wiki/Agricultural_microbiology
Course Outcomes	On completion of the course, students should be able to do CO1 :Outline the physico- chemical aspects of the soil and its microbial diversity CO2: Evaluate the role of microbes in the different biogeochemical cycles and in agriculture CO3: Discuss biological nitrogen fixation in symbiotic and non symbiotic associations with plants. CO4: Explain the value, production, application and crop response of biofertilizers CO5: Apply the knowledge on biopesticides and their role in pest control.

Mapping of COs with PSOs:

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

Semester	FIFTH	Course Code	21MIBU0515
Course Title	PRACTICAL-V: FOOD, DAIRY AND INDUSTRIAL MICROBIOLOGY		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	40%
Category	• Core Course		
Scope of the Course	• Students will be able to develop their practical skills on to isolate food pathogenic microorganisms from contaminated food. • Students can execute fermentation process to make various fermented products.		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food, dairy and industrial microbiology 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	The Course aims to: • provide practical knowledge and skills in production as well as evaluate microbial quality of food products. • make the modern technical capabilities to analyse food for specific microorganisms • 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 • extend knowledge on traditional fermented products to industrial fermentation products in the applied areas of food microbiology • give skills in immobilization of microorganisms		

EXP. No.	EXPERIMENTS	No. of Hours
1	Food microorganisms- direct cell count and direct plate cell count from food sample	3
2	Isolation of lactic acid bacteria from milk sample	3
3	Assessment of milk quality by phosphatase test for pasteurized milk.	3
4	Wine production from grapes - analysis of physiochemical parameters	3
5	Enumeration of anaerobic bacteria from food samples	3
6	Observation of food samples to study *Lactobacillus* and *Saccharomyes*	3
7	Isolation and identification of microorganisms from canned foods	3
8	Immobilization of yeast cell using sodium alginate	3
9	Production of Citric acid using *Aspergillus niger*	3
10	Production of Cellulase by solid state fermentation	3

11	Starch (Amylase), casein (Protease) and lipid (Lipase) hydrolyses tests	3
12	Visit to Food, dairy, and Fermentation Industries	12
	Total Hours	**48 hrs**
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. 4. K. R. Aneja. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.. New Delhi. India. 5. Kannan N, 2003..Handbook of laboratory culture media, Reagents, Stains and buffers. Panimalar Publishing Corporation, New Delhi.	
Course Outcomes	On completion of the course, students should be able to: 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 for the production of fermented foods. CO5: Demonstrate practical skills in immobilization of microorganisms.	

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	**FIFTH**	Course Code	**21MIBU0515**
Course Title	**PRACTICAL-VI: AGRICULTURAL MICROBIOLOGY**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on agricultural microbiology • Students will be able to develop employability in biofertilizers production		
Cognitive Levels addressed by the Course	K-1: Remember Concept of microbial isolation from soil and root nodules K-2: Understand organic matter degradation in soil K-3: Apply to know biofertilizers production techniques K-4: Analyze the plant microbial interaction K-5: Evaluate the isolation and role of biopesticides K-6: Create knowledge agricultural microbiology		
Course Objectives	The Course aims to: • provide practical knowledge in the isolation and characterization of microbes important in agriculture. • comprehend plant-pathogen interactions • gain expertise in isolation of organisms that have the potential of biofertilizers • provide skills for biofertilizer production • impart training on Study of plant pathogens		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Isolation and Enumeration of Bacteria, Fungi and Actinomycetes from soil	6
2.	Determination of organic matter decomposition in soil	3
3.	Isolation of antagonistic microorganisms from soil	3
4.	Isolation and authentication of *Rhizobium* from legume root nodules	3
5.	Isolation of *Azotobacter* from soil	3
6.	Isolation of *Azospirillum* from roots	6
7.	Examination of Mycorrhizae-AM	6
8.	Isolation of Phosphate solubilizing bacteria from soil	6
9.	Isolation and identification of cyanobacteria	6
10.	Isolation on *Trichoderma viride*	6
	Total Hours	**48**

References	1. James. G. Cappucino. And Natabe Sherman, 2014. Microbiology – A Laboratory Manual, X Ed., Pearson Education (Singapore) Pvt. Ltd., India. 2. Dubey, R.C and Maheswari, D.K. 2012. Practical Microbiology, 5 Ed., Chand and Company Ltd., New Delhi. 3. Aneja. K.R, 2017. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, 5 Ed. New Age International publishers (P) Ltd, New Delhi. 4. John G. Holt. 2000. Bergey's Manual of Determinative Bacteriology. 9 Ed. Lippincott Williams and Wilkins, USA. 5. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panama Publishing Corporation, New Delhi. 6. Sadasivam, S and Manikam, A., 1992. Biochemical methods for agricultural sciences. Wiley Eastern Ltd., New Delhi.
	E-Resources: 1.https://www.google.com/search?q=isolation+of+rhizobium+from+root+Nodule 2.https://www.google.com/search?channel=nrow5&client=firefox-b-d&q=biofertilizers+isolation+methods
Course Outcomes	On completion of the course, students should be able to: CO 1:Demonstrate the importance of microbes in agriculture CO2: Explain the methods of isolation, identification of nitrogen fixing bacteria. CO3: Use standard methods for the mass production of Biofertilizers CO4: Create expertise in examination of Mycorrhizae CO5: Discuss and demonstrate the methods to identify plant pathogens

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	SIXTH	Course Code	19MIBU0617
Course Title	APPLIED ENVIRONMENTAL 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%)**	40%
Category	• Core Course		
Scope of the Course	• Students will be able to develop their skills on environmental microbiology Students can execute Field Projects on the environmental pollution		
Cognitive Levels addressed by the Course	K-1: Remember Concept of soil and microbial interactions K-2: Understand Microbial analysis of drinking water, Aero and Aquatic microbiology K-3: Apply to know Waste management K-4: Analyze Bioremediation and Geomicrobiology K-5: Evaluate Environmental monitoring K-6: Create knowledge on Applied Environmental Microbiology		
Course Objectives	The Course aims to: • understand the current views of microbial association in various environments; • know an idea on Aero and Aquatic microbiology • critically think the role of microbes in treatment of wastes/sewage • impart information on microbial bioremediation • study the concepts of bio-safety and environmental monitoring		

UNIT	Content	No. of Hours
I	**Soil and soil microbial interactions:** Characteristics and classification of soil. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition.	13
II	**Microbial analysis of drinking water, Aero and Aquatic microbiology:** Microbial analysis of drinking water: Tests for coli forms - presumptive test confirmed test and completed tests. Aeromicrobiology - Phylloplane microflora – Aquatic microbiology.	13
III	**Waste management & Sewage Treatment** : Types of wastes characterization of solid and liquid wastes. Solid waste treatment–Nature of sewage and its composition. Sewage Treatment: Treatment methods primary and secondary(anaerobic–methanogenesis) treatments	13
IV	**Bioremediation and Geomicrobiology:** Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose and pectin. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation. Global Environmental Problems: Global Warming, Acid rain, Ozone depletion. Bio deterioration of wood and metals.	13
V	**Environmental monitoring:** Environmental regulations - Biohazards - Types of hazardous emission – Bio safety measures - Environmental Impact Assessment.	12

References	Text Books: 1. Raina M. Maier, Ian L. Pepper and Charles P. Gerba. 2008. Environmental Microbiology. Academic Press. New York. 2. Atlas, R.M. and Bartha, R. 2002. Microbial Ecology: Fundamentals and Applications. 4 Ed., Benjamin Cummings, Redwood City.CA. 3. Subba Rao, N. S. 1995. Soil Microbiology. IV Ed. Oxford & IBH Publishing Co. Pvt. Ltd.New Delhi. 4. Salle, A.J. 2007. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York.
	Reference Books: 1. Mara. D and Horan. N 2003. The Handbook of Water and Waste Water Microbiology. Academic. Press, California. 2. Clescri, L.S., Greenberk, A.E. and Eaton, A.D.1998. Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association. 3. Subba Rao, N.S. 1995. Biofertilizers in Agriculture and Forestory.3rd Ed., Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi. 4. Kumar, H.D. 1991. Biotechnology, II Ed., East – West Press Private Ltd., New Delhi. 5. Pelczar.M.J. and Reid 1986 " Microbiology". V Ed., Tata McGraw Hill Co., New Delhi.pp:593-617.

	E-Resources:
	1. https://www.microbe.net/resources/microbiology-web-resources
	2. https;//www.microbes.info/resources/3/environmental-microbiology
	3.https://blogs.ntu.edu.sg/library-resources/resource-guide-formicrobiology
	4.https://www.asm.org/division/w/web-sites.htm

Course Outcomes	On completion of the course, students should be able to: CO 1:Discuss on the soil characteristics and biogeochemical cycling CO2:Predict the importance of microbial analysis of drinking water and Aero and aquatic microbiology CO3:Explain the different aspects of waste management and sewage treatment systems CO4:Elaborate on bioremediation CO5:Evaluate the environmental monitoring regulations

Mapping of COs with PSOs:

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

Semester	**SIXTH**	Course Code	**21 MIBU0618**
Course Title	**MICROBIAL TECHNOLOGY**		
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	❖ Basic understanding on basic concepts in microbial technology ❖ Skill development for biotransformation and production of useful compounds ❖ Creates employability scope in the biotechnology industries		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in microbial technology K-2 Comprehensive knowledge on fermentation K-3 Use techniques for biotransformation and production of useful compounds K-4 Capacity to analyze pharmaceutical compounds. K-5 Make newer approaches to bio-mining and bioremediation K-6 Assessment of on biosafety, bioethics, hazards of environmental engineering		
Course Objectives	**The course aims to:** • introduce the basic concepts of microbial biotechnology and fermentation process • gain an in-depth knowledge on microbial productions of Energy and pharmaceutical products • impart basic knowledge on Bio-pesticides and Biofertilizers Microbial production. • give an insight on Bio-mining, and bioremediation • provide outline on biosafety, bioethics, hazards of environmental engineering		

UNIT	Content	No. of Hours
I	**Introduction to Microbial technology** Definition- scope, historical development in Microbial technology – Isolation, screening, selection and strain development strategies for industrially important microorganism. Mode of culturing- Batch, Continuous and Fed-batch culture methods. Microbial growth kinetics – Formulation of fermentation media - Defined and undefined media -Factors affecting fermentation. Immobilization of microbial cells / enzymes. Biosensors – definition, types and applications.	13
II	**Microbial productions** Production of biofuel from biomass - methane, alcohol and bio-hydrogen. Production of pharmaceutical compounds through microbes – TPA, Insulin, Recombinant Vaccines – production of antibodies. Steroids. Production of antibiotics	13
III	**Bio-pesticides and Biofertilizers production** Microbial production of bio-pesticides (*Bacillus thuriengiensis*). Microbial production of biofertilizers – *(Rhizobia, Azospirillum* and AM). Single cell protein (algae and yeast)	13

IV	**Bio-mining, and bioremediation** Extraction of Cu, Au, U and rare-earth elements from ore by microbes; -recovery of petroleum by microbes - Treatment of tannery effluents by microbes. Sewage Treatment. Microorganisms in bioremediation: Degradation of xenobiotics.	13
V	**Regulation in microbial technology** Rules and regulation in microbial technology - 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. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Ed, Anmol Publications Pvt. Ltd., New Delhi. 3. Trevan, M.D, Boffey, S., Goulding, K.H. and Stanbury, P. 1990. Biotechnology-The basic Principles. Tata McGraw Hill, New Delhi. 4. Subba Rao, N. S., 2019. Biofertilizers in Agriculture and Forestry, 4 Ed., Cbs Publ & Dist Pvt Ltd, New Delhi. **Reference Books** 1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S.Chand&Company Ltd., New Delhi. 2. Kumar, H.D. 1991 Biotechnology, 2nd Ed., East – West Press Private Ltd., New Delhi. 3. Demain, A.L., Solomon, N.A. 1986. "Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington. 4. Gupta, S.K., 2014 Approaches and trends in plant disease management. Scientific publishers, Jodhpur, India. **Web resources** 1.https://www.edx.org/learn/biotechnology 2. http://bmc biotechnol.biomedcentral.com 3. http://www.microbiologyonline.org.uk/links.html	
Course Outcomes	**Upon completion of this course, students should be able to :** CO1: Understand basic concepts of microbial technology and fermentation process CO2: Explain the process of microbial productions CO3: Familiar with production of Bio-pesticides and Biofertilizers CO4: Delineate the processes in bio-mining, and bioremediation CO5: Analyse and biosafety, bioethics, hazards of environmental engineering	

Mapping of COs with PSOs:

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

Semester	**SIXTH**	Course Code	**21MIBU0619**
Course Title	**BIOINSTRUMENTATION**		
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	1. To acquire bioinstrumentation skills 2. Wide opportunities in the industrial sectors 3. Promising career in the field of Microbiology		
Cognitive Levels addressed by the Course	K1- Capable of working with accuracy in the bioinstrumentation labs. K2- Production of bioproducts in the field of Microbiology K3- Assess the cellular & biomolecular processes for the bioproduct development K4- Provides significant application in various areas of Life Sciences K5- Development and application of modern technology of bioinstrumentation in Microbiology		
Course Objectives	The Course aims to: • understand the principles of microscopes • analyse the mechanism of buffer action and its applications • learn the techniques of centrifuge and chromatography • explain the principle and applications of Spectrophotometric techniques • specify the principle and applications of Electrophoresis		

Unit	Content	No. of Hours
I	**Microscopy** Microscopy- Types - general principles and applications of Light, phase-contrast, fluorescence Confocal Microscopy, Electron Microscopes (SEM & TEM), Reflection Electron Microscopes (REM) and X-Ray Microscopes.	12
II	**Buffers and pH** Principle and Applications of buffers- Mechanism of buffer action and preparation of common buffers- Acetate, citrate, phosphate and tris buffers. pH -Basic principles and working system of-pH meter.	13
III	**Centrifugation and Chromatography** Centrifugation techniques- Basic principles and Applications - Types of Centrifuges- Analytical and preparative ultra-centrifugation methods. Chromatography - Basic principles and Applications of Paper, Thin-layer, Column Gas and High Pressure Liquid Chromatography	13
IV	**Spectroscopic techniques** Principle and Applications of UV-Visible and FT-IR, AAS, Mass Spectra, and NMR	13
V	**Electrophoretic techniques** Electrophoresis- General Principles and applications of Horizontal & Vertical gel electrophoresis and immune electrophoresis.	13

References	**Text Books**
	1. C.R. Kothari and Gaurav Garg.2019. Research Methodology- Methods and Techniques. New Age International Publishers, New Delhi.pp.1-25. 2. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publishing House, New Delhi. 3. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP

	Publishers, Chennai. 4. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani 5. Rodney Boyer 2001 Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pvt. Ltd, Indian Branch, Delhi, India.
	Reference Books 1. L.Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai.pp.39-98;113-153;185-375. 2. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 3. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 4. Keith Wilson and John Walker 2002 Practical biochemistry- Principles and techniques. Fifth Edn. Cambridge Univ. Press. 5. P. Asokan 2002. Analytical biochemistry– Biochemical techniques. First Edition – Chinnaa publications, Melvisharam, Vellore
	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? Language s=language_en& pe =document
Course Outcomes	**On completion of the course, students should be able to:**
	CO1: Understand the importance of Microscopes CO2: Know the preparation of buffers and pH meter CO3: Carryout the techniques of centrifuge and chromatography CO4: Realize the principle and applications of Spectrophotometric techniques CO5: Perform Electrophoresis

Mapping of COs with PSOs

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

Semester	SIXTH	Course Code	21MIBU0620
Course Title	**PRACTICALVIII: ENVIRONMENTAL MICROBIOLOGY, MICROBIAL TECHNOLOGY AND BIOINSTRUMENTATION**		
No. of Credits	**1**	No. of contact hours per Week	**3**
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Core Course		
Scope of the Course	❖ Basic understanding on basic concepts in Environmental Microbiology ❖ Skill development for microbial production of useful compounds ❖ Creates employability scope in the bio-based industries		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in Environmental Microbiology K-2 Comprehensive knowledge on microbial association in various environments; K-3 Use techniques for air quality and aero microbiology K-4 Capacity to analyze water quality K-5 Make newer approaches to study bioinstrumentation K-6 Assessment of Microbial Fermentation		
Course Objectives	**The course aims to:** • understand the current views of microbial association in various environments; • know an idea on air quality and water quality • analyse calcium and magnesium using flame photometer • extend knowledge on microbial fermentation • impart skills for the preparation of buffers, determination of pH. and separation of molecules		

EXP. No.	EXPERIMENTS	No. of Hours
1	Soil Analysis- pH, EC, chlorides, nitrate, calcium, magnesium and total phosphorus.	**6**
2	Water analysis by MPN technique–presumptive, confirmed and completed coli form test	**3**
3	Microbial assessments of air quality–open plate technique.	**3**
4	Isolation and Total viable count of faecal bacteria from water.	**3**
5	Microbial production of bioethanol	**3**
6	Microbial production of bio-hydrogen	**3**
7	Amylase production from *Bacillus* sp.	**3**
8	Immobilization of bacterial cell using sodium alginate	**3**
9	Production of *Rhizobium* biofertilizer	**3**
10	Production of *bt* biopesticide	**3**
11	Preparation of buffers and Determination of pH in water and soil samples.	**3**
12	Separation of amino acids and sugars using paper and thin layer chromatography	**3**
13	Differential centrifugation of samples.	**3**
14	Separation of gas and organic acids using GC and HPLC	**6**
	Total hours	**48 hrs**

References	1. Atlas RM and Bartha R. Microbial Ecology Fundamentals and Applications, 3rd Ed., Benjamin and Cummings. Pub.Co.NewYork.1993.
	2. James. G. Cappucino. And Natabe Sherman, 2014. Microbiology – A Laboratory Manual, X Ed., Pearson Education (Singapore) Pvt. Ltd., India.
	3. Rajan.S and Selvi Christy R. Experimental Procedures in Life Sciences. Anajanaa Book House, Chennai
	4. S. Palanichamy and M. Shunmugavelu 2009. Research methods in Biological Sciences. Palani paramount publications, Palani
	5. Rodney Boyer 2001 Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pvt. Ltd, Indian Branch, Delhi, India.
	
	Web resources:
	1. https://www.microbe.net/resources/microbiology-web-resources
	2. https;//www.microbes.info/resources/3/environmental-microbiology
	3.https://blogs.ntu.edu.sg/library-resources/resource-guide-formicrobiology
	4.https://www.asm.org/division/w/web-sites.htm

Course outcomes	**Upon completion of this course, students should be able to:** CO 1: Conduct experiments on microbial quality of air & water CO 2: Evaluate microbiological assessment of soil samples CO 3: Develop practical skill molecular and biotechnological techniques CO 4: Produce microbial products in lab scale CO5: Demonstrate on bio-instruments

Mapping of COs with PSOs:

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

Semester	FOURTH	Course Code	21MIBU04D1
Course Title	ELECTIVE -DISCIPLINE CENTRIC: MICROBIAL GENETICS		
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	ELECTIVE -DISCIPLINE CENTRIC		
Scope of the Course	❖ 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 Levels addressed by the Course	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	The Course aims to: • 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. 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	10
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.	10
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.	10
References	**Text Books:** 1. Stanley R. Maloy, John. E. Cronan, Jr. and David Freifielder. 2004. Microbial Genetics. II Ed. Jones & Bartlett Publishers. London. 2. Uldis N. Streips, Ronald E. Yasbin. 2002. Modern Microbial Genetics, 2nd Edition, Wiley. 3. Lori A.S. Snyder. 2020. Bacterial Genetics and Genomics. Garland Science Publisher. **Reference Books:** 4. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2019. Prescott's Principle of Microbiology, 9th Ed., Mc Graw Hill, New York. 5. Dubey, R.C and Maheswari, D.K 2013. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 6. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2010. Microbiology. 5th Ed. Tata McGraw Hill Book Company, New Delhi. Lansing M. Prescott, John P. Harley and Donald A. Klein. 1999. Microbiology. 4th Ed. WCB/McGraw Hill Company. pp: 255 to 309. 7. S. Biwasis and Amita Biswas. 1998. An Introduction to Viruses. Vikaas Publishing House Pvt. Ltd. pp: 175-208. 8. Glick, B.R. AND Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. pp: 207-232. 9. Hans G. Schlegel. 2012(Reprint). General Microbiology. VIIEd.Cambridge University Press. UK.. 10. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd., New Delhi. **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 to: CO1: Outline the genes and mechanisms of mutation CO2: Discuss the different gene transfer mechanisms CO3: Explain plasmids and their applications CO4: Acquire knowledge on bacteriophages CO5: Design of vaccines	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
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	**21MIBUO4D2**
Course Title	**ELECTIVE -DISCIPLINE CENTRIC: MEDICAL PARASITOLOGY AND ENTOMOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised	If revised, Percentage of revision effected (Minimum 20%)	30%
Category	**ELECTIVE -DISCIPLINE CENTRIC**		
Scope of the Course	1. Understand the concept of entomology and parasitology 2. Know the different types of parasites 3. Learn the laboratory skills for examination of parasitic infection		
Cognitive Levels addressed by the Course	K1- Analyze the mechanism of disease transmission K2- Assess the various vector control measures K3- Identify the different types of parasites K4- Examine the blood smear preparation for parasitic infection K5- Understand the parasitic infection in immuno-compromised patients		
Course Objectives	The Course aims to: • inculcate the vector borne diseases in humans • explain the life cycle of human parasites • know the life cycle of helminth parasites • understand the cultivation of protozoan parasites • remember the parasitic infections in immune-compromised hosts		

Unit	Content	No. of Hours
I	**Entomology and disease transmission** Modern concepts and scope of entomology. Biology and lifecycle of arthropod vectors- ticks, mites, fleas, mosquitoes and flies Mechanism of vector borne disease transmission in India. Vector control measures. Role of ICMR and VCRC in vector control in India.	13
II	**Parasitology:** Definition-types of parasites-host-parasite relationships, disease transmission and life-cycle of protozoan parasites- *Entamoeba, Plasmodium, Leishmania, Trypanosoma, Giardia, Trichomonas, Balantidium, Toxoplasma, Cryptosporidium*. Preventive and control measures of protozoan parasites.	13
III	**Helminthology:** Life cycle and diseases of Cestodes- *Taenia solium, T. saginata, T. echinococcus,* Trematodes- *Fasciola hepatica, Fasciolopsis buski, Paragonimus westermanii, Schistosomes*. Nematodes - *Ascaris, Ancylostoma, Trichuris, Trichinella, Enterobius, Strongyloides* and *Wuchereria*. Preventive and control measures of helminth parasites.	13
IV	**Laboratory techniques in parasitology:** Examination of faeces for ova and cysts - worm burden, concentration methods, floatation and sedimentation techniques staining by Iron haemotoxylin method, blood smear examinations-thick/thin smears-cultivation of protozoan parasites.	13
V	**Parasitic infections in Immuno-compromised patients:** Parasitic infections in immune-compromised hosts and AIDS patients, *Cryptosporidial* diarrhoea, *Giardiasis, Strongyloides*, infection and *Toxoplasmosis* - diagnosis and treatment.	12

References	Text Books 1. Chatterjee, K. D. 2019. Parasitology (Protozoology & Helminthology). 13 Ed. CBS Publishers & Distributors, New Delhi. 2. Jayaram Panicker, CK (2017). Text Book of Parasitology. 6 Ed, Jaypee Brothers Medical Publishers, New Delhi. 3. Parija, SC (2013). Text book of Medical Parasitology. 4 Ed. Orient longmans. 4. Arora, D.R. and Arora, B.(2002). Medical Parasitology, 1st Edn. CBS Publishers & Distributors, New Delhi.
	Reference Books 1. Schmidt, G.D. john janovy, jr.and Roberts, L.S. (2009) Foundations of Parasitology, 9 Edn, McGraw-Hill, New york. 2. Levanthal, R. and Cheadle, R.S. (2020). Medical Parasitology. F.A. Davies Co., Philadelphia. 3. Robert Desowitz (1980). Ova and Parasites. Harper and Row Publishers, New York. 4. Eldridge, B.F., Edman, John. 2004. Medical Entomology, 2 Ed. Kluwer Academic Publisher
	E-Resources 1. https://www.who.int/malaria/publications/atoz /9241544104_part1/en/ 2. http://www.microbiologyonline.org.uk/links.html 3. http://www.microbeworld.org.uk 4. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php
Course Outcomes	**On completion of the course, students should be able to:**
	CO1: Analyze the medical importance of vector borne diseases. CO2: Understand the life cycle and disease transmission of protozoan parasites CO3: Learn the life cycle and diseases of cestodes and nematodes parasites CO4: Remember the laboratory techniques of examining parasitic infections CO5: Realize the parasitic infection in AIDS patients.

Mapping of Cos with PSOs

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

Semester	**FIFTH**	Course Code	**21MIBU05DI**
Course Title	**ELECTIVE -DISCIPLINE CENTRIC: BIO-PROCESS AND FERMENTATION TECHNOLOGY**		
No.of Credits	3	No.of contact hours per week	3
New Course /Revised Course	Revised Course	If revised ,Percentage of Revision effected (Minimum20%)	20%
Category	• Elective -Discipline Centric		
Scope of the Course	• Students will be able to develop their skills on industrially important microbes and knowtheir uses in biotech industries • Students can execute field Projects on the microbial technology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in bioprocess technology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives	The Course aims to: • impart information on historical aspects of fermentation and its techniques • make the student knowledgeable on screening methods for fermentative microbes • expose the students on different types of fermentation media • give an in-depth knowledge on various types of fermentation and product recovery. • enhance student's interest on rules and regulation of industrial effluent disposal and biosafety		

UNIT	Content	No. of Hours
I	**History and Fermentor *(source NPTEL)*** Historical of development of fermentation – Pasteur and fermentation. Discovery of antibiotics. Scope and future prospects of fermentation microbiology and biotechnology. Fermentation- upstream and downstream process	9
II	**Microbiology of industrial fermentation** Chemical synthesis of bacterial protoplasm (or) Biomass – central and inter mediatory metabolism. Growth cycle. Industrial important microbes- Strain selection and improvement	10
III	**Fermentation media** Production media – Formulation strategies of production media. Raw material, screening for production media. Pure culture method - plating method. Maintaining culture.	10
IV	**Types of Fermentation & Product recovery** Solid state fermentation- Submerged fermentation - Batch, Fed-Batch and continuous fermentation - Recovery and purification of intracellular and extracellular products.	10

V	**Rules and regulation** Control of industrial fermentation- industrial prospects. monitoring and control strategies- Bio safety in fermentation	9
References	**Text Books:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi. 4. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 5. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited	
	Reference Books: 1. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed., Pergamon Press. 2. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 3. Casida, L.E. 1986. Industrial Microbiology, Eastern Limited, New York	
	E-Resources: 1. www.rmit.edu.au/courses/034150 2. microbiologyonline.org 3. https://www.omicsonlineorg/.../industrial-microbiology-journals-articles- ppt-list.php 4. www.nature.com/nrmicro/series/applied and industrial	
CourseOutcomes	**On completion of the course, students should be able to:** CO1: Discuss the historical aspects of fermentation and its techniques. CO2: Explain screening methods for fermentative microbes. CO3: Outline the different types of fermentation media. CO4: Delineate various types of fermentation and product recovery CO5: Describe the rules and regulation of industrial effluent disposal and biosafety	

Mapping of Cos with PSOs

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

Semester	**FIFTH**	Course Code	**19MIBU05E2**
Course Title	**ELECTIVE -DISCIPLINE CENTRIC: COMMUNICABLE DISEASE AND PREVENTION**		
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	**Elective -Discipline Centric**		
Scope of the Course	❖ students gain the knowledge of common pathogenic microorganism and the diseases ❖ Learn diagnostic approaches for microbial pathogens and various control measures		
Cognitive Levels addressed by the Course	K-1: Remember the basics concepts in infection and Epidemiology K-2: Understand pathogen, host, and environment characteristic interactions and how they create disease patterns in the population K-3: Apply to know the diseases transmitted through faecal-oral route K-4: Analyze diseases transmitted through vectors K-5: Evaluate on sexually transmitted diseases and preventive measures K-6: Create knowledge on the communicable diseases of respiratory tract		
Course Objectives	The: Course aims to • make the students knowledgeable on the concepts of infection and epidemiology • give an outline on the diseases transmitted through Faecal-oral route • give an in-depth knowledge on diseases of respiratory tract. • highlight causative agents, symptoms, treatment, and prevention of sexually transmitted diseases. • expose the students on the vector borne diseases.		

UNIT	**Content**	**No. of Hours**
I	**Basic concepts of infection and epidemiology** Infection, Infectious Process, Host – Pathogen Interactions. Infectious Disease – definitions, incubation periods, clinical forms. Factors influencing disease transmission. Epidemiology of communicable diseases –host, reservoir, carrier, vector. Emerging and re-emerging infectious diseases. Control measures of communicable disease – Control of sources, blocking the channels of transmission, protecting the susceptible host.	9
II	**Diseases transmitted through Faecal-oral route** Prevalence, causes, symptoms, treatment and prevention of faecal-oral transmitted diseases: Cholera, Shigellosis, typhoid, viral diarrhoea, Amoebiasis, Giardiasis and Ascariasis	10
III	**Diseases of respiratory tract:** Prevalence, causative agents, symptoms, treatment, prevention and control measures of diseases of upper and lower respiratory tract: Pneumonia, Tuberculosis, Pertussis, Diphtheria, common cold, Influenza, Swine Flu, Avian Flu, Enterovirus, SARS, MERS, COVID	10
IV	**Sexually transmitted diseases:** Prevalence, causative agents, symptoms, treatment, and prevention of STDs: Chlamydia, Chancroid, Syphilis, Gonorrhoea, Genital herpes, Hepatitis B, HIV, HPV, Trichomoniasis	10

V	**Vector borne diseases** Diseases transmitted through vectors; Chikungunya, Dengue fever, Zika, Japanese encephalitis, Lymphatic filariasis, Malaria and Leishmaniasis – prevalence, symptoms, causes, treatment and control measures	9
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.	
	Reference Books: 1. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg. 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 2. Prescott, Harley and Klein, 2003. Microbiology; McGraw-Hill . 3. 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. 4. Greenwood D, Richard C.B. and PeuthererS.J.. 2000. Medical Microbiology. Churchill Livingstone. 5. D.C. Shanson, Wright PSG, 1982Microbiology in Clinical Practice. . 6. Baron EJ, Peterson LR and Finegold SM Mosby. 1990. Bailey and Scott's Diagnostic Microbiology.	
	E-Resources 1. https://www.microbe.net/resources/microbiology/web-resources/ 2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php	
Course Outcomes	**On completion of the course, students should be able to:** CO1: Discuss the concepts of infection and epidemiology of communicable diseases. 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 sexually transmitted diseases. CO5: Describe the causes, symptoms, treatment and control of vector borne diseases.	

Mapping of Cos with PSOs

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

MODULAR COURSES

Semester	**SIXTH**	Course Code	**21MIBU06M1**
Course Title	**MODULAR COURSES: MICROALGAL TECHNOLOGY**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course / Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Modular Course		
Scope of the Course	❖ Basic understanding on basic concepts in algal technology ❖ Skill development on Spirulina cultivation technology ❖ Creates employability scope in the algal based industries		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in microalgae K-2 Comprehensive knowledge on algal technology K-3 Use techniques for algal cultivation K-4 Capacity to analyze the potentials of microalgae K-5 Make newer approaches to post harvest techniques K-6 Assessment of microalgal based value added products		
Course Objectives	**The course aims to:** • make the students knowledgeable on diversity and distribution of microalgae • give an outline on the processes involved in mass cultivation of microalgae • give an in-depth knowledge on harvesting methods of microalgae. • highlight potential applications of microalgae. • expose the students on the cultivation of *Spirulina*.		

UNIT	Content	No. of Hours
I	**Introduction to microalgae** General characteristics of microalgae – Photosynthesis. Diversity and distribution of microalgae – cyanobacteria – diatom. Freshwater – Marine. Morphology – Reproduction – sexual – asexual – life cycle.	6
II	**Mass cultivation of microalgae** Biological Principles and Technology of Mass Cultivation –Nutrients – Light –Temperature. Laboratory Cultivation. Culture Monitoring and Maintenance. Cultivation Systems - Open outdoor systems – artificial ponds, raceway ponds, pit method-Closed and semiclosedoutdoor photobioreactors - Heterotrophic Fermentors	7
III	**Harvesting microalgal biomass** Microalgal biomass harvesting-Gravity Sedimentation, centrifugation, filtration, flotation, flocculation, Electrolytic Coagulation.Single cell proteins from microalgae. Pigments – carotenoids – phycocyanin – phycoerythrin.	6
IV	**Potentials of microalgae** Potential applications of microalgae – Nutraceuticals; Pharmaceuticals; Biofertilizers; and Bioremediation. Biofuels – biodiesel – biobutanol – biohydrogen – Bioethanol.CO_2 sequestration.	7

V	**Spirulina cultivation technology** Biology of Spirulina - cultivation methods, post-harvest technology and single cell protein formulation- value added products.	6
References	**Text Books** 1. Borowitzka MA, Borowitzka LJ (1989) Microalgal Biotechnology, CambridgeUniversity Press. 2. Rajarao VN. (1990). Perspectives in Phycology, Today and Tomorrow Printers and publishers. 3. Van den Hoek C, Mann DG and HM. Jahns. (1995). Algae, an introduction to phycology **References** 1. Whittan M. Potts Kluwer Academic Publishers. Origin of algae and their plastids. Ed D 2. Bhattacharya, Springer Wien, New York. The Biology of Blue Green Algae- NC Carr& amp. BA 3. Thajuddin N. and Dhanasekaran D. (2016) Phytoplankton: Diversityand Ecology. Pal R and Choudhury A, Springer. 4. Ismail R, Sanjay K. Gupta, Amritanshu S, Poonam S, Sheena K and Faizal B. (2016). Microalgae Applications in Wastewater Treatment. 5. International Publishing Switzerland Bux F and Chisti Y (eds.) Algae Biotechnology, Green Energy and Technology. 6. Biris ES, Maria T, Tania M, Radu M and Antonia O. (2016). Applications of Microalgae in Wastewater Treatments: a Review. ProEnvironment 7. Sonal D and Singh DP. (2015). Phycoremediation: Future Perspective of Green Technology. 8. Craggs R, Park J, Heubeck S and Sutherland D. (2014). High rate algal pond systems for low-energy wastewater treatment, nutrient recovery and energy production. Vol 52, 2014 - Issue 1: Algal and cyanobacterial bioenergy and diversity. **Web resources:** a. http://www.oilgae.com/ref/glos/algal_biotechnology.html b. https://www.igb.fraunhofer.de/en/research/competences/environmental-biotechnology/microalgae.html c. http://www.fao.org/3/w3732e/w3732e03.htm	
Course Out comes	**Upon completion of this course, students should be able to:** CO1: Discuss the diversity and distribution of microalgae. CO2: Outline the processes involved in mass cultivation of microalgae CO3: Explain various harvesting methods of microalgae. CO4: Discuss the potential applications of microalgae. CO5: Demonstrate the cultivation of *Spirulina*.	

Mapping of COs with PSOs:

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

Semester	SIXTH	Course Code	21MIBU06M2
Course Title	**MODULAR COURSES: MOLECULAR TECHNIQUES**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course / Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Modular Course		
Scope of the Course	❖ 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 Levels addressed by the Course	K-1 Ability to remember basic concepts in molecular tools K-2 Comprehensive knowledge on electrophoresis techniques K-3 Use techniques for molecular sequencing and its applications K-4 Capacity to analyze the PCR techniques and its applications K-5 Make newer approaches to genome sequencing and K-6 Assessment of physical mapping		
Course Objectives	**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	7
V	**Genome sequencing and Physical mapping of genome analysis** Restriction fragment Length Polymorphism (RFLP) technique, Random Amplified polymorphic DNA (RAPD) technique and 16S rRNA sequencing. Methods and applications of Chromosome walking &Chromosome jumping.	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. **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	

Mapping of COs with PSOs:

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

Semester	SIXTH	Course Code	21MIBU06M3
Course Title	**MODULAR COURSES: RECOMBINANT DNA TECHNOLOGY**		
No. of Credits	**2**	No. of contact hours per Week	**2**
New Course / Revised Course	**Revised Course**	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Modular Course		
Scope of the Course	❖ Basic understanding on basic concepts in genetic engineering ❖ Skill development on rDNA technology ❖ Creates employability scope in the forensic labs		
Cognitive Levels addressed by the Course	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	**The course aims to:** • make the students knowledgeable on various techniques and enzymes used in recombinant DNA construction. • give an outline on Cloning vectors and Gene libraries • provide an in-depth knowledge on Gene transfer techniques. • highlight the processes involved in expression of rDNA. • expose the students on the methods to analyse the Rdna		

UNIT	Content	No. of Hours
I	**Construction of recombinant DNA** Isolation of DNA and recombinant DNA construction. Core techniques used in rDNA technology – Restriction digestion, ligation and transformation. Enzymes used- Restriction enzymes, DNA ligases, reverse transcriptase, klenow fragment, Alkaline phosphatase, Polynucleotide kinase, terminal transferase, Dnase and Rnase.	7
II	**Cloning vectors and Gene libraries** Cloning vectors - plasmids, phages and cosmids. Cloning strategies. Cloning and selection of individual genes, Gene libraries: cDNA and genomic libraries.	6
III	**Gene transfer techniques** Specialised cloning strategies. Expression vectors, Promoter probe vectors, vectors for library construction - artificial chromosomes. Gene transfer techniques – Transformation, transduction, electroporation, microinjection, Gene gun. Agrobacterium mediated gene transfer.	6
IV	**Expression of rDNA** Rationale for the design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems.	6

V	**Analysis of recombinant DNA** PCR methods and application.DNA sequencing Methods; dideoxy and chemical method. Nucleic acid hybridization methods. Microarray technique.	7
References	**Text Books:** 1. Principles of gene manipulation. 1994. Old & Primrose. Blackwell Scientific Publications. 2. Molecular cloning. 3 volumes. Sambrose and Russell. 2000. CSH press. 3. Winnacker, E.L. (1987). From genes to Clones: Introduction to Gene technology. VCH Publications, Federal Republic of Germany 4. Glover, D.M. (1984) Gene Cloning:. The Mechanism of DNA Manipulation. Chapman and Hall, London. **5.** Brown, T.A. (1995) Gene Cloning. Chapman and Hall, London. **References:** 1. Albert G. Moat, John W. Foster and Michael P. Spector (2002) Microbial Physiology, 4th Edn. Wiley Liss. 2. . Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press. 3. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company **Web resources:** a. https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/ b. https://www.rpi.edu/dept/chem-eng/Biotech-environ/Projects00/rdna/rdna.html c. http://www.whatisbiotechnology.org/index.php/science/summary/rdna d. https://www2.le.ac.uk/projects/vgec/highereducation/topics/recombinanttechniques e. http://biology.kenyon.edu/courses/biol114/Chap08/Chapter_08a.html	
Course Outcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the various techniques and enzymes used in recombinant DNA construction. CO2:Outline the Cloning vectors and Gene libraries. CO3:Explain Gene transfer techniques. CO4:Delineate processes involved in expression of rDNA. CO5:Describe the various methods to analyse the rDNA.	

Mapping of COs with PSOs:

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

Semester	SIXTH	Course Code	21MIBP 06M4
Course Title	MODULAR COURSES: BIOINFORMATICS		
No. of Credits	2	No. of contact hours per Week	2
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	Modular Course		
Scope of the Course	❖ 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 Levels addressed by the Course	K-1 Ability to remember basic concepts in bioinformatics K-2 Comprehensive knowledge on computational biology K-3 Use techniques to explain the tools used in Bioinformatics K-4 Capacity to analyze the genome sequence and protein analysis K-5 Make newer approaches used in microbial genomics K-6 Assessment of Bioinformatic tools and its applications		
Course Objectives (Maximum: 5)	**The course aims to:** • study on Bioinformatics, microbial genomics, and proteomics • understand genome analysis, sequence analysis and protein analysis • explain the tools used in Bioinformatics • impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations • know computational biology		

UNIT	Content	No. of Hours
I	**Introduction to Bioinformatics** Overview of Bioinformatics. Computer basics and it operations – servers, workstations, operating systems, Unix, Linux. Internet – World Wide Web. Search engines, biological databases– Pubmed – Entrez - Literature search.	6
II	**Sequence analysis** Methods, homology algorithms (BLAST) for proteins and nucleic acids. Pair-wise alignment - BLAST, Dot plots, Multiple alignment - ClustalW, ProbCons. public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB).	7
III	**Whole genome analysis** Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing. Sequence assembly – *denovo*, mapping	7
IV	**DNA microarray and general Analysis** DNA microarray printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Analysis of single nucleotide polymorphisms using DNA chips.	6
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.	6

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. abdPeruski 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 4. https://www.ncbi.nlm.nih.gov/
Course Outcomes	**On completion of the course, students should be able to:** CO1: Evaluate whole genome analysis methods CO2: Apply the computational tools used for sequence analysis tools CO3: Demonstrate the use of internet in data analysis CO4: Acquire knowledge on DNA microarray techniques CO5: Familiar with the different methods of protein analysis

Mapping of COs with PSOs:

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

SKILL BASED ELECTIVE COURSES

Semester	**FIFTH**	Course Code	**21MIBU05S1**
Course Title	**SKILL BASED ELECTIVE : MUSHROOM TECHNOLOGY**		
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	Core		
Scope of the Course	1. Understand the concepts Mushroom production 2. Utilize the various methodologies of 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 Mushroom production K2- realize the various techniques involved in Mushroom cultivation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of Mushroom cultivation K5- Motivate the people to become Mushroom cultivation Entrepreneur and Industrialists		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate Knowledge and techniques of Mushroom • To understand the various processing Technologies of Mushroom cultivation • To evaluate the process of information about mushroom biology: • To validate the importance of tropical mushroom cultivation technology • To identify Nutrient profile of Mushrooms		

UNIT	Content	No. of Hours
I	**Introduction to mushroom biology:** Fungal characteristics - habitat, morphology and reproduction of fungi, Different parts of a typical mushroom, Key to differentiate edible from poisonous mushrooms	6
II	**mushroom culture techniques**: Phases of mushroom cultures - pure culture, acceptable spawn, selection of fruiting culture, development of spawn, preparation of compost, mushroom development	6
III	T**ropical mushroom cultivation technology** Oyster mushroom technology, paddy mushroom technology and milky mushroom technology, mushroom farming	7
IV	**Nutrient profile of Mushroom;** Protein, aminoacids, calorific values, carbohydrates, fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus.	7
V	**Mushroom in health care sector**: Antiviral value, antibiotic effect, antifungal effect, anti-tumour effect, anti-inflamatory haematological value, cardiovascular and renal effect.	6

References	**Text Books** 1.Bahl, N.1998. Handbook on mushrooms. Oxford & IBH Co., Pvt, Ltd, New Delhi. 2. Suman BC and Sharma VP. Mushroom Cultivation, Processing and Uses.Agribios (India) Publishers, Jodhpur. 2005. **References:** 1.Kaul, T.N, . Introduction to Mushroom Science, Oxford & IBH Co., Pvt, Ltd, New Delhi. 2.PhilipPhilip G.Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 3.Paul Stamets JS and Chilton JS. Mushroom Cultivator: A practical guide togrowing mushrooms athome, Agarikon Press. 2004. 4. Shu-Ting Chang, Philip G Miles, Chang ST. Mushrooms: Cultivation,nutritional value, medicinal effect and environmental impact, 2nd edition,CRC press. 2004. 5. Swaminathan M. Food and Nutrition, Bappco. The Bangalore Printing andPublishing Co. Ltd., Bangalore. 1990. **Web resources:** 1.https://en.wikipedia.org/wiki/Fungiculture 2.http://www.krishisewa.com/articles/production-technology/46-technology-for-mushroom-cultivation.html 3.https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming/ 4.https://en.wikipedia.org/wiki/Mushroom
Course Outcomes	**On completion of the course, students should be able to:** CO1: Outline the importance of mushrooms CO2: Explain the characteristics of mushrooms CO3: Acquire knowledge on mushroom production technologies CO4: Discuss the applications of mushroom biotechnology CO5: Identify the Post harvest and handling of mushrooms

Mapping of COs with PSOs:

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

Semester	**FIFTH**	Course Code	**21MIBU05S2**
Course Title	**SKILL BASED ELECTIVE : CLINICAL LAB TECHNOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	Revised Course	If revised ,Percentage of Revision effected (Minimum20%)	30%
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on clinical lab technology and knowtheir uses in hospitals • Students can execute field Projects on the clinical technology		
Cognitive Levels addressedby the Course	K-1:Rememberthe basics of medical diagnostic technology 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:Evaluateon 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	The Course aims to: • make the students knowledgeable on the Collection of clinical specimens • give an outline on the methods in urine examination • give an in-depth knowledge on blood count • make students learn Histo pathological Examination. • expose the students on the stool sample analysis.		

UNIT	Content	No.of Hours
I	**Collection of clinical specimens** Basic laboratory principles -Code of conduct -Safety measures. Methods of collection of urine, blood, sputum, stool etc. The techniques of preservation of samples – chemical preservatives. Blood plasma and serum preparation – anticoagulants.	7
II	**Urine Examination** Collection and preservation of urine, physical examination – chemical examination-microscopic examination of deposits, organised and unorganised sediments- pregnancy tests. Urine culture test.	6
III	**Analysis of Blood** Blood- various compositions and their function, recent collecting method - blood coagulation. Blood groups. Blood smear prep - TC, DC and WBC count-Peripheral blood smear examination and morphological abnormalities- Reticulocyte count- absolute eosinophil count- E.S.R, P.C.V, Blood indices - Platelet count: BT, CT, - Prothrombin time. Examination for malarial parasites.	7

IV	**Microtome - Histopathological Examination** Tissue reception, labelling, fixation for different tissue and sectioning -Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking)- section cutting. Preparation of common stains technique - Hematoxylin, eosin, congo red, methyl violet, Leishman stain.	6
V	**Stool sample analysis** Stool – Collection and preservation. Normal and abnormal constituents. Microscopic examination – concentration methods ova & cyst - Stool culture test.	6
References	**Text Books:** 1. Seiverd, Charles E. Hematology for Medical Technologies. 4th Ed. Lea &Febiger,U.S., 2. C.F.A. Culling. Handbook of Histopathological and Histochemical Technique – Third Edition. Butterworths. London. 3. P.B. Godkar, Text Book of Medical Laboratory Technology, 2nd Edn.2003. Bhalani Publication. 4. John A. Washington. Medical Microbiology. University of Texas Medical Branch at Galveston; 1996. 5. Talib. V.H. Handbook of Medical Microbiology. CBS Publishers. 2nd Edition. 2008.	
	E-Resources: 1. https://clinlab.ucsf.edu/ 2. https://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html 3. http://www.hematologyatlas.com/principalpage.htm 4. https://www.bloodline.net/ 5. http://www.protocol-online.org/prot/Histology/index.html	
CourseOutcomes	**Upon completion of this course, students should be able to:** CO1: Discuss the method of Collection of clinical specimens CO2: Outline the methods in urine examination CO3: Explain total and differential blood count. CO4: Delineate the histopathological sample preparation and examination. CO5: Describe the stool sample analysis	

Mapping of COs with PSOs:

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

Semester	**FIFTH**	Course Code	**21MIBU05S3**
Course Title	**SKILL BASED ELECTIVE : SANITATION MICROBIOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum20%)	20%
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on sanitation and knowtheir uses in HACCP. • Students can execute field Projects on the fermentation		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in sanitation K-2 Comprehensive knowledge on sanitation in the food processing industry K-3 Use techniques for food and dairy products quality analysis K-4 Capacity to analyze the role of government organizations involved in sanitation standards K-5 Make new techniques sanitation and air quality K-6 Assessment of quality and safety assurance in the industries		
Course Objectives	The Course aims to: • make the students knowledgeable on the concepts of sanitation and disinfection • give an outline on the Airborne diseases and preventive measures • provide an in-depth knowledge on waste water management • highlight the practices in Solid waste management • expose the students on the aspects of food sanitation		

UNIT	Content	No.of Hours
I	**General concept of sanitation and disinfection.** Sanitation of food processing and industrial units. Safe location of animal houses, hospitals, industrial fermentation units etc. Biosafety in hospitals and laboratories. Regulations and measures.	7
II	**Airborne diseases and preventive measures.** Air pollution – Types and sources Methods of sampling air. Air sanitation – techniques and applications	6
III	**Water quality and Wastewater management** Water standards. Microbiological analysis for water – MPN technique. Water borne diseases. Microbiology of municipal sewage and sewage treatment. BOD and COD. Treatment of Industrial effluent – Mechanical and biological.	7
IV	**Solid waste management** Solid waste disposal-sanitary landfills, composting, vermicompost. Disposal of animal and agricultural waste. Anaerobic digesters- biogas production	6

V	**Food sanitation** Food Sanitation: GMP, HACCP, Food safety standards. Personnel hygiene.	6
References	**Text Books:** 1. Fundamentals of bacteriology-A.J.Salle 2. Ecological aspect of waste water treatment vol 2 biological activities and treatment process-Cruds C.R and hawkes 3. Microbiology- Prescott, M.J., Harley,J.P. and Klein, D.AMcGraw-Hill (2003) 4. Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2008). Brock biology of microorganisms 12th edn. Int. Microbiol, 5. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg. 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 6. D.C. Shanson, Wright PSG, Microbiology in Clinical Practice. 1982. **References:** 1. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003). 2. 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. 3. Bergeys Manual of determinative Bacteriology.	
	E-Resources: a) https://www.microbe.net/resources/microbiology/web-resources/ b) https://www.foodqualityandsafety.com/article/getting-it-right/ c) http://www.protocol-online.org/prot/Microbiology/index.html d) https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php	
CourseOutcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the General concept of sanitation and disinfection. CO2:Explain Airborne diseases and preventive measures. CO3:Outline the processes in waste water management. CO4:Discuss the Solid waste management CO5:Describe the Food sanitation.	

Mapping of COs with PSOs:

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

Semester	**FIFTH**	Course Code	**21MIBU05S5**
Course Title	**SKILL BASED ELECTIVE : COMPOSTING TECHNOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	Revised Course	If revised Percentage of Revision effected (Minimum20%)	40%
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on composting and knowtheir uses in agriculture. • Students can execute field Projects on the vermicomposting		
Cognitive Levels addressedby 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 production • K4Analyzeplantmicrobeinteraction.To understand infection process and control measures • K-5 Evaluate importance of bioinoculants K-6: Create knowledge on environmental pollution, bioinoculants		
Course Objectives	The Course aims to: • make the students knowledgeable on bioconversion of organic materials and factors influencing decomposition • give an outline on the Decomposition of cellulose, hemi cellulose and lignin • give an in-depth knowledge on factors affecting composting process and various composting methods. • highlight the benefits of compost enrichment. • expose the students on compost and crop productivity.		

UNIT	Content	No.of Hours
I	**Introduction to composting** Introduction- Bioconversion – different solid waste - litter composition - factors influencing decomposition, decomposition process – humus and humic acid.	7
II	**Decomposition of cellulose, hemi cellulose and lignin** Microbial decomposition of cellulose, hemi cellulose and lignin – composting microorganism - aerobic, anaerobic, mesophilic and thermophilic – process of decomposition.	6
III	**Factors affecting composting process** Scope and benefits of the compost, waste availability in India – C:N and C:P relationship, other nutrients, moisture content, aeration, pH, particle size. Composting methods – Indore method, Bangalore method.	6
IV	**Compost enrichment** Rapid and enriched compost – the role of compost activators/ inoculants – screening and mass multiplication of cellulolytic cultures. Enrichment of compost using nitrogen fixing microorganisms,	7

	Phosphate solubilizing microorganisms – method of enrichment .	
V	**Compost application in agriculture** Compost and crop productivity- Utilization of compost for crop production. Waste disposal and management, legislation of environmental problems.	6
References	**Text Books:** 1. Gaur, A.C., (1999). Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 2. Insam, H., Riddech, N., & Klammer, S. (Eds.). (2013). Microbiology of composting. Springer Science & Business Media 3. Martin Alexander (1976), Introduction to soil microbiology, Wiley eastern Ltd., New Delhi. 4. Subba Rao, N.S., (1999), Soil microbiology, IV Ed., Oxford IBH pub.Co.Pvt.Ltd., New Delhi **5.** Maheshwari, D. K. (Ed.). (2014). *Composting for sustainable agriculture* (Vol. 3). Springer.	
	E-Resources: a) http://compost.css.cornell.edu/microorg.html b) http://www.fao.org/3/y5104e/y5104e05.htm c) http://www.fao.org/3/a-y5104e.pdf	
CourseOutcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the bioconversion of organic materials and factors influencing decomposition. CO2:Outline the processes in decomposition of cellulose, hemi cellulose and lignin. CO3:Explain various factors affecting composting process. CO4:Describe the benefits of compost enrichment. CO5:Discuss the effect of compost and crop productivity.	

Mapping of COs with PSOs:

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

GENERIC ELECTIVE COURSES OFFERED TO OTHER DEPARTMENT

Semester	IV/ V	Course Code	**21MIBU00N1**
Course Title	**GENERIC ELECTIVE : DAIRY MICROBIOLOGY**		
No.of Credits	3	No.of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised Percentage of Revision effected (Minimum20%)	30%
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on dairy microorganisms and knowtheir uses • Students can execute field Projects on the dairy microbiology		
Cognitive Levels addressedby the Course	K-1 Ability to remember basic concepts in dairy microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for dairy quality analysis K-4 Capacity to analyze the role of government organizations involved in dairy 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 dairy industry		
Course Objectives	The Course aims to: • To make the students to understand the importance of milk and processing unit • To gain an in-depth knowledge on characteristics of dairy products • To impart basic knowledge on sources of contamination in milk. • To give an insight on applications of sanitation in dairy industries • To provide outline the quality assurance of milk especially HACCP and FDA		

UNIT	Content	No.of Hours
I	**Introduction to milk:** Introduction - Composition of milk. Microorganisms- Starter cultures and their biochemical activities. Milk processing unit and mode of operations: Pasteurization, UHT treatment, homogenization, storage and transportation. Judging and grading of milk and its products.	9
II	**Various dairy Products:** Fluid milk products and dried milk Products. Skimmed milk powder, other dairy products: Ice Cream, Butter, Whey. Milk Fermentation – Yoghurt, butter milk and Kefir.	10
III	**Sources of contamination:** Various sources of contamination-*Clostridium, Salmonella, Shigella, Staphylococcus* and *Campylobacter* and milk borne diseases	10
IV	**Plant Sanitation:** In-plant Hygiene –Cleaning of Dairy Equipment – Processing Plant Sanitation. Utilization and disposal of dairy by products – whey.	10
V	**Quality and safety assurance:** Microbiological standards for milk and milk products - Quality control and quality assurance measures - MBRT, Phosphatase tests. Food standards - HACCP, FDA, WHO, FSSAI, lSI in food safety	9

References	**Text Books:** 1. Dairy Microbiology by RobinsonR.K.1990Volume IIand I.Elsevier Applied Science, London. 2. Milk&MilkProducts-Fourthedition-clarencehenryeckles,Tata Mc Graw Hill publishing company Limited, New Delhi, 1957 3. Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi. MaCrae 4. Robinson, R.K. (2 vol.set). 1986.Modern Dairy Technology Elsevier Applied Science, UK. 5. Rosenthal,I. 1991. Milk and Milk Products. VCH, New York.
	Reference Books: 1. Yarpar, WJ. and Hall, C.W. 1975.DairyTechnologyand Engineering AVI, Westport. 2. Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgrawHill Publishing Co., New Delhi. 3. Adams. M. R and M. D Moss . 1995. Food Microbiology. New Age International limited. 4. Roday. S. Food Hygeine and Sanitation. Tata McGraw Hill Publications.1998.
	E-Resources: 1. http://www.microbes.info 2. http://www.fsis.usda.gov/ 3. http://www.microbes.info/ resource/food microbiology 4. http://www.binewsonline.com/1/what is food microbiology.html
Course Outcomes	On completion of the course, students should be able CO1: Understand the importance of milk and processing unit CO2: Explain the characteristics of dairy products CO3: Familiar with sources of contamination in milk. CO4: Delineate the processes of sanitation in dairy industries CO5: Describe the aspects of quality assurance of milk especially HACCP and FDA

Mapping of COs with PSOs:

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

Semester	IV/ V	Course Code	**21MIBU00N2**
Course Title	**GENERIC ELECTIVE : BIOFERTILIZER AND BIOPESTICIDES**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected **(Minimum 20%)**	50%
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on biofertilizers and biopesticides • Students will be able to develop Employability in biofertilizer and biopesticides production		
Cognitive Levels addressed by the Course	• K-1: Remember soil microorganisms • K-2: Understand nitrogen fixing and phosphate solubilizing bacteria • K-3: Apply to know biofertilizer production techniques • K-4: Analyze biopesticides production • K-5: Evaluate field application and benefits of biofertilizers and biopesticides • K-6: Create knowledge on biofertilizer and biopesticides		
Course Objectives	The Course aims to: • understand the current views on nitrogen fixers • know an idea on phosphate solubilizers • critically think the plant pathogenic microbes • impart information on biopesticides • study the concept of the production of biofertilizer and biopesticides		

UNIT	Content	No. of Hours
I	**Nitrogen fixing biofertilizers** *Rhizobium*, Cyanobacteria, *Azospirillum* and *Azotobacter* - Isolation, identification, characterization, mass multiplication, formulation, field application and benefits.	10
II	**Phosphate solubilising biofertilizers** Isolation, identification, characterization,masscultivation,formulation,field applications and benefits of phosphate solubilizing bacteria – *Bacillus* Sp. and fungus – *Aspergillus* Sp.	10
III	**Plant pathogenic microorganisms** Algal, bacterial, fungal, mycoplasma, Nematode and viral, diseases and symptoms. Mode of entry of pathogens and factors affecting disease incidence - Plant disease resistance and various control measures. Phenolic compounds. Interaction of plant pathogens with host.	10
IV	**Biopesticides** Definition and History of Biopesticides – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis, B.popillae & Pseudomonas* sp.), Fungal (*Entomophthora musca, Beaveria* sp., *Metarrhizium* sp. *& Verticillium*	9

	sp.), Protozoan (*Mattesia* sp., *Nosema* sp., *Octospora muscaedomesticae & Lambornella* sp.).	
V	**Biofertilizer and biopesticides Production and marketing** Mass cultivation and formulation of biofertilizers and biopesticides – carrier materials- storage and shelf life - quality control and marketing - field applications and benefits.	9
References	Text Books: 1.Subba Rao NS (2004). Soil Microbiology. Fourth edition, Oxford and BH Publishing Co.Pvt. Ltd., New Delhi. 2.Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning(P)Ltd.,NewDelhi. 3.Dinesh K Maheswari. 2012.Bacteria in Agrobiology, Springer Heidelberg, NewYork. 4.Kannaiyan S.Biotechnology of biofertilizers,CHIPS,Texas.5th edition,Mc Graw Hill,NewYork.2003. 5.MahendraK. Rai (2005). Hand book of Microbial biofertilizers,The Haworth Press,Inc.NewYork.	
	Reference Books: 1. Alexander,A.M. (1987). Introduction to Soil Microbiology. S'h Edition, John Wiley and Sons. 2. Hans Schlegel. (l993). GeneralMicrobiology. 7thedition. Cambridge University press. 3. Tilak KVBR, PalKK and Dey R. Microbes for sustainable agriculture, I.K. 4. International Publishing house, Pvt. Ltd. NewDelhi.2010. 5. Reddy, S.M.et.al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.	

	E-Resources:
	1. https://www.microbe.net/resources/microbiology-web-resources
	2. https;//www.microbes.info/resources/3/soil-microbiology
	3.https://blogs.ntu.edu.sg/library-resources/resource-guide-formicrobiology	

Course Outcomes	On completion of the course, students should be able to: CO 1: Discuss on the nitrogen fixing microorganisms its importance CO2: Predict the importance phosphate solubilising microorganisms and its importance CO3: Analyse the plant pathogenic microbes CO4: Examine the role of biopesticides CO5:Extend knowledge about production, marketting and applications of biofertilizer, and biopesticide	

Mapping of COs with PSOs:

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

Semester	IV/ V	Course Code	**21MIBU00N3**
Course Title	**GENERIC ELECTIVE : FOOD MICROBIOLOGY**		
No.of Credits	3	No.of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum 20%)	40%
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products • Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food quality analysis K-4 Capacity to analyze the role of government organizations involved in food quality control K-5 Make new techniques to study food spoilage organisms and Food borne diseases K-6 Assessment of quality and safety assurance in the food industry		
Course Objectives	The Course aims to: • introduce the scope and development of food microbiology • highlight fermentation technologies in the food processing industry. • create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control. • give an overview on food spoilage organisms- Food borne diseases- to understand infection process and food borne outbreaks. • impart knowledge on quality and safety assurance in the foodindustry.		

UNIT	Content	No.of Hours
I	**Microbiology of Foods** Introduction - History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic & Extrinsic factors - pH, moisture, water activity, oxidation-reduction potential, nutrient contents.	9
II	**Food poisoning and Food-borne diseases** Food infection and Food intoxication. Food hygiene and sanitation. Food poisoning mycotoxins and bacterial toxins. Microbial contamination of foods –Food spoilage by microbes in meat, vegetables and canned food.	10
III	**Microbial fermentations** Alcoholic Beverages- alcohol - Fermented foods – Preparation pickled cucumber, sauerkraut and bread. Fermented milk and dairy products – Yoghurt and cheese and Kafir.	10
IV	**Food preservation** Principles of food preservation. Methods of food physical preservations – drying, heat processing, chilling and freezing, radia - Pasteurization - chemical methods – Nitrates, Nitrites.	10

V	**Quality and safety assurance** Quality control and quality assurance measures. Food standards. GMP, HACCP, FDA.BIS Laboratory services.	9

References	**Text Books:** 1. Carl,A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed.Academic Press, London. 2. Sivasankar, B. 2010. Food processing and preservation, 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. AspenPublication, USA. 5. Joshi V. K and Ashok Pandey. 1999. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. (VOL II).
	Reference Books: 1.Carl,A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press,London. 2.Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgraw Hill publishingCo., New Delhi. 3.Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd.,New Delhi. 4. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 5. Jay, J.M.2000 Modern Food Microbiology 6th Ed. Aspen Publication, USA
	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 to:** CO1:Explain the role of microorganisms in food and factors influencing their growth. CO2:Discuss and demonstrate an overview on food spoilage organisms- Food borne diseases. CO3:Assess the techniques/processes used in microbial products using fermentation technology. CO4:Apply the different aspects of food preservation CO5:Evaluate the quality assurance of foods especially by HACCP,FDA

Mapping of COs with PSOs:

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

Semester	IV/ V	Course Code	**21MIBU00N4**
Course Title	**GENERIC ELECTIVE : INDUSTRIAL MICROBIOLOGY**		
No.of Credits	3	No.of contact hours per Week	3
New Course / Revised Course	Revised Course	If revised, Percentage of Revision effected (Minimum20%)	35%
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on industrially important microbes and knowtheir uses in biotech industries • Students can execute field Projects on the microbial fermentations		
Cognitive Levels addressedby the Course	K-1 Ability to remember basic concepts in Industrial microbiology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives	The Course aims to: • understand industries involving microbial technology • make knowledge on production of various industrial microbialproducts. • know the various techniques used in industries. • impart the functioning of bioreactors • create a comprehensive knowledge on upstream and downstream processing		

UNIT	Content	No.of Hours
I	**History and Fermentor *(source NPTEL)*** History concept of industrial microbiology. Fermentor and types- Components - Agitator, Aerator, Pressure Gauge, pH, DO probe. Fermentation- upstream and downstream process – Filtration, Centrifugation.	10
II	**Screening methods for Industrial microbes** Industrially important microbes – Assay techniques of fermentated products - Screening methods - Strain selection and improvement - mutation and recombinant DNA technology.	10
III	**Biology of Industrial Microorganisms** Single cell protein, *Saccharomyces* - Raw materials used in media production, Large scale cultivation of Industrially important microbes. Media formulation strategies - carbon, nitrogen, vitamin and mineral sources.	10
IV	**Industrial production** Industrial products derived from microbes- intracellular and extra cellular fermentedproducts- production of enzyme - amylase - production of antibiotics – penicillin.	9

V	**Rules and regulation** Noval approaches to Industrial effluent treatment and disposal. Institutional Bio-safety committee.	9
References	**Text Books:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001.Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial 4. Microbiology II Ed. Panima Publishing Corporation, New Delhi.	
	Reference Books: 1. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 2. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited 3. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of FermentationTechnology, II Ed., Pergamon Press. 4. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 5. 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 to: CO1: Discuss historical aspects of industrial microbiology and fermentation techniques CO2: Compare screening methods for Industrial microbes CO3: Explain the biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial microbiology	

Mapping of COs with PSOs:

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

VALUE ADDED COURSE (21MIBU0VA)

Semester	**FIFTH**	Course Code	**21MIBU05S1**
Course Title	**SKILL BASED ELECTIVE : MUSHROOM TECHNOLOGY**		
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	Core		
Scope of the Course	1. Understand the concepts Mushroom production 2. Utilize the various methodologies of 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 Mushroom production K2- realize the various techniques involved in Mushroom cultivation K3- Apply the knowledge on various techniques in Industrial level K4- Understand the problems and facts of Mushroom cultivation K5- Motivate the people to become Mushroom cultivation Entrepreneur and Industrialists		
Course Objectives	**The Course aims** • To evaluate Knowledge and techniques of Mushroom • To understand the various processing Technologies of Mushroom cultivation • To evaluate the process of information about mushroom biology: • To identify Nutrient profile of Mushrooms • To validate the importance of tropical mushroom cultivation technology		

UNIT	Content	No. of Hours
I	**Introduction to mushroom biology:** Fungal characteristics - habitat, morphology and reproduction of fungi, Different parts of a typical mushroom, Key to differentiate edible from poisonous mushrooms	6
II	**mushroom culture techniques**: Phases of mushroom cultures - pure culture, acceptable spawn, selection of fruiting culture, development of spawn, preparation of compost, mushroom development	6
III	T**ropical mushroom cultivation technology** Oyster mushroom technology, paddy mushroom technology and milky mushroom technology, mushroom farming	7
IV	**Nutrient profile of Mushroom;** Protein, aminoacids, calorific values, carbohydrates, fats, vitamins &minerals. In therapeutic diets for adolescence, for aged persons & diabetes mellitus.	7
V	**Mushroom in health care sector**: Antiviral value, antibiotic effect, antifungal effect, anti-tumour effect, anti-inflamatory haematological value, cardiovascular and renal effect.	6

References	**Text Books** 1.Bahl, N.1998. Handbook on mushrooms. Oxford & IBH Co., Pvt, Ltd, New Delhi. 2. Suman BC and Sharma VP. Mushroom Cultivation, Processing and Uses.Agribios (India) Publishers, Jodhpur. 2005. **References:** 1.Kaul, T.N, . Introduction to Mushroom Science, Oxford & IBH Co., Pvt, Ltd, New Delhi. 2.PhilipPhilip G.Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 3.Paul Stamets JS and Chilton JS. Mushroom Cultivator: A practical guide togrowing mushrooms athome, Agarikon Press. 2004. 4. Shu-Ting Chang, Philip G Miles, Chang ST. Mushrooms: Cultivation,nutritional value, medicinal effect and environmental impact, 2nd edition,CRC press. 2004. 5. Swaminathan M. Food and Nutrition, Bappco. The Bangalore Printing andPublishing Co. Ltd., Bangalore. 1990. **Web resources:** 1.https://en.wikipedia.org/wiki/Fungiculture 2.http://www.krishisewa.com/articles/production-technology/46-technology-for-mushroom-cultivation.html 3.https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming/ 4.https://en.wikipedia.org/wiki/Mushroom
Course Outcomes	**On completion of the course, students should be able to:** CO1: Gain Knowledge in mushroom biology CO2: understand the various processing Technologies of mushroom cultivation CO3: evaluate the health benefits of mushroom CO4: validate the importance of tropical mushroom cultivation technology CO5: identify Nutrient profile of Mushrooms

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA2**
Course Title	**VALUE ADDED COURSE: CLINICAL LAB TECHNOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	New Course	If revised ,Percentage of Revision effected (Minimum20%)	--
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on clinical lab technology and knowtheir uses in hospitals • Students can execute field Projects on the clinical technology		
Cognitive Levels addressedby the Course	K-1:Rememberthe basics of medical diagnostic technology 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:Evaluateon 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	The Course aims to: • make the students knowledgeable on the Collection of clinical specimens • give an outline on the methods in urine examination • give an in-depth knowledge on blood count • make students learn Histo pathological Examination. • expose the students on the stool sample analysis.		

UNIT	Content	No.of Hours
I	**Collection of clinical specimens** Basic laboratory principles -Code of conduct -Safety measures. Methods of collection of urine, blood, sputum, stool etc. The techniques of preservation of samples – chemical preservatives. Blood plasma and serum preparation – anticoagulants.	7
II	**Urine Examination** Collection and preservation of urine, physical examination – chemical examination-microscopic examination of deposits, organised and unorganised sediments- pregnancy tests. Urine culture test.	6
III	**Analysis of Blood** Blood- various compositions and their function, recent collecting method - blood coagulation. Blood groups. Blood smear prep - TC, DC and WBC count-Peripheral blood smear examination and morphological abnormalities- Reticulocyte count- absolute eosinophil count- E.S.R, P.C.V, Blood indices - Platelet count: BT, CT, - Prothrombin time. Examination for malarial parasites.	7

IV	**Microtome - Histopathological Examination** Tissue reception, labelling, fixation for different tissue and sectioning -Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking)- section cutting. Preparation of common stains technique - Hematoxylin, eosin, congo red, methyl violet, Leishman stain.	6
V	**Stool sample analysis** Stool – Collection and preservation. Normal and abnormal constituents. Microscopic examination – concentration methods ova & cyst - Stool culture test.	6
References	**Text Books:** 1. Seiverd, Charles E. Hematology for Medical Technologies. 4th Ed. Lea &Febiger,U.S., 2. C.F.A. Culling. Handbook of Histopathological and Histochemical Technique – Third Edition. Butterworths. London. 3. P.B. Godkar, Text Book of Medical Laboratory Technology, 2nd Edn.2003. Bhalani Publication. 4. John A. Washington. Medical Microbiology. University of Texas Medical Branch at Galveston; 1996. 5. Talib. V.H. Handbook of Medical Microbiology. CBS Publishers. 2nd Edition. 2008.	
	E-Resources: 1. https://clinlab.ucsf.edu/ 2. https://library.med.utah.edu/WebPath/TUTORIAL/URINE/URINE.html 3. http://www.hematologyatlas.com/principalpage.htm 4. https://www.bloodline.net/ 5. http://www.protocol-online.org/prot/Histology/index.html	
CourseOutcomes	**Upon completion of this course, students should be able to:** CO1: Discuss the method of Collection of clinical specimens CO2: Outline the methods in urine examination CO3: Explain total and differential blood count. CO4: Delineate the histopathological sample preparation and examination. CO5: Describe the stool sample analysis	

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA3**
Course Title	**VALUE ADDED COURSE: SANITATION MICROBIOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	New Course	If revised, Percentage of Revision effected (Minimum20%)	--
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on sanitation and knowtheir uses in HACCP. • Students can execute field Projects on the fermentation		

Cognitive Levels addressedby the Course	K-1 Ability to remember basic concepts in sanitation K-2 Comprehensive knowledge on sanitation in the food processing industry K-3 Use techniques for food and dairy products quality analysis K-4 Capacity to analyze the role of government organizations involved in sanitation standards K-5 Make new techniques sanitation and air quality K-6 Assessment of quality and safety assurance in the industries
Course Objectives	The Course aims to: • make the students knowledgeable on the concepts of sanitation and disinfection • give an outline on the Airborne diseases and preventive measures • provide an in-depth knowledge on waste water management • highlight the practices in Solid waste management • expose the students on the aspects of food sanitation

UNIT	Content	No.of Hours
I	**General concept of sanitation and disinfection.** Sanitation of food processing and industrial units. Safe location of animal houses, hospitals, industrial fermentation units etc. Biosafety in hospitals and laboratories. Regulations and measures.	7
II	**Airborne diseases and preventive measures.** Air pollution – Types and sources Methods of sampling air. Air sanitation – techniques and applications	6
III	**Water quality and Wastewater management** Water standards. Microbiological analysis for water – MPN technique. Water borne diseases. Microbiology of municipal sewage and sewage treatment. BOD and COD. Treatment of Industrial effluent – Mechanical and biological.	7
IV	**Solid waste management** Solid waste disposal-sanitary landfills, composting, vermicompost. Disposal of animal and agricultural waste. Anaerobic digesters- biogas production	6

V	**Food sanitation** Food Sanitation: GMP, HACCP, Food safety standards. Personnel hygiene.	6
References	**Text Books:** 1. Fundamentals of bacteriology-A.J.Salle 2. Ecological aspect of waste water treatment vol 2 biological activities and treatment process-Cruds C.R and hawkes 3. Microbiology- Prescott, M.J., Harley,J.P. and Klein, D.AMcGraw-Hill (2003) 4. Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2008). Brock biology of microorganisms 12th edn. Int. Microbiol, 5. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg. 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 6. D.C. Shanson, Wright PSG, Microbiology in Clinical Practice. 1982. **References:** 1. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003). 2. 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. 3. Bergeys Manual of determinative Bacteriology.	
	E-Resources: e) https://www.microbe.net/resources/microbiology/web-resources/ f) https://www.foodqualityandsafety.com/article/getting-it-right/ g) http://www.protocol-online.org/prot/Microbiology/index.html d) https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php	
Course Outcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the General concept of sanitation and disinfection. CO2:Explain Airborne diseases and preventive measures. CO3:Outline the processes in waste water management. CO4:Discuss the Solid waste management CO5:Describe the Food sanitation.	

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA4**
Course Title	**VALUE ADDED COURSE: COMPOSTING TECHNOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	New Course	If revised Percentage of Revision effected (Minimum20%)	--
Category	• Skill based elective Course		
Scope of the Course	• Students will be able to develop their skills on composting and knowtheir uses in agriculture. • Students can execute field Projects on the vermicomposting		
Cognitive Levels addressedby 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 production K4Analyzeplantmicrobeinteraction.To understand infection process and control measures K-5 Evaluate importance of bioinoculants K-6: Create knowledge on environmental pollution, bioinoculants		
Course Objectives	The Course aims to: • make the students knowledgeable on bioconversion of organic materials and factors influencing decomposition • give an outline on the Decomposition of cellulose, hemi cellulose and lignin • give an in-depth knowledge on factors affecting composting process and various composting methods. • highlight the benefits of compost enrichment. • expose the students on compost and crop productivity.		

UNIT	Content	No.of Hours
I	**Introduction to composting** Introduction- Bioconversion – different solid waste - litter composition - factors influencing decomposition, decomposition process – humus and humic acid.	7
II	**Decomposition of cellulose, hemi cellulose and lignin** Microbial decomposition of cellulose, hemi cellulose and lignin – composting microorganism - aerobic, anaerobic, mesophilic and thermophilic – process of decomposition.	6
III	**Factors affecting composting process** Scope and benefits of the compost, waste availability in India – C:N and C:P relationship, other nutrients, moisture content, aeration, pH, particle size. Composting methods – Indore method, Bangalore method.	6
IV	**Compost enrichment** Rapid and enriched compost – the role of compost activators/ inoculants – screening and mass multiplication of cellulolytic cultures. Enrichment of compost using nitrogen fixing microorganisms,	7

	Phosphate solubilizing microorganisms – method of enrichment .	
V	**Compost application in agriculture** Compost and crop productivity- Utilization of compost for crop production. Waste disposal and management, legislation of environmental problems.	6
References	**Text Books:** 1. Gaur, A.C., (1999). Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 2. Insam, H., Riddech, N., & Klammer, S. (Eds.). (2013). Microbiology of composting. Springer Science & Business Media 3. Martin Alexander (1976), Introduction to soil microbiology, Wiley eastern Ltd., New Delhi. 4. Subba Rao, N.S., (1999), Soil microbiology, IV Ed., Oxford IBH pub.Co.Pvt.Ltd., New Delhi **5.** Maheshwari, D. K. (Ed.). (2014). *Composting for sustainable agriculture* (Vol. 3). Springer.	
	E-Resources: a) http://compost.css.cornell.edu/microorg.html b) http://www.fao.org/3/y5104e/y5104e05.htm c) http://www.fao.org/3/a-y5104e.pdf	
Course Outcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the bioconversion of organic materials and factors influencing decomposition. CO2:Outline the processes in decomposition of cellulose, hemi cellulose and lignin. CO3:Explain various factors affecting composting process. CO4:Describe the benefits of compost enrichment. CO5:Discuss the effect of compost and crop productivity.	

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA5**
Course Title	**VALUE ADDED COURSE: DAIRY MICROBIOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course / Revised Course	New Course	If revised Percentage of Revision effected (Minimum20%)	--
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on dairy microorganisms and knowtheir uses • Students can execute field Projects on the dairy microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in dairy microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for dairy quality analysis K-4 Capacity to analyze the role of government organizations involved in dairy 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 dairy industry		
Course Objectives	The Course aims to: • To make the students to understand the importance of milk and processing unit • To gain an in-depth knowledge on characteristics of dairy products • To impart basic knowledge on sources of contamination in milk. • To give an insight on applications of sanitation in dairy industries • To provide outline the quality assurance of milk especially HACCP and FDA		

UNIT	Content	No.of Hours
I	**Introduction to milk:** Introduction - Composition of milk. Microorganisms- Starter cultures and their biochemical activities. Milk processing unit and mode of operations: Pasteurization, UHT treatment, homogenization, storage and transportation. Judging and grading of milk and its products.	7
II	**Various dairy Products:** Fluid milk products and dried milk Products. Skimmed milk powder, other dairy products: Ice Cream, Butter, Whey. Milk Fermentation – Yoghurt, butter milk and Kefir.	6
III	**Sources of contamination:** Various sources of contamination-*Clostridium, Salmonella, Shigella, Staphylococcus* and *Campylobacter* and milk borne diseases	6
IV	**Plant Sanitation:** In-plant Hygiene –Cleaning of Dairy Equipment – Processing Plant Sanitation. Utilization and disposal of dairy by products – whey.	6
V	**Quality and safety assurance:** Microbiological standards for milk and milk products - Quality control and quality assurance measures - MBRT, Phosphatase tests. Food standards - HACCP, FDA, WHO, FSSAI, lSI in food safety	7

References	**Text Books:** 1. Dairy Microbiology by RobinsonR.K.1990Volume IIand I.Elsevier Applied Science, London. 2.Milk&MilkProducts-Fourthedition-clarencehenryeckles,Tata Mc Graw Hill publishing company Limited, New Delhi, 1957 3. Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi. MaCrae 4. Robinson, R.K. (2 vol.set). 1986.Modern Dairy Technology Elsevier Applied Science, UK. 5. Rosenthal,I. 1991. Milk and Milk Products. VCH, New York.
	Reference Books: 1. Yarpar, WJ. and Hall, C.W. 1975.DairyTechnologyand Engineering AVI, Westport. 2. Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgrawHill Publishing Co., New Delhi. 3. Adams. M. R and M. D Moss . 1995. Food Microbiology. New Age International limited. 4. Roday. S. Food Hygeine and Sanitation. Tata McGraw Hill Publications.1998.
	E-Resources: a) http://www.microbes.info b) http://www.fsis.usda.gov/ c) http://www.microbes.info/ resource/food microbiology d) http://www.binewsonline.com/1/what is food microbiology.html
Course Outcomes	On completion of the course, students should be able CO1: Understand the importance of milk and processing unit CO2: Explain the characteristics of dairy products CO3: Familiar with sources of contamination in milk. CO4: Delineate the processes of sanitation in dairy industries CO5: Describe the aspects of quality assurance of milk especially HACCP and FDA

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA6**
Course Title	**VALUE ADDED COURSE: BIOFERTILIZER AND BIOPESTICIDES**		
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	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on biofertilizers and biopesticides • Students will be able to develop Employability in biofertilizer and biopesticides production		
Cognitive Levels addressed by the Course	K-1: Remember soil microorganisms K-2: Understand nitrogen fixing and phosphate solubilizing bacteria K-3: Apply to know biofertilizer production techniques K-4: Analyze biopesticides production K-5: Evaluate field application and benefits of biofertilizers and biopesticides K-6: Create knowledge on biofertilizer and biopesticides		
Course Objectives	The Course aims to: • understand the current views on nitrogen fixers • know an idea on phosphate solubilizers • critically think the plant pathogenic microbes • impart information on biopesticides • study the concept of the production of biofertilizer and biopesticides		

UNIT	Content	No. of Hours
I	**Nitrogen fixing biofertilizers** *Rhizobium*, Cyanobacteria, *Azospirillum* and *Azotobacter* - Isolation, identification, characterization, mass multiplication, formulation, field application and benefits.	6
II	**Phosphate solubilising biofertilizers** Isolation, identification, characterization, mass cultivation, formulation, field applications and benefits of phosphate solubilizing bacteria – *Bacillus* Sp. and fungus – *Aspergillus* Sp.	6
III	**Plant pathogenic microorganisms** Algal, bacterial, fungal, mycoplasma, Nematode and viral, diseases and symptoms. Mode of entry of pathogens and factors affecting disease incidence - Plant disease resistance and various control measures. Phenolic compounds. Interaction of plant pathogens with host.	7
IV	**Biopesticides** Definition and History of Biopesticides – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis, B.popillae & Pseudomonas* sp.), Fungal (*Entomophthora musca, Beaveria* sp., *Metarrhizium* sp. & *Verticillium* sp.), Protozoan (*Mattesia* sp., *Nosema* sp., *Octospora muscaedomesticae*	7

	& Lambornella sp.).	
V	**Biofertilizer and biopesticides Production and marketing** Mass cultivation and formulation of biofertilizers and biopesticides – carrier materials- storage and shelf life - quality control and marketing - field applications and benefits.	6
References	Text Books: 1.Subba Rao NS (2004). Soil Microbiology. Fourth edition, Oxford and BH Publishing Co.Pvt. Ltd., New Delhi. 2.Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning(P)Ltd.,NewDelhi. 3.Dinesh K Maheswari. 2012.Bacteria in Agrobiology, Springer Heidelberg, NewYork. 4.Kannaiyan S.Biotechnology of biofertilizers,CHIPS,Texas.5th edition,Mc Graw Hill,NewYork.2003. 5.MahendraK. Rai (2005). Hand book of Microbial biofertilizers,The Haworth Press,Inc.NewYork.	
	Reference Books: 1. Alexander,A.M. (1987). Introduction to Soil Microbiology. S'h Edition, John Wiley and Sons. 2. Hans Schlegel. (l993). GeneralMicrobiology. 7thedition. Cambridge University press. 3. Tilak KVBR, PalKK and Dey R. Microbes for sustainable agriculture, I.K. 4. International Publishing house, Pvt. Ltd. NewDelhi.2010. 5. Reddy, S.M.et.al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.	

	E-Resources:
	1. https://www.microbe.net/resources/microbiology-web-resources
	2. https;//www.microbes.info/resources/3/soil-microbiology
	3.https://blogs.ntu.edu.sg/library-resources/resource-guide-formicrobiology	

Course Outcomes	On completion of the course, students should be able to: CO 1: Discuss on the nitrogen fixing microorganisms its importance CO2: Predict the importance phosphate solubilising microorganisms and its importance CO3: Analyse the plant pathogenic microbes CO4: Examine the role of biopesticides CO5:Extend knowledge about production, marketing and applications of biofertilizer, and biopesticide.	

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA7**
Course Title	**VALUE ADDED COURSE: FOOD MICROBIOLOGY**		
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	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skill on food microbiology and know the microbial quality analysis of food products • Students can execute science projects on the food microbiology		
Cognitive Levels addressed by the Course	K-1 Ability to remember basic concepts in food microbiology K-2 Comprehensive knowledge on fermentation technologies in the food processing industry K-3 Use techniques for food quality analysis K-4 Capacity to analyze the role of government organizations involved in food quality control K-5 Make new techniques to study food spoilage organisms and Food borne diseases K-6 Assessment of quality and safety assurance in the food industry		
Course Objectives	The Course aims to: • introduce the scope and development of food microbiology • highlight fermentation technologies in the food processing industry. • create awareness among the students about the food quality analysis and the role of government organizations involved in food quality control. • give an overview on food spoilage organisms- Food borne diseases- to understand infection process and food borne outbreaks. • impart knowledge on quality and safety assurance in the foodindustry.		

UNIT	Content	No.of Hours
I	**Microbiology of Foods** Introduction - History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic & Extrinsic factors - pH, moisture, water activity, oxidation-reduction potential, nutrient contents.	6
II	**Food poisoning and Food-borne diseases** Food infection and Food intoxication. Food hygiene and sanitation. Food poisoning mycotoxins and bacterial toxins. Microbial contamination of foods –Food spoilage by microbes in meat, vegetables and canned food.	7
III	**Microbial fermentations** Alcoholic Beverages- alcohol - Fermented foods – Preparation pickled cucumber, sauerkraut and bread. Fermented milk and dairy products – Yoghurt and cheese and Kafir.	7
IV	**Food preservation** Principles of food preservation. Methods of food physical preservations – drying, heat processing, chilling and freezing, radia - Pasteurization - chemical methods – Nitrates, Nitrites.	6

V	**Quality and safety assurance** Quality control and quality assurance measures. Food standards. GMP, HACCP, FDA.BIS Laboratory services.	6

References	**Text Books:** 1. Carl,A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed.Academic Press, London. 2. Sivasankar, B. 2010. Food processing and preservation, 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. AspenPublication, USA. 5. Joshi V. K and Ashok Pandey. 1999. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. (VOL II).
	Reference Books: 1.Carl,A.B and Tortorello, M.L. 2014. Microbiology, 2nd Ed. Academic Press,London. 2.Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgrawHill publishingCo., New Delhi. 3.Sivasankar, B. 2010. Food processing and preservation, PHL Learning Pvt. Ltd.,New Delhi. 4. Tucker, G.S.2008. Food Biodeterioration and Preservation. Blackwell Publishers, UK. 5. Jay, J.M.2000 Modern Food Microbiology 6th Ed. Aspen Publication, USA
	Web resources: a) http://www.microbes.info b) http://www.fsis.usda.gov/ c) http://www.cdc.gov. d) http://www.microbes.info/ resource/food microbiology e) http://www.binewsonline.com/1/what is food microbiology.html
Course Outcomes	**On completion of the course, students should be able to:** CO1:Explain the role of microorganisms in food and factors influencing their growth. CO2:Discuss and demonstrate an overview on food spoilage organisms- Food borne diseases. CO3:Assess the techniques/processes used in microbial products using fermentation technology. CO4:Apply the different aspects of food preservation CO5:Evaluate the quality assurance of foods especially by HACCP,FDA.

Mapping of COs with PSOs:

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

Semester	I to IV	Course Code	**21MIBU0VA8**
Course Title	**VALUE ADDED COURSE: INDUSTRIAL MICROBIOLOGY**		
No.of Credits	2	No.of contact hours per Week	2
New Course /Revised Course	New Course	If revised, Percentage of Revision effected (Minimum20%)	--
Category	• Generic Elective Course		
Scope of the Course	• Students will be able to develop their skills on industrially important microbes and know their uses in biotech industries • Students can execute field Projects on the microbial fermentations		
Cognitive Levels addressedby the Course	K-1 Ability to remember basic concepts in Industrial microbiology K-2 Comprehensive knowledge on fermentation technologies K-3 Use techniques for production of various industrial microbial products. K-4 Capacity to analyze industries involving microbial technology K-5 Make newer approaches to Industrial waste and sewage treatment and disposal K-6 Assessment of on Institutional Biosafety		
Course Objectives	The Course aims to: • understand industries involving microbial technology • make knowledge on production of various industrial microbialproducts. • know the various techniques used in industries. • impart the functioning of bioreactors • create a comprehensive knowledge on upstream and downstream processing		

UNIT	Content	No.of Hours
I	**History and Fermentor *(source NPTEL)*** History concept of industrial microbiology. Fermentor and types- Components - Agitator, Aerator, Pressure Gauge, pH, DO probe. Fermentation- upstream and downstream process – Filtration, Centrifugation.	6
II	**Screening methods for Industrial microbes** Industrially important microbes – Assay techniques of fermentated products - Screening methods - Strain selection and improvement - mutation and recombinant DNA technology.	7
III	**Biology of Industrial Microorganisms** Single cell protein, *Saccharomyces* - Raw materials used in media production, Large scale cultivation of Industrially important microbes. Media formulation strategies - carbon, nitrogen, vitamin and mineral sources.	7
IV	**Industrial production** Industrial products derived from microbes- intracellular and extra cellular fermentedproducts- production of enzyme - amylase - production of antibiotics – penicillin.	6

V	**Rules and regulation** Noval approaches to Industrial effluent treatment and disposal. Institutional Bio-safety committee	6
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 4. Microbiology II Ed. Panima Publishing Corporation, New Delhi.	
	Reference Books: 1. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 2. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited 3. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of FermentationTechnology, II Ed., Pergamon Press. 4. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 5. 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 to: CO1:Discuss historical aspects of industrial microbiology and fermentation techniques CO2: Compare screening methods for Industrial microbes CO3: Explain the biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial microbiology	

Mapping of COs with PSOs:

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

ALLIED COURSES OFFRED FROM THE DEPARTMENT OF BIOLOGY

Semester	**FIRST**	Course Code	**21BIOU01A1**
Course Title	**ALLIED BIOCHEMISTRY – I**		
No. of credits	3	No. of contact hours per week	3
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	20%
Category	• Allied Course		
Scope of the Course	❖ Basic understanding on the various biological molecules and their importance ❖ Skill development for analysis of biological macromolecules ❖ Creates employability scope in the biochemical laboratories / hospitals / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember chemical nature of biomolecules K-2 Develop comprehensive knowledge on classification and properties of carbohydrates, proteins, 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 the role of vitamins in normal metabolism		
Course Objectives	**The course aims to:** • understand the nature of various biological molecules and their importance • highlight the salient feature on the classification and structural properties of carbohydrates • create interest on the classification and properties of proteins • impart knowledge on the structure and functions of lipids • acquire overall knowledge on nucleic acids and vitamins		

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.	
II	**Carbohydrates** Carbohydrates-Sources, significance, structure, physical and chemical properties and classification of monosaccharides - glucose and fructose, disaccharides - sucrose and lactose and polysaccharides - starch and cellulose.	13
III	**Proteins** Proteins- Sources, significance, structure (primary, secondary and tertiary), physical and chemical properties and classification of proteins. Amino acids – Essential and non-Essential aminoacids and their roles.	13
IV	**Lipids** Lipids-Sources, significance, structure, physical and chemical properties (saponification, rancidity, definition of acid number, saponification number and iodine number) and classification of lipids-Fatty acids – Simple lipids: tertiary compound lipids (phospholipid), derived lipids: steroids (cholesterol), saturated fatty acids (butyric acid), unsaturated fatty acid (linoleic acid).	13

IV	**Nucleic acids and Vitamins** Nucleic acids-Sources, significance, structure and functions of DNA (Watson and Crick model)-Structure and functions of RNA (mRNA, tRNA and rRNA). Vitamins-Sources, significance-Water soluble vitamins (vitamin Riboflavin and vitamin Ascorbic acid), fat soluble vitamins (Vitamin A, D, E and K)-Functions and deficiency syndromes.	13
References	**Text Books:** 1. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd edition, Wiley publisher. 2010. 2. Deb AC. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p)ltd, London. 2011. 3. Ambika Shanmugam. Fundamentals of Biochemistry for Medical students. Nagaraj and Company Pvt ltd, India. 1998. 4. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010. 5. J.L. Jain 2003 Fundamental of Biochemistry S. Chand of company Ltd, New Delhi.G.S. Sandhu 2002 Text book of biochemistry 18th Edn. Campus books International, New Delhi. **Reference Books:** 1. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013. 2. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, UniversitiesPress, (India) Pvt. Ltd, Hyderabad, India. 2014. 3. Rajagopal G. Concise textbook of biochemistry, 2nd edition, Ahuja Publishing House. 2010. 4. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Colepublishers. 2012. 5. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013. **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: CO1: Explain the chemical nature of biological macromolecules CO2: Discuss the classification and structural properties of carbohydrates CO3: Demonstrate the sources, significance and classification of protein CO4: Outline structure and the functions of lipids. CO5: Describe the structure and the biological activities of Nucleic acid and vitamins	

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	**21BIOU01A2**
Course Title	**ALLIED PRACTICAL-1: ALLIED BIOCHEMISTRY – I**		
No. of credits	1	No. of contact hours per week	3
New Course / Revised Course	Revised	If revised, percentage of Revision effected **(Minimum 20%)**	20
Category	Allied Course		
Scope of the Course	❖ Basic knowledge on the estimation: 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 carbohydrates, proteins, lipids and nucleic acid K-5 Make use of techniques to identify the unknown biomolecules K-6 Assessment of nucleic acids and vitamins		
Course Objectives	The course aims to: • impart a practical knowledge on the estimation of Carbohydrates using various methods • demonstrate the estimation of proteins • identify unknown carbohydrates and proteins • perform estimation of Amino acids • estimate and quantify various biomolecules		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Estimation of Carbohydrates Anthrone method (total carbohydrates. Benedict's method (Glucose) and DNS method (Reducing sugars)	6
2.	Reactions of carbohydrates	3
3.	Scheme for identification of unknown carbohydrates	3
4.	Estimation of Proteins	3
5.	Colour reactions of proteins	6
6.	Precipitation reactions of proteins	6
7.	Scheme for identification of unknown proteins	6

8.	Estimation of Lipids	6
9.	Estimation of Amino acids	3
10.	Estimation of Nucleic acids	3
11.	Estimation of vitamin - Ascarbic acid	3
References	**References:** 1. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry, 4th edition, Cambridge University press, Britain. 1995. 2. Shawn O' Farrell and Ryan T Ranallo. Experiments in Biochemistry: A Hands-on Approach-A manual for the undergraduate laboratory, Thomson Learning, Inc., Australia. 2000. 3. Strolv BA, Makavora VC. Laboratory manual in Biochemistry. MIR Publisher, Moscow. 1989. 4. Oser BL Hawks. Physiological Chemistry, TATA Mc Graw Hill. 1965.	
Course Outcomes	On completion of the course, students should be able to: CO 1: Explain carbohydrate estimation CO2: Demonstrate the reactions of carbohydrates CO 3: Identify unknown biomolecules CO 4: Assess the colour and precipitation reactions of proteins CO5: Estimate and quantify Nucleic acids and vitamins-Ascarbic acid	

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	**21BIOU02A3**
Course Title	**ALLIED BIOCHEMISTRY – II**		
No. of credits	3	No. of contact hours per week	3
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	20%
Category	• Allied Course		
Scope of the Course	❖ Basic understanding on the metabolism of various biological molecules ❖ 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 the classification and functions of enzymes K-2 Develop comprehensive knowledge on various metabolic pathways K-3 Use biochemical tools for better understanding of blood and its function K-4 Capacity to analyse the functions of human endocrine hormones K-5 Make new techniques to study Biochemical importance and regulation K-6 Assessment of plant secondary metabolites		
Course Objectives	**The course aims to:** • understand the classification, structure and functions-mechanism of enzyme action • highlight the salient feature of metabolic pathways • create interest on the blood and its functions • impart knowledge on human endocrine hormones • acquire overall knowledge on major plant secondary metabolites		

UNIT	**Content**	**No. of Hours**
I	**Enzymes** Enzymes-Definition, classification, structure and functions-Mechanism of Enzyme action-Factors affecting Enzyme activity-pH, temperature and substrate concentration-Michaleis Menton equation-Enzyme inhibition-Competitive and Non competitive inhibition.	13
II	**Introduction to metabolism** Introduction to metabolism – concepts and principles of metabolism – 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 (EMP)-Kreb's cycle (TCA)- Pentose Phosphate Pathway HMP shunt. Electron Transport Chain (ETC).	13
III	**Blood** Blood-Introduction, composition, characterization, functions and coagulation of blood. Buffer system of blood. Blood group antigens. Structure and functions of myoglobin and haemoglobin.	12
IV	**Hormones** Hormones-Definition, classification of hormones-Human Endocrine hormones pituitary, thyroid, parathyroid, pancreas, adrenal testis and ovary-Diseases associates with deficiency of endocrine hormones.	13

V	**Major plant secondary metabolites** Secondary metabolites and major/accessory plant pigments- chlorophyll, carotenoids, phycobilin and anthocyanins. Phytohormones- Definition, classification, structure and functions of auxins, gibberellins, cytokinin and abscisic acid.	13
References	**Text Books:** 1. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd edition, Wiley publisher. 2010. 2. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition, Wileypublisher.2013. 3. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition, Wiley publisher. 2010. 4. Deb AC. Edition. Fundamentals of Biochemistry, 10th edition, New Central Book Agency (p) ltd, London. 2011. 5. Ambika Shanmugam. Fundamentals of Biochemistry for Medical students. Nagaraj and Company Pvt ltd, India. 1998. **Reference Books:** 1. Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevier publishers. 2013. 2. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014. 3. Rajagopal G. Concise textbook of biochemistry, 2nd edition, Ahuja Publishing House. 2010. 4. Reginald H Garrett and Charles M Grisham, 5th edition. Biochemistry, Brooks Cole publishers. 2012. 5. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013.. **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 5. https://www.jagranjosh.com/general-knowledge/list-of-important- hormones-and-their-functions	
Course Outcomes	On completion of the course, students should be able to: CO 1: Explain the classification and structural properties enzymes CO2: Discuss significance metabolic pathways CO3: Demonstrate the composition, characterization, functions and coagulation of blood. CO4: Outline biochemical importance of hormones. CO5: Describe the biological activities plant pigments and phytohormones	

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	**SECOND**	Course Code	**21BIOU02A4**
Course Title	**ALLIED PRACTICAL-II: ALLIED BIOCHEMISTRY – II**		
No. of credits	1	No. of contact hours per week	3
New Course / Revised Course	Revised	If revised, percentage of Revision effected **(Minimum 20%)**	20
Category	Allied Course		
Scope of the Course	❖ Basic knowledge on the estimation of biological macromolecules ❖ Developing skills in separation of protein, and aminoacids ❖ Creates employability scope in biochemical laboratories/ diagnostic centres/ industries		
Cognitive Levels addressed by the course	K-1 Ability to remember quantitation techniques used in biochemistry K-2 Comprehensive knowledge on various biomolecules and their properties K-3 Handling and use of Instruments used to analyse biomolecules K-4 Capacity to analyse albumin, uric acid and urea in blood K-5 Make use of techniques to demonstrate plant pigments K-6 Assessment of blood sugar, blood glucose and serum cholesterol		
Course Objectives	The course aims to: • impart a practical knowledge on the estimation of blood sugar • demonstrate the estimation of serum cholesterol • estimate blood urea, serum proteins, serum uric acids • perform estimation of enzymes, amino acids and IAA • estimate and quantify various chlorophyll in plant samples		

EXP. No.	EXPERIMENTS	No. of Hours
1.	Estimation of blood sugar by Folin-Wu method	3
2.	Estimation of blood glucose	3
3.	Estimation of serum cholesterol	3
4.	Estimation of IAA (Indole-3-acetic acid)	3
5.	Separation and Estimation of Enzymes	6
6.	Separation of amino acids by chromatographic techniques	6
7.	Estimation of blood urea by diacetyl monoxime (DAM) method	6
8.	Estimation of serum proteins and albumin/globulin ratio by Biuret method	6
9.	Estimation of serum uric acid by Caraway method	3
10.	Estimation of blood urea by diacetyl monoxime (DAM) method	3
11.	Estimation of chlorophyll in plant leaf	3
12.	Estimation of carotenoids and phycobiliproteins	3

References	**References:** 1. Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry, 4th edition, Cambridge University press, Britain. 1995. 2. Shawn O' Farrell and Ryan T Ranallo. Experiments in Biochemistry: A Hands-on Approach-A manual for the undergraduate laboratory, Thomson Learning, Inc., Australia. 2000. 3. Strolv BA, Makavora VC. Laboratory manual in Biochemistry. MIR Publisher, Moscow. 1989. 4. Oser BL Hawks. Physiological Chemistry, TATA Mc Graw Hill. 1965.
Course Outcomes	On completion of the course, students should be able to: CO 1: Explain blood glucose estimation CO 2: Demonstrate and estimation of various biochemical reactions CO 3: Identify various biomolecules CO 4: Assess blood urea, serum proteins, serum uric acids CO5: Estimate and quantify secondary metabolites of plants

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	**THIRD**	Course Code	**21BIOU03A1**
Course Title	**ALLIED BIOLOGY (BOTANY) - I**		
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	Allied Course		
Scope of the Course	1. Understand various forms of lower plants 2. Acquire the knowledge on Taxonomy, Physiological importance and Plant Anatomy and embryology 3. Understand the process of plant tissue culture and conservation		
Cognitive Levels addressed by the Course	K1- Inculcate the diversity and distribution of lower plants K2- Observation on various aspects of Taxonomy of angiosperms K3- Acquire knowledge on Physiological mechanism of plants K4- Understand the structure of anatomy and embryology of plants K5- Create awareness on Plant Tissue culture & Conservation		
Course Objectives	**The Course aims** • To evaluate knowledge on diversity of lower plants • To analyse the importance and aspects of plant taxonomy • To evaluate the Physiological mechanism of plants • To understand the structure of anatomy and embryology of plants • To analyse the importance of Plant Tissue culture & Conservation		

Unit	Content	No. of Hours
I	**Plant Diversity** General characteristics of Algae; Reproduction and life cycle of *Chalmydomonas*, General characteristics of Fungi: Reproduction and life cycle of *Agaricus*. General characteristics of Bryophytes: Reproduction and life cycle of *Funaria*, General characteristics of Pterdophytes: Reproduction and life cycle of *Selaginella*. General characteristics of Gymnosperms; Reproduction and life cycle of *Cycas* (Gametophyte development studies not required in all type studies)	13
II	**Plant Taxonomy** Outline of Bentham and Hookers system of classification – General vegetative and floral characteristics of the following families with their economic importance – Annonaceae, Apocynaceae, Euphorbiaceae , Fabaceae and Poaceae	12
III	**Plant Anatomy & Embryology** Meristem – Structure and classification. Brief account on plants Tissues: simple and Complex tissue. Internal structure of dicot stem & Root , monocot stem & Root, Normal secondary thickening (*Boerhhavia*) in dicot stem. Pollination; Types. Types of Endosperms, Development of Dicot & Monocot embryo	15
IV	**Plant Physiology** Osmosis , Absorption of water –Active and Passive absorption of water. Brief account on Transpiration. Photosynthesis, light and dark reactions; Respiration. Biological clock, Phytohormones – Physiological effect of Auxin, and Cytokinin.	14
V	**Plant Tissue culture & Conservation** Plant tissue culture : chemicals glassware requirement, sterilization, Types of media, growth hormones, inoculation and culture maintenance. Brief account on Micropropagation, somatic embryogenesis, callus culture, protoplast culture. Biodiversity -Status, types, biodiversity hotspots threats and Conservation: in situ and ex situ. Brief account on IUCN	10

References	**Text Books** 1. Vashista, P.C., Sinha, A.K. and Kumar, A. 2006. Gymnosperms. Revised Edition. S. Chand & Company Ltd, New Delhi. 2. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Algae. Dominant Publishers and distributors, New Delhi. 3. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Broyophytes. Dominant Publishers and distributors, New Delhi. 4. Vashista, P.C., Sinha, A.K. and Kumar, A. 2005. Pteridophyta. Revised Edition. S. Chand & Company Ltd, New Delhi. **References** 1. Pandey, B. P. 2004. College Botany Volume I & II. S. Chand & company Ltd, New Delhi. 2. Sharma, O.P. 2013. Plant Taxonomy. McGraw Hill Education Pvt. Ltd. New Delhi. 3. Sharma, O.P., 1993. Plant taxonomy. Tata McGraw-Hill Education. 4. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd., New Delhi. 5. Johri, R.M. 2005.Taxonomy. Vols. I-IV, Sonali Publication, New Delhi. 6. Pandey, S.N. and Sinha, B.K. 2009. Plant Physiology. IV Edition, Vikas Publishing company, Noida, UP. 7. Sinha, S. K. 2004. Modern Plant Physiology. Narosa publishing House, New Delhi, Chennai, Mubai. 8. Verma, S. K. 1995. A text book of Plant Physiology and Biochemistry. S. Chand & Company Ltd. Ram Nagar, New Delhi. 9. Taiz, L. and Zeiger, E. 2002.Plant Physiology, III Edition Sinauer Associates. 10. Bhojwani, S.S. and Bhatnagar, S.P. 2008. The Embryology of Angiosperms. V Edition, Vikas publishing house Pvt Ltd., Noida, India.	
	Upon completion of this course, students be able to: CO1: evaluate knowledge on diversity of lower plants CO2: analyse the importance and aspects of plant taxonomy CO3: evaluate the Physiological mechanism of plants CO4: To understand the structure of anatomy and embryology of plants CO5: analyse the importance of Plant Tissue culture & Conservation	

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	1	1	3	3
CO5	3	3	3	3	3

Semester	**THIRD**	Course Code	**21BIOU03A2**
Course Title	**PRACTICAL 1- ALLIED BIOLOGY I (BOTANY)**		
No. of Credits	1	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Allied Course		
Scope of the Course	1. Understand various forms of lower plants 2. Acquire the practical knowledge on Taxonomy, Physiological importance and Plant Anatomy and embryology 3. Understand the protocol of plant tissue culture		
Cognitive Levels addressed by the Course	K1- Inculcate the morphology and reproduction of lower plants K2- Observation on vegetative and floral features of angiosperms K3- Acquire knowledge on Physiological mechanism of plants K4- Understand the structure of anatomy and embryology of plants K5- Observe the methods on Plant Tissue culture		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate knowledge on morphology of various life forms • To analyse the identification procedure of Angiosperms • To evaluate the Physiological mechanism of plants • To understand the structure of anatomy and embryology of plants • To analyse the importance of Plant Tissue culture & Conservation		

Unit	Content	No. of Hours
1	Observation on fresh and mounted specimens of Algae: *Nostoc, Chladophora, Spirulina* Fungi : *Rhizopus, Penicillium, Agaricus* Bryophytes: *Riccia, Marchantia, Funaria* Pteridophytes : *Psilotum, Lycopodium, Marsilea* Gymnosperms : Cycus (Male and Female Cone) Pinus: leaf and Cone	10
2	Vegetative and floral characteristics of the following families Annonaceae, Apocynaceae Euphorbiaceae Fabaceae Poaceae	10
3	Internal structure of dicot stem & Root Internal structure of monocot stem & Root Observation of various stages of plant embryos	10
4	Osmotic potential of Cell Sap by plasmolytic method Estimation of Photosynthetic pigments Estimation of carbohydrate from plant tissues Estimation of Crude protein from plant tissues	9
5	Demonstration on Sterilization and inoculation in plant tissue culture	9
References	1. Vashista, P.C., Sinha, A.K. and Kumar, A. 2006. Gymnosperms. Revised Edition. S. Chand & Company Ltd, New Delhi. 2. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Algae. Dominant Publishers and distributors, New Delhi.	

	3. Johri, R.M., Latha, S. and Sharma, S. 2004. Textbook of Broyophytes. Dominant Publishers and distributors, New Delhi. 4. Vashista, P.C., Sinha, A.K. and Kumar, A. 2005. Pteridophyta. Revised Edition. S. Chand & Company Ltd, New Delhi. 5. Sharma, O.P., 1993. Plant taxonomy. Tata McGraw-Hill Education. 6. Pandey, S.N. and Sinha, B.K. 2009. Plant Physiology. IV Edition, Vikas Publishing company, Noida, UP. 7. Taiz, L. and Zeiger, E. 2002.Plant Physiology, III Edition Sinauer Associates. 8. Bhojwani, S.S. and Bhatnagar, S.P. 2008. The Embryology of Angiosperms. V Edition, Vikas publishing house Pvt Ltd., Noida, India.	
	Upon completion of this course, students be able to: CO1: evaluate knowledge on morphology of various life forms CO2: analyse the identification procedure of Angiosperms CO3: evaluate the Physiological mechanism of plants CO4: understand the structure of anatomy and embryology of plants CO5: aanalyse the importance of Plant Tissue culture & Conservation	

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	1	1	3	3
CO5	3	3	3	3	3

Semester	**FOURTH**	**Course Code**	**21BIOU04A3**
Course Title	**ALLIED BIOLOGY-II (ZOOLOGY)**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Curse	If revised, Percentage of revision effected (Minimum 20%)	--
Category	Allied Course		
Scope of the Course	✚ Understand the history and scope of zoology ✚ Know the difference between invertebrates and chordates ✚ Learn the economic importance of apiculture, sericulture and poultry		
Cognitive Levels addressed by the Course	K1- Classification of invertebrates and chordates K2- Make the students to understand the human parasites of medical importance K3- Identify the poisonous and non-poisonous snakes in India K4- Analyze the migration of fish and birds K5- Understand the economic importance of beneficial insects		
Course Objectives	The Course aims to: • know the classification of invertebrates up to classes • able to know the digestive and urinogenital system of fish • familiarize the parasitic diseases of humans • understand the parental care in amphibians • inculcate the economic importance of Invertebrates and chordates		
Unit	Content		No. of Hours
I	**Introduction to Zoology:** Definition, concept, scope and history of zoology – outline classification of animal kingdom with examples.		9
II	**Invertebrata:** Outline classification of invertebrate up to class level with examples– Type study: cockroach – external morphology, digestive and reproductive system.		9
III	**Chordata:** Outline classification of chordata upto class level with examples – Type study: Catla- external features- digestive and urinogenital system.		10
IV	**Parasitology:** Human parasites of medical importance– Biology and life cycle of *Entamoeba histolytica* and *Taenia solium*.		10
V	**Economic Zoology and Special features:** Beneficial and productive insects – Apiculture, sericulture and poultry. Economic importance of honey, silk and eggs. Migration in fish – parental care in amphibian – identification of poisonous and non-poisonous snakes – migration of birds.		10
References	Text Books 1. R.L. Kotpal-2017, Modern text book of Zoology- Invertebrate- Rastogi Publication, Meerut. 2. M.Ekabaranatha Iyar and T.N. Ananthakrishnan (Recent Edition) Manual of Zoology. Vol. I. Part I & II, Visvanathan Publications, Chennai 3. N.C Nair, A. Thangamani, S. Leelavathy, S. Prasanakumar, N. Soundrapandian,		

	T.Murugan L. M. Narayanan and N. Arumugam, 2017, Animal diversity (Invertebrata& Chordata), Saras Publication, Nagarcoil. 4. A. Thangamani, S. Prasanakumar, L. M. Narayanan and N. Arumugam, 2017, Chordate Zoology, Saras Publication, Nagarcoil. 5. E.L.Jordan and P.S. Verma 2011 Chordate Zoology, S.Chand & Company Ltd, New Delhi.
	Reference Books 1. R. L. Koptal- 2017, Animal Diversity, Rastogi Publication, Meerut. 2. E.L.Jordan and P.S. Verma 2009 Invertebrate Zoology, S.Chand & Company Ltd, New Delhi. 3. N. Arumugam 2002, Invertebrate Zoology, Saras publication, Nagercoil. 4. Fatik Baran Mandal (2012) Chordate Zoology, PHI, Learning Private Limited, New Delhi – 110001. 5. N. Arumugam, T. Murugan, J. Johnson and P. Ram Prabhu, Applied Zoology- 2017-Saras Publication, Nagarcoil.
	E-Resources 1. http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64
Course Outcomes	On completion of the course, students should be able to:
	CO1: Understand animal's classification and their salient features. CO2: Know the digestive and urinogenital system of fish CO3: Learn the life cycle and diseases of human parasites CO4: Remember the migration of fish, birds and parental care in amphibia CO5: Realize the economic importance of honey bees, silkworm and poultry.

Mapping of COs with PSOs

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

Semester	**FOURTH**	**Course Code**	**21BIOU04A4**
Course Title	**ALLIED BIOLOGY-II (ZOOLOGY) PRACTICALS**		
No. of Credits	1	No. of contact hours per week	3
New Course/ Revised Course	New course	If revised, Percentage of revision effected (Minimum 20%)	--
Category	Allied Course		
Scope of the Course	1. Understand the systematic position of animals belonging to different phyla. 2. Know the keys for identification of invertebrate and vertebrate animal specimens. 3. Observe the museum specimens of representative animals of each phylum.		
Cognitive Levels addressed by the Course	K1- Observe the microscopic slides of protozoans K2- Understand the morphology of sponges and corals K3- Analyze the specimens of fishes K4- Identify the snakes and lizards in India K5- Remember the salient features of birds		
Course Objectives	The Course aims • to identify the microscopic specimens of different invertebrate and vertebrate animals • to able to know the medical importance of helminth worms • to understand the morphology of honey bees and cockroach • to learn the economically important fish species • to observe the amphibian, reptiles and birds		
Unit	Content		No. of Hours
1.	Identification of protozoans from pond water (Amoeba, Paramecium, Euglena and Volvox).		48
2.	Study of Poriferans: Sponges and Corals		
3.	Study of Platyhelminthes: *Taenia solium* and *Fasciola hepatica*.		
4.	Observation of Annelids: Earthworm and Nereis.		
5.	Observation of Arthropods: Honey bees and Cockroach		
6.	Identification of Echinoderms: Star fish and Sea cucumber		
7.	Observation of fish: Catla, Rohu and Mrigal		
8.	Identification of amphibian spotters: Frog and Toads		
9.	Identification of Reptiles: Snakes and Lizards		
10.	Identification of birds: Pigeon and Parrot		
References	Reference Books: 1. S.S. Lal-2018, Practical Zoology- Invertebrate. Rastogi Publication, Meerut. 2. S.S. Lal-2018, Practical Zoology- Vertebrate. Rastogi Publication, Meerut. 3. Jeya surya, Dulsy Fathima, R.P. Meyyan Pillai, S. Prasanakumar, N. Arumugam, L.M. Narayanan, V. Kumaresan and, A. Marikuttikan 2017, Practical Zoology (Animal Physiology Vol.III),Saras Publication, Nagercoil. 4. Jeyasurya, N. Arumugam, N.C Nair, S. Leelavathy, N. Soundrapandian, and L. M. Narayanan 2017, Practical Zoology (Vol. 1& II), Saras Publication, Nagercoil.		
	E-Resources 1. http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64		

Course Outcomes	On completion of the course, students should be able to
	CO1: Identify the different invertebrate and vertebrate animals CO2: Know the helminth parasites of medical importance CO3: Observe the structure of earthworm and nereis CO4: Learn the taxonomic position of insects CO5: Identify the fish, amphibian, reptiles and birds

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