B.Sc., MICROBIOLOGY

SYLLABUS

(2019 Onwards)

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

THE GANDHIGRAM RURAL INSTITUTE
(Deemed to be University)

DEPARTMENT OF BIOLOGY

PROPOSAL FOR B.Sc., MICROBIOLOGY PROGRAMME

The subject Microbiology is an upcoming field in biological discipline having wider scope and applications. Many applied aspects of Microbiology helps to improve the economy of the nation. The under graduate (UG) degree in B.Sc., Microbiology creates wider job chances in educational, research, industrial, medical and environmental sectors. This first UG degree initiates a desire in the students for further post graduate degree in M.Sc., Microbiology. The students would be better engaged through inquiry-based laboratory exercises and peer instruction.

Eligibility:

A pass in Higher Secondary examinations or its equivalent in Science Stream with Biology / Botany / Zoology / Microbiology as one of the subject

Course Duration:

The duration of the Programme shall be for minimum of three consecutive years and with six semesters

Regulation:

The rules and regulation as followed for six semesters Under Graduate (UG) programme under CBCS would be followed

Student Intake: Maximum 30

OBE ELEMENTS FOR B.Sc., MICROBIOLOGY PROGRAMME

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

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

PEO2: To independently carry out practicals, 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 field of microbiology.

PROGRAMME OUTCOME (PO)

PO 1: Become knowledgeable in the subject of Microbiology and apply the principles of the same to the needs of the subject of the Employer/Institution/Enterprise/Society.
PO 2: Gain analytical skills in the field of Microbiology.
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.

Semester- Wise Credit Distribution for B.Sc., Microbiology 2019- 20

Course Code	Title of the Course	Credits	Hours		Max Marks		
			Theory	Practical	CFA	ESE	Total
FIRST SEMESTER							
19/18TAMU0101/ 19/18HIDU0101/ 19/18MALU0101/ 19/18FREU0101	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
19/18ENGU01X1	English	3	3	-	40	60	100
19MIBU0101	Fundamentals of Microbiology	3	3	-	40	60	100
19MIBU0102	Practical I: Fundamentals of Microbiology	1	-	3	60	40	100
19/18CHEU01A1/ 19MIBU01A1	Allied: Chemistry- I/ Biochemistry- I	3	3	-	40	60	100
19/18CHEU01A2 19MIBU01A2	Allied Practical- I: Chemistry- I/ Biochemistry- I	1	-	3	60	40	100
19NSSU0001/ 19FATU0001/ 19SPOU0001	NSS/ Fine Arts/ Sports	1	-	1	50	-	50
19YOGU0001	Yoga	1	-	1	50	-	50
19EVSU0001	Environmental Studies	3+1	3	2	40	60	100
	Total	**20**	**15**	**10**			
SECOND SEMESTER							
19/18TAMU0202/ 19/18HIDU0202/ 19/18MALU0202/ 19/18FREU01202	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
19/18ENGU02X2	English	3	3	-	40	60	100
19/18CTAU0001/ 19/18CHIU0001/ 19//18MAU0001	Core Tamil/ Core Hindi/ Core Malayalam	2	2	-	20	30	50
19MIBU0203	Microbial Diversity	3	3	-	40	60	100
19MIBU0204	Practical II: Microbial Diversity	1	-	3	60	40	100
19CHEU02A3	Allied: Chemistry- II/ Biochemistry- II	3	3	-	40	60	100
19CHEU02A4	Allied Practical II: Chemistry- II/ Biochemistry- II	1	-	3	60	40	100
19GTPU0001	Gandhi's Life, Thought and Work	2	2	-	20	30	50
19EXNU0001	Extension Education	2	2	-	20	30	50
19ENGU00C1	Communication and Soft Skills	2	2	-	20	30	50
	Total	**22**	**20**	**6**			

THIRD SEMESTER							
19/18TAMU0303/ 19/18HIDU0303/ 19/18MALU0303/ 19/18FREU01303	Tamil/ Hindi/ Malayalam/ French	3	3	-	40	60	100
19/18ENGU02X2	English	3	3	-	40	60	100
19/18CTAU0002/ 19/18CHIU0002/ 19/18MAU0002	Core Tamil/ Core Hindi/ Core Malayalam	2	2	-	20	30	50
19MIBU0305	Microbial Physiology	3	3	-	40	60	100
19MIBU0306	Practical III: Microbial Physiology	1	-	3	60	40	100
19APRU03A1	Allied: Biostatistics- I	3+1	3	2	24+24	36+16	100
19CSAU03A1	Computer Fundamentals and office Automation	3+1	3	2	24+24	36+16	100
19SHSU0001	Shanthi Sena	1	2	-			
19EXNU03V1	VPP	2	-	-	50	-	50
19MIBU04F1	Extension / Field visit	-	-	2	-	-	-
	Total	**23**	**19**	**9**			
FOURTH SEMESTER							
19MIBU0407	Agricultural Microbiology	3	3	-	40	60	100
19MIBU0408	Immunology	3	3	-	40	60	100
19MIBU0409	Medical Microbiology	3	3	-	40	60	100
19MIBU0410	Practical IV: Agricultural Microbiology	1	-	3	60	40	100
19MIBU0411	Practical V: Immunology & Medical Microbiology	1	-	3	60	40	100
19APRU03A2	Allied: Biostatistics- II	3+1	3	2	24+24	36+16	100
19MIBU04EX	Major Elective	3	3	-	40	60	100
-	Non Major Elective	3	3	-	40	60	100
19MIBU04F2	Extension/ Field Visit	-	-	2	-	-	-
	Total	**21**	**18**	**10**			
FIFTH SEMESTER							
19MIBU0512	Food Microbiology	4	4	-	40	60	100
19MIBU0513	Industrial Microbiology	4	4	-	40	60	100
19MIBU0514	Microbial genetics & Molecular Biology	4	4	-	40	60	100
19MIBU0515	Practical VI: Food &Industrial Microbiology	1	-	3	60	40	100
19MIBU0516	Practical VII: Microbial genetics & Molecular Biology	1	-	3	60	40	100
19MIBU05EX	Major Elective	3	3	-	40	60	100
19MIBU05SX	Skill based Elective	2	2	-	-	-	-
-	Non Major Elective	3	-	2	-	-	-
19MIBU05F3	Extension/ Field Visit	-	-	2	-	-	-
	Total	**22**	**17**	**10**			

SIXTH SEMESTER							
19MIBU0617	Environmental Microbiology	4	4	-	40	60	100
19MIBU0618	Microbial Biotechnology	4	4	-	40	60	100
19MIBU0619	Bioinstrumentation Techniques	4	4	-	40	60	100
19MIBU0620	Practical VII: Environmental Microbiology and Microbial Biotechnology	1	-	3	60	40	100
19MIBU0621	Project	4	-	8	40	40+20*	100
19MIBU06MX	Modular Course- I	2	2	-	50	-	50
19MIBU06MY	Modular Course- 2	2	2	-	50	-	50
19MIBU05F4	Extension/ Field Visit	-	-	2	-	-	-
	Total	**21**	**16**	**13**	-	-	-
	Grand Total	**129**					

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

LIST OF MAJOR ELECTIVE COURSES OFFERED

Course Code	Course Title	Credit
Fourth semester		
19MIBU04E1	Dairy Microbiology	3
19MIBU04E2	Medical Parasitology & Entomology	3
Fifth Semester		
19MIBU05E1	Fermentation Technology	3
19MIBU05E2	Communicable Diseases	3

MODULAR COURSE OFFERED

Course Code	Course Title	Credit
19MIBU06M1	Micro algal Technology	2
19MIBU06M2	Molecular Techniques	2
19MIBU06M3	Recombinant DNA Technology	2
19MIBU06M4	Bioinformatics (Microbial Genomics & Proteomics)	2

SKILL BASED ELECTIVE OFFERED

Course Code	Course Title	Credit
19MIBU05S1	Mushroom Biotechnology	2
19MIBU05S2	Clinical Lab Technology	2
19MIBU05S3	Sanitation Microbiology	2
19MIBU05S4	Entrepreneur Microbiology	2
19MIBU05S5	Composting Technology	2

NON- MAJOR ELECTIVE COURSES OFFERED

Course Code	Course Title	Credit
19MIBU00N1	Dairy Microbiology	3
19MIBU00N2	Biofertilizer and Biopesticides	3
19MIBU00N3	Food Microbiology	3
19MIBU00N4	Industrial Microbiology	3

LIST OF ALLIED COURSES OFFERED

Course Code	Course Title	Credit
	First Semester	
19MIBU01A1	Allied Biochemistry –I	3
19MIBU01A2	Allied Practical –I: Biochemistry-I	1
	Second Semester	
19MIBU02A3	Allied Biochemistry –II	3
19MIBU02A4	Allied Practical –II: Biochemistry-II	1

Course Code & Course Title	**19MIBU0101: FUNDAMENTALS OF MICROBIOLOGY** **Credits- 3**		
Class	B.Sc. Microbiology	Semester	First
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To enhance the students knowledge on the historical aspects and development of microbiology • To give an overview on microscopy and microbial growth • To make the students knowledgeable on the various microbial techniques involved. • To acquire an overall knowledge on the morphology and functions of the structures within the prokaryotes and eukaryotes.		

UNIT	Content	No. of Hours
I	**History 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. Recent advancement.	10
II	**Microbial growth and Microscopy** Microbial growth and nutritional requirements. Batch-Continuous-Synchronous culture-Growth curve. Microscopy-Principles and applications of Simple, Compound, Phase contrast, Fluorescent, SEM and TEM- Specimen preparations for Electron Microscope.	10
III	**Staining and Sterilization Techniques** Principles and types of staining- Simple, Differential (Gram's, Spore and Capsule)-Sterilization, Principles types: Physical-Moist heat-Dry heat-Filtration (Membrane and HEPA), Radiations, Chemical agents- Mode of action.	10
IV	**Microbial Culture Techniques** Isolation-Serial 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.	10
V	**Prokaryotic and Eukaryotic Cell** 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.	8

References	**Text Books:** 1. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2009. Prescott's Principle of Microbiology, Mc Graw Hill, New York. 2. Dubey, R.C and Maheswari, D.K 2005. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 3. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company. **Reference Books:** 1. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 2. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi.. 3. Hans G. Schlegel. 2012(Reprint). General Microbiology. VIIEd.Cambridge University Press. UK.. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 5. John L. Ingrahm and Catherine Ingrahm.. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA. **Web 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: Assess the microbial growth and principles and applications of microscopy CO3: Describe Principles and types of staining techniques CO4: Demonstrate the different cultural techniques in microbiology CO5: Identify key organelles and their functions in both eukaryotes and Prokaryotes

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	3	3	3	-	-	3	3	1.8
CO2	3	3	3	3	3	3	3	3	3	3	3.0
CO3	3	3	3	-	3	3	3	3	1	1	2.3
CO4	3	3	3	1	1	3	3	3	3	3	2.6
CO5	3	1	1	1	3	3	3	3	2	3	2.3
										Mean Overall Score	2.4

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Scope and History of microbiology	2
	1.2 Theories of Spontaneous generation	2
	1.3 Biogenesis	2
	1.4 Contribution of Anton van Leevwenhoek	1
	1.5 Contribution of Louis Pasteur	1
	1.6 Contribution of Robert Koch	1
	1.7 Contribution of Edward Jenner	1
	Total Hours	**10 hrs**
II	2.1 Microbial growth and nutritional requirements	1
	2.2 Batch-Continuous-Synchronous culture-Growth curve	1
	2.3 Microscopy-Principles and applications	1
	2.4 Principles and applications of Simple microscope	1
	2.5 Principles and applications of Compound microscope	1
	2.6 Principles and applications of Phase contrast microscope	1
	2.7 Principles and applications of Fluorescent microscope	1
	2.8 Principles and applications of SEM microscope	1
	2.9 Principles and applications of TEM	1
	2.10 Specimen preparations of Electron Microscope	1
	Total hours	**10 hrs**
III	3.1 Principles and types of staining- Simple, Differential (Gram's and Spore)	2
	3.2 Sterilization, Principles types	2
	3.3 Moist heat-Dry heat-Filtration (Membrane and HEPA), Radiations, Chemical agents	3
	3.4 Mode of action of sterilizing agents	3
	Total hours	**10 hrs**
IV	4.1 Serial dilution techniques	2
	4.2 Culture and media preparation	2
	4.3 Types of media – Solid, Liquid Natural, Semi Synthetic, Synthetic, Enriched, Selective, Differential media	3
	4.4 Pure culture techniques-Pour plate, Spread plate and Streak Plate	2
	4.5 Preservation	1
	Total hours	**10 hrs**
V	5.1 Structure and Organization of Prokaryotic and Eukaryotic Cell	3
	5.2 Size, Shape, Cell wall, Membrane, Ribosomes, Nucleoid, Slime, Capsule, Flagella, Spores, Cysts and Plasmids	3
	5.3 Difference between Prokaryotic and Eukaryotic cells	2
	Total hours	**8 hrs**

Course Code & Course Title	**19MIBU0102: PRACTICALS I : FUNDAMENTALS OF MICROBIOLOGY Credits - 1**		
Class	M.Sc. Microbiology	Semester	First
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The Course aims** • To enhance the student's knowledgeable and impress upon them the important aspects of microorganisms • To understand the working procedure and principles of microscopes. • To provide practical knowledge and skill in the isolation and handling of microorganisms and instruments • To know pure culture techniques and methods of culturing of microorganisms • To acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes		

Practical	Topics covered	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	3
4	Staining techniques-Simple, Differential, Spore and Capsular staining	6
5	Sterilization techniques - Handling of laboratory instruments and glass wares-Autoclave, Hot air oven, Laminar air flow pH meter, Petriplates	6
6	Media preparation Liquid media-Nutrient broth, Solid media-Nutrient agar, Semisolid media-Nutrient semisolid medium, Differential media-Mac Conkey agar, Selective medium-EMB	6
7	Isolation and enumeration of bacteria by serial dilution and plating and Total count (Haemocytometer count)	6
8	Pure culture techniques-Pour plate, Spread plate and Streak plate	6
9	Determination of motility of bacteria-Hanging drop method	3
10	Measurement of size of the microorganisms-Micrometry	3

References	**References:** 1. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (I Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India. 2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 3. Aneja. K.R, 2002. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, III Ed. New Age International publishers (P) Ltd, New Delhi. 4. Breed and Buchanan, 2003.Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5). 5. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panama Publishing Corporation, New Delhi.
Course Outcomes	**On completion of the course, students should be able to:** CO 1: Demonstrate standard methods for the isolation, identification and culturing of microorganisms. CO2: Explain the staining techniques CO3: Identify the different groups of microorganisms CO4: Asses the principles and applications of microscope CO5: Examine the pure culture techniques

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	3	3	3	3	3	3	3	3	3	3.0
CO2	3	3	1	1	3	3	3	3	1	3	2.4
CO3	3	3	1	1	3	3	3	3	3	3	2.8
CO4	3	3	3	3	3	3	3	3	3	3	3.0
CO5	3	3	3	1	3	3	3	1	2	3	2.5
										Mean Overall Score	2.74

PRACTICAL SCHEDULE

Practical	Topics covered	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	3
4	Staining techniques-Simple, Differential, Spore and Capsular staining	6
5	Sterilization techniques - Handling of laboratory instruments and glass wares-Autoclave, Hot air oven, Laminar air flow pH meter, Petriplates	6
6	Media preparation Liquid media-Nutrient broth, Solid media-Nutrient agar, Semisolid media-Nutrient semisolid medium, Differential media-Mac Conkey agar, Selective medium-EMB	6
7	Isolation and enumeration of bacteria by serial dilution and plating and Total count (Haemocytometer count)	6
8	Pure culture techniques-Pour plate, Spread plate and Streak plate	6
9	Determination of motility of bacteria-Hanging drop method	3
10	Measurement of size of the microorganisms-Micrometry	3
	Total hours	**45**

Course Code & Course Title	**19MIBU0203**: **MICROBIAL DIVERSITY** **Credits- 3**		
Class	B.Sc. Microbiology	Semester	Second
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To highlight the different aspects of the classification of Prokaryotes and Eukaryotes. • To enhance the students knowledge on the diversity of microbes. • To help students have an in-depth knowledge on the different groups and species of microbes • To make the students aware of the economical value of microorganisms • To 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	**Bacteria:** Bacteria-General characteristics and classification of Eubacteria and Archaebacteria. (Bergey's Mannual). *E. coli, Rhizobium* sp., *Methanobacteria* sp., importance of Bacteria.	10
III	**Fungus:** Fungus-General characteristics and classification (Alexopoulous) of fungi. *Rhizopus* sp., *Aspergillus* sp., *Penicillium* sp. and *Agaricus* sp. Economic importance of Fungi.	10
IV	**Algae and protozoa:** 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, life cycle of *Plasmodium vivax*. Importance of protozoa.	10
V	**Virus:** 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 TR, M J Chan ECS and Kreig N R (2006). Microbiology. Fifth edition, Tata CGraw Hill Book Company. 2.Prescott L M, JP Haley and D A Lein (2005). Microbiology, sixth edition, International edition, McGraw Hill. 3.Alexopoulos, CJ, and Mims, C.W. (1979), Introductory Mycology, John Wiley, New York **References:** 1. Hans G. Schlegel. 2012. General Microbiology. VII Ed. Cambridge University Press. UK. 2. Dubey H. C. 1978. A Textbook of Fungi, Bacteria and Viruses. Vikaas Publishing House Ltd. Ltd. Pp: 1-341. 3. S. Biwasis and Amita Biswas. 1998. An Introduction to Viruses. Vikaas Publishing House Pvt. Ltd. Pp: 1- 17; 209 – 224. 4. John G. Holt. 1994. Bergey's Manual of Determinative Bacteriology. Lippincott Williams and Wilkins. Pp: 351-352; 597-724. 5. Chatterjee, K. D. 1981. Parasitology. Chatterjee Medical Publishers. Pp: 1-106. **Web 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 an in-depth knowledge on *E. coli, Rhizobium* sp. and *Methanobacteria* sp. CO3: Explain the basic principles and methods of classification of fungi and algae and in-depth knowledge on *Rhizopus* sp., *Aspergillus* sp., *Penicillium* sp. and *Agaricus* sp sp., green algae, brown algae, pyrrophyta and *Chlorella* . CO4: Discuss the basic principles and methods of classification of protozoa's and an in-depth knowledge on *Plasmodium vivax.* CO5: Evaluate the basic principles and methods used for the classification of viruses and an in-depth knowledge on TMV, T_4, PV and HIV

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	1	1	3	-	-	3	3	1.4
CO2	3	3	3	1	3	3	3	3	3	3	2.9
CO3	3	3	3	1	3	3	3	3	3	3	2.9
CO4	3	1	-	1	3	3	3	3	3	3	2.3
CO5	3	3	3	1	3	3	3	3	3	3	2.9
										Mean Overall Score	2.48

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Introduction to microbial classification	2
	1.2 Taxonomy-modern approaches	2
	1.3 Numerical, molecular taxonomy and phylogeny	2
	1.4 Hackel three kingdom concept	2
	1.5 Whittaker's five kingdom concept	2
	Total Hours	**10 hrs**
II	2.1 General characteristics and classification of Eubacteria and Archaebacteria. (Bergey's Mannual)	2
	2.2 *E. coli*	2
	2.3 *Rhizobium* sp	2
	2.4 *Methanobacteria* sp	2
	2.5 Importance of Bacteria	2
	Total Hours	**10 hrs**
III	3.1 General characteristics and classification (Alexopoulous) of fungi	2
	3.2 *Rhizopus* sp.	1
	3.3 *Aspergillus* sp.	2
	3.4 *Penicillium* sp.	2
	3.5 *Agaricu*s sp.	2
	3.6 Economic importance of Fungi	1
	Total Hours	**10 hrs**
IV	4.1 Ganeral characters, classification, mode of reproduction and economic importance of green algae	2
	4.2 Ganeral characters, classification, mode of reproduction and economic importance of brown algae	2
	4.3 Ganeral characters, classification, mode of reproduction and economic importance of pyrrophyta. Salient features of *Chlorella*	2
	4.4 General characteristics, classification, life cycle of *Plasmodium vivax*	2
	4.5 Importance of protozoa	2
	Total Hours	**10 hrs**
V	5.1 Virus-morphology, general characters, classification (Baltimore classification)	4
	5.2 Life cycle and mode of reproduction of plant virus TMV	1
	5.3 Life cycle and mode of reproduction of bacteriophage T4	1
	5.4 Life cycle and mode of reproduction insect virus PV	1
	5.5 Life cycle and mode of reproduction of human virus HIV	1
	Total Hours	**8hrs**
Total hours for Units I to V		**48 hrs**

Course Code & Course Title	**18MIBU0204: PRACTICAL II : MICROBIAL DIVERSITY** **Credits- 1**		
Class	B.Sc. Microbiology	Semester	Second
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To provide practical knowledge on the cultural characteristics of microorganisms • To make the modern technical capabilities to analyse the structures of prokaryotes and eukaryotes • To encourage development of skills on observations of organisms • To extend knowledge on diversity of microorganisms • To give skills in the isolation various microorganisms		

Practical	Topics covered	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*.	6
9	Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.	3
10	Visit to microbial rich environments like lakes and demonstrate the presence of distinct and conspicuous microorganisms.	6

References	**Reference:** 1. Kannan N, 2003. Hand book of Laboratory culture media, Reagents and Buffers. Panima Publishing Corporation, New Delhi. 2. Dubey RC and Maheswari DK, 2004. Practical Microbiology 1st Edition, S.Chand & Company Ltd., New Delhi. 3. Sundararaj T. Microbiology laboratory manual. Revised and published by Aswathy Sundararaj. No.5 First cross street, Thirumalai nagar, Perungudi, Chennai. 4. Aneja KR, 2005. Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai. . 5. Harold J Benson, 1998. Microbiological Applications - Laboratory Manual in General Microbiology. Seventh International edition, Me Grew-Hill, Boston.
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.

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	3	3	1	3	3	3	3	3	3	2.9
CO2	3	2	1	1	3	3	3	1	3	3	2.4
CO3	3	3	3	1	3	3	3	3	3	3	2.9
CO4	3	3	3	1	3	3	3	3	3	3	2.9
CO5	3	3	3	1	3	3	3	3	3	3	2.9
										Mean Overall Score	2.8

PRACTICAL SCHEDULE

Practical	Topics covered	Hours
1	Cultural characteristics of microorganisms, colony morphology, shape and margin	6
2	Observation on Gram positive bacteria.	3
3	Observation of Gram negative bacteria.	3
4	Isolation and observation of an Archaea.	6
5	Microscopic observation of a 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.*	6
9	Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.	3
10	Visit to microbial rich environments like lakes and demonstrate the presence of distinct and conspicuous microorganisms.	6
	Total hours	**45 hrs**

Course Code & Course Title	**19MIBU0305: MICROBIAL PHYSIOLOGY** **Credits –3**		
Class	B.Sc. Microbiology	Semester	Third
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on bacterial morphology and cell wall composition • To give an outline on the processes involved in motility, sporulation and quorum sensing • To give an in-depth knowledge on microbial nutrition and growth. • To highlight photosynthetic pathways in different bacterial groups. • To expose the students to the mechanisms of bacterial respiration and energy generation.		

UNIT	Content	No. of Hours
I	**Bacterial morphology and ultra structure:** Composition and cell arrangement structure and Biosynthesis of cell wall in Gram positive and Gram negative bacteria. Bacterial cell division, replication of bacterial chromosome, co-ordination of cell division with replication of chromosome, partitioning of chromosome into daughter cells.	9
II	**Motility and sporulation:** Organs of locomotion- cilia, flagella, pili or fimbriae. Swarming motility, gliding motility and motility in spirochete – chemotaxis. Differentiation in bacterial cells-sporulation, germination and outgrowth of bacterial endospores. Microbial biofilms and quorum sensing.	9
III	**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.,	10
IV	**Photosynthesis and Carbon assimilation:** Photosynthesis – Oxygenic and anoxygenic, photosynthetic and accessory pigments - chlorophyll - bacteriochlorophyll- rhodopsin-carotenoids- phycobiliproteins. Carbon dioxide fixation, Calvin cycle- C3-C4 pathway.	10
V	**Bacterial metabolism:** Carbohydrate metabolism- glycolysis – Embden Meyerhof pathway-Entner Doudroff pathway, alcoholic fermentation, TCA cycle, glyoxalate cycle, electron transport chain, substrate level and oxidative phosphorylation, pentose phosphate pathway	10

References	**Text Books:** 1. Pelczar, Jr., Michael, E. C. S. Chan and Noel Kreig, 2000. Microbiology. V Ed.Tata McGraw Hill Book Company. 2. Roger Y. Stanier., John L. Ingraham., Mark L.Wheelis., Page R.Painter., 1987. General Microbiology, V Ed., Macmillan Press Ltd., London. 3. Salle, A.J, 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York. 4. Gottschalk, G, 1986. Bacterial Metabolism. II Ed. Heidelberg Springer. **References:** 1. Albert G. Moat, John W. Foster and Michael P. Spector, 2002. Microbial Physiology, 4th Edn. Wiley Liss. 2. David L. Nelson and Michael M. Cox, 2017. Lehninger Principles of Biochemistry, 7th edition, W.H. Freeman and Company, New York 3. Charu Gera and S. Srivastava, 2006. Quorum- sensing: The phenomenon of microbial communication, Current science. 90: 666-676. 4. Jeremy M Berg, John L Toymoczko and Lubert Stryer, 2006. Biochemistry VI Edition. W.H. Freeman and Company, New York 5. Lansing M. Prescott, John P. Harley and Donald A. Klein, 2002) Microbiology. V Ed. WCB/McGraw Hill Company. 6. Fuqua W C, Winans S C and Greenberg E P, 1994. Quorum sensing in bacteria: the LuxR-LuxI family of cell density-responsive transcriptional regulators, Journal of bacteriology. 176(2): 269–275. **Web 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	**Upon completion of this course, students should be able to:** CO1: Discuss the bacterial cell wall composition, morphology and replication. CO2:Outline the principle mechanisms of motility and sporulation in microorganisms. CO3: Explain various microbial nutrition and growth curve. CO4:Delineate the principle and mechanisms of bacterial photosynthesis and carbon assimilation. CO5: Describe the pathways involved in bacterial respiration

Course Outcomes (COs)	PO					PSO					Mean Score of COs
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	-	3	3	-	-	3	3	1.5
CO2	3	3	2	1	3	3	1	1	3	3	2.3
CO3	3	3	-	1	3	3	-	-	3	3	1.9
CO4	3	3	-	1	3	3	-	1	3	3	2.0
CO5	3	3	-	-	-	3	-	-	3	3	1.5
									Mean Overall Score		1.84

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Composition and cell arrangement structure and Biosynthesis of cell wall in Gram positive and Gram negative bacteria.	2
	1.2. Bacterial cell division and replication of bacterial chromosome	2
	1.3. Co-ordination of cell division with replication of chromosome	2
	1.4. Partitioning of chromosome into daughter cells.	2
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**9hrs**
II	2.1. Organs of locomotion- cilia, flagella, pili or fimbriae.	2
	2.2. Swarming motility, gliding motility and motility in spirochete – chemotaxis.	2
	2.3. Differentiation in bacterial cells- sporulation, germination and outgrowth of bacterial endospores.	2
	2.4. Microbial biofilms and quorum sensing.	2
	2.5. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**9hrs**
III	3.1. Nutritional types – autotrophs, heterotrophs, lithotrophs and organotrophs.	2
	3.2. Transport mechanisms –diffusion-active transport.	2
	3.3. Definition of growth, Growth curve, generation time and specific growth rate.	2
	3.4. Batch culture, Continuous culture– synchronous and asynchronous culture.	2
	3.5. Factors influencing microbial growth – pH, temperature, pressure, salinity and oxygen.	2
	Total hours	**10hrs**
IV	4.1. Photosynthesis – Oxygenic and Anoxygenic,	2
	4.2. Photosynthetic and accessory pigments - chlorophyll – bacterio chlorophyll, rhodopsin- carotenoids- phycobiliproteins.	2
	4.3. Carbon dioxide fixation,	2
	4.4. Calvin cycle- C3- C4 pathway.	2
	4.5.Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	2
	Total hours	**10hrs**
V	5.1. Carbohydrate metabolism	2
	5.2. Glycolysis- Embden Meyerhof pathway- Entner Doudroff pathway,	2
	5.3. alcoholic fermentation,	1
	5.4. TCA cycle, glyoxalate cycle, electron transport chain	2
	5.5. Substrate level and oxidative phosphorylation	2
	5.6. Pentose phosphate pathway	1
	Total hours	**10hrs**
	Total hours for Units I to V	**48 hrs**

Course Code & Course Title	**19MIBU0306: PRACTICAL III:MICROBIAL PHYSIOLOGY** **Credits- 1**		
Class	B.Sc. Microbiology	Semester	**Third**
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart a practical knowledge on how to measure bacterial growth curve and calculate generation time • To demonstrate through experiments, the effects of environmental factors on growth of bacteria • To identify unknown bacteria and fungi based on biochemical and culture characteristics • To determine motility of bacteria • To demonstrate pigment production in bacteria		

UNIT	Content	No.of Hours
	EXPERIMENTS: 1. Culture characteristics of Microorganisms-colony morphology, shape and margin. 2. Measurement of microbial growth-turbidity method and cell count 3. Effect of pH, temperature and salinity on bacterial growth. 4. Anaerobic cultivation – candle jar, gas pack method. 5. Morphology of microorganisms: Morphological variations in algae (Diatoms, Chlamydomonas, Volvox). Morphological variations in Cyanobacteria (*Oscillatoria, Nostoc, Anabaena*) Morphology of fungi 6. Demonstration of pigment production on Nutrient agar medium *(Staphylococcus aureus, Pseudomonas aeruginosa & Serratia)*. 7. Physiological characterization of bacteria: IMViC test, H_2S, Oxidase, catalase, urease test, gelatin liquefaction, casein, starch hydrolysis. Carbohydrate fermentation.	42
References	1. Short course in bacterialgenetics.J.H.Miller,1992.CSHLaboratories. 2. Methods for General and molecular bacteriology, 1994. Murray et.al. ASM Press. 3. ExperimentswithGeneFusions, 1994.T.Silhavy. Cold Spring Harbour Lab. Press. 4. Dubey, R.C and Maheswari, D.K, 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 5. Breed and Buchanan, 2003. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5).	

Course Outcomes	**Upon completion of this practical course, students should be able to:** CO 1: Explain bacterial growth curve and generation time CO 2: Demonstrate the effects of environmental factors on growth of bacteria CO 3: Identify unknown bacteria and fungi based on biochemical and culture characteristics CO 4: Determine the motility of bacteria CO5: Characterize pigment production in bacteria

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	3	3	-	3	3	3	3	3	3	2.7
CO2	3	3	3	3	3	3	3	3	3	3	3.0
CO3	3	3	3	1	3	3	3	2	3	3	2.7
CO4	3	2	3	1	3	3	3	2	3	3	2.6
CO5	3	1	3	-	3	3	3	1	3	3	2.3
										Mean Overall Score	2.66

LECTURE SCHEDULE

S. No.	Experiment	Hours
1	Culture characteristics of Microorganisms- colony morphology, shape and margin.	3+3
2	Measurement of microbial growth- turbidity method and cell count.	3+3
3	Effect of pH, temperature and salinity on bacterial growth.	3+3
4	Anaerobic cultivation- candle jar, gas pack method.	3+3
5	Morphology of microorganisms: Morphological variations in algae (Diatoms, Chlamydomonas, Volvox). Morphological variations in Cyanobacteria (*Oscillatoria, Nostoc, Anabaena*) Morphology of Fungi.	3+3
6	Demonstration of pigment production on Nutrient agar medium (*Staphylococcus aureus, Pseudomonas aeruginosa&Serratia*).	3+3
7	Physiological characterization of bacteria: IMViC test, H2S, Oxidase, catalase, urease test, gelatin liquefaction, casein, starch hydrolysis. Carbohydrate fermentation.	3+3
	Total hours	**42 hrs**

Course Code & Course Title	19MIBU0407 AGRICULTURAL MICROBIOLOGY Credits- 3		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart in-depth information on soil and agriculture • To make the students understand the role of microbes in agriculture • To give an overview on plant microbe interaction. • To make the students to know about various techniques involved in biofertilizers production • To 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.	8
II	**Microbial transformations of minerals:** Biogeochemical cycles-Carbon, Nitrogen, Phosphorous and Sulphur cycles. Organic matter decomposition ,humus formation and C:N ratio.	10
III	**Biological Nitrogen fixation:** Microorganisms in the Rhizosphere, Rhizoplane and Phylloplane-Biologicalnitrogen fixation, symbiotic and free living nitrogenise structure and function - Genetics of N_2 fixation-nitrogen fixation.	10
IV	**Biofertilizers production:** Biofertilizers – Importance and various types of Biofertilizer *Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla*, Phosphate solubilizing microorganism-Mycorrhizal biofertilizers, PGPR - *Pseudomonas* Sp.	10
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).	10

References	**Text Books:** 1.Gupta, S.K., 2014 Approaches and trends in plant disease management. Scientificpublishers,Jodhpur, India. 2. Jamaluddin *et al*., 2013 Microbes and sustainable plant productivity. ScintificPublishers Jodhpur, India. G 3. Subba Rao, N. S., 1997. Biofertilizers in Agriculture and Forestry, III Ed., Oxford &IBH Publishing Co.Pvt.Ltd.,New Delhi. 4. Subba Rao, N. S. 1995. Soil microorganisms and plant growth. Oxford & IBHPublishing Co.Pvt.Ltd. New Delhi. 5. Martin Alexander, 1983. Introduction to Soil Microbiology, Wiley eastern Ltd., NewDelhi. **References:** 1. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 2. Glick, B.R. AND Pasternak, J.J, 1994. Molecular Biotechnology, ASM Press, Washington DC. 3. Purohit, S. S., Kothari, P. R. and Mathur, 1993. Basic and Agricultural Biotechnology, Agrobotanical Publishers (India). Bikaner. **Web 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:** 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.

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	1	-	2	3	3	-	-	3	3	1.8
CO2	3	1	-	2	3	3	-	-	3	3	1.8
CO3	3	2	-	2	3	3	-	-	3	3	1.9
CO4	3	1	-	1	3	3	-	-	3	3	1.7
CO5	3	-	-	2	3	3	-	-	3	3	1.7
Mean Overall Score											1.78

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Soil- formation, soil structure, soil types	2
	1.2 Physical and chemical properties of soil	3
	1.3 Microbes in soil - types, abundance, distribution factors influencing microbial activity in soil.	3
	Total hours	**8hrs**
II	2.1 Biogeochemical cycles	1
	2.2 Carbon cycle, Nitrogen cycle,	3
	2.3 Phosphorous cycle, Sulphur cycle	3
	2.4 Organic matter decomposition ,humus formation and C:N ratio	3
	Total hours	**10 hrs**
III	3.1 Microorganisms in the Rhizosphere, Rhizoplane and Phylloplane	3
	3.2 Biological nitrogen fixation	2
	3.3 Symbiotic and free living nitrogenase structure and function	3
	3.4 Genetics of N_2 fixation	2
	Total hours	**10 hrs**
IV	4.1 Biofertilizers- Importance and various types of Biofertilizers	2
	4.2 *Rhizobium, Azotobacter, Azospirillum,* Cyanobacteria	3
	4.7 Isolation, mass production and field application of Phosphate solubilizing microorganism	2
	4.8 Isolation, mass production and field application of Mycorrhizal Biofertilizers,PGPR, *Pseudomonas*	3
	Total hours	**10 hrs**
V	5.1 Characters of plant pathogens	2
	5.2 Symptoms and control measures of bacterial, fungal and viral Diseases	2
	5.3 Microbial pesticides-classification, mode of action of bacterial pesticides (*Bacillus thuringiensis*)	2
	5.4 Classification, mode of action of fungal pesticides (*Trichoderma viride*)	2
	5.5 Classification, mode of action of viral pesticides (NPV)	2
	Total hours	**10 hrs**
	Total hours for Units I to V	**48 hrs**

Course Code & Course Title	**19MIBU0408 IMMUNOLOGY** **Credits- 3**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To elaborate the structural features of the components of the immune system as well as their functions and responsiveness. • To introduce the basics of antigen and antibody • To impart basic knowledge hypersensitivity reactions and autoimmune diseases. • To give an insight on vaccines and monoclonal antibody production • To gain an in depth knowledge on *In-vitro* antigen – antibody reactions and its application in diagnosis		

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:** Antigen characteristics, types of antigens, adjuvants, immunogenicity, antigenicity, antigen -antibody reactions. Humoral immune response, immunoglobulin structure and properties, theories of antibody diversity, isotype switching, monoclonal antibodies, complement, complement Activation.	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.	10
IV	**Vaccines:** Principles underlying the preparation of live, attenuated vaccines and recombinant vaccine. Monoclonal antibody - production and application. Types of grafts, graft rejection –properties and types of rejection;tissue typing, immunosuppressive therapy.	9
V	**Antigen – antibody reactions:** *In-vitro* Methods - agglutination, precipitation, complement fixation, immunofluorescence, ELISA, Radio immunoassays; *In-vivo* Methods: skin tests and immune complex tissue demonstrations. applications of these methods in diagnosis of microbial diseases.	10

References	**Text Books:** 1. Kuby Immunology; Oven, 2013. Punt, Stranford, 7th Edn. W. H. Freeman 2. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg, 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 3. Roitt, I.M, 1998. Essential Immunology, Blackwell Scientific Publishers. **References:** 1. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014). 2. Understanding Immunology (Cell and Molecular Biology in Action). (2006), Peterwood, Pearson Education Ltd. **Web resources:** a) https://www.microbe.net/resources/microbiology/web-resources/ b) guides.emich/immunology c) http://oew.mit.edu/courses/.../hst-176-cellular-and molecular.Immunology -fall-2005	
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 vaccines and monoclonal antibody production CO5: Delineate *In-vitro* antigen – antibody reactions and its application in diagnosis	

Course Outcomes (COs)	PO					PSO					Mean Score of COs
	1	2	3	4	5	1	2	3	4	5	
CO1	3	2	-	-	3	3	-	-	3	3	1.7
CO2	3	-	-	-	3	3	-	-	3	3	1.5
CO3	3	-	-	-	3	3	-	-	3	3	1.5
CO4	3	-	-	1	3	3	-	-	3	3	1.6
CO5	3	-	-	1	3	3	-	-	3	3	1.6
Mean Overall Score											1.58

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Historical background	1
	1.2. Innate and acquired immunity, humoral and cell mediated immunity	1
	1.3. Organs and cells involved in immune response	2
	1.4. Identification and characterization of T and B cells	2
	1.5. Cell surface receptors, cellular cooperation, MHC restriction	2
	1.6. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**9hrs**
II	2.1. Antigen characteristics, types of antigens, adjuvants	1
	2.2. Immunogenicity, antigenicity, antigen -antibody reactions.	1
	2.3. Humoral immune response	2
	2.4. Immunoglobulin structure and properties	2
	2.5. Theories of antibody diversity, isotype switching	2
	2.6. Monoclonal antibodies, complement, complement Activation	1
	2.7. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**10hrs**
III	3.1. Hypersensitivity reactions – Antibody mediated - Type I anaphylaxis	1
	3.2. Type II Antibody dependent cell cytotoxicity	2
	3.3. Type III Immune complex reactions - the respective disease and immune response-Lymphokines, cytokines	2
	3.4. Type IV hypersensitivity reactions.	1
	3.5. Autoimmune diseases – Rheumatoid arthritis, Systemic lupus erythematosus, Multiple sclerosis.	2
	3.6. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**10hrs**
IV	4.1. Principles underlying the preparation of live, attenuated vaccines and recombinant vaccines.	3
	4.2. Monoclonal antibody - production and application.	2
	4.3. Types of grafts, graft rejection- properties and types of rejection; tissue typing, immunosuppressive therapy.	2
	4.4. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	2
	Total hours	**9hrs**
V	5.1. Antigen – antibody reaction: In-vitro Methods - agglutination, precipitation, complement fixation	2
	5.2. Immunofluorescence, ELISA, Radio immunoassay	2
	5.3. In-vivo Methods: skin tests and immune complex tissue demonstrations.	2
	5.4. Applications of these methods in diagnosis of microbial diseases.	3
	5.5. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**10hrs**
	Total hours for Units I to V	**48 hrs**

Course Code &	**19MIBU0409 MEDICAL MICROBIOLOGY**

Course Title			**Credits- 3**
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To introduce the basic concepts of medical microbiology • To gain an in depth knowledge on microbial pathogenesis • To impart basic knowledge on bacterial diseases, epidemiology and virulence factors associated with the pathogen. • To give an insight on different viral and fungal diseases • To provide outline on prevention and control of microbial diseases		

UNIT	Content	No. of Hours
I	**Introduction:** Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. 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. Symptoms, pathogenesis, mode of transmission, prevention and treatment of the bacterial diseasescaused by*Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium*, *Vibrio*, *Yersinia, Haemophilus, Mycobacterium*, Spirochetes, Bordetella, Rickettsiae, *Chlamydia*.	10
IV	**Viral and Fungal diseases:** General properties of viruses Host interactions: Pox viruses; Herpes virus, Hepatitis viruses and Human Immuno deficiency viruses (HIV) Fungal diseases of man, Epidemiology. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens.	9
V	**Prevention and control:** Antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules.	10
References	**Text Books:** 1. Ananthanarayanan. R. and C.K. Jayaram Panicker, 1997. Textbook of	

	Microbiology Orient Longman. 2. Broude A. I, 1981. Medical "Microbiology": and Infectious Diseases W.B. Saunders & Co., Philadelphia 3. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection. Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996. 4. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg, 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 5. Greenwood D, Richard C.B.and.Peutherer S.J., 2000. Medical Microbiology. Churchill Livingstone. 6. D.C. Shanson, Wright PSG, Microbiology in Clinical Practice., 1982. 7. Baron EJ, Peterson LR and Finegold SM Mosby, 1990. Bailey and Scott's Diagnostic Microbiology. **References:** 1. Prescott, Harley and Klein, McGraw-Hill, 2003. Microbiology 2. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. 3. Bergeys Manual of determinative Bacteriology. **Web 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

Course Outcomes (COs)	PO					PSO					Mean Score of COs
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	-	3	3	-	-	3	3	1.5
CO2	3	-	-	-	3	3	-	-	3	3	1.5
CO3	3	-	-	2	3	3	-	-	3	3	1.7
CO4	3	-	-	-	3	3	-	-	3	3	1.5
CO5	3	-	-	-	3	3	-	-	3	3	1.5
										Mean Overall Score	1.54

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists.	3
	1.2. Classification of medically important microorganisms	2
	1.3. Normal microbial flora of human body; role of the resident flora; normal flora and the human host.	3
	1.4. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**9hrs**
II	2.1. Mechanisms of microbial pathogenesis: Establishment, spreading, tissue damage and anti-phagocytic factors	3
	2.2. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts	2
	2.3. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence	2
	2.4. Organs and cells involved immune system and immune response	2
	2.5. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**10hrs**
III	3.1. Classification of pathogenic bacteria.	1
	3.2. Symptoms, pathogenesis, mode of transmission, prevention and treatment of the bacterial diseases caused by *Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium*, *Vibrio*, *Yersinia, Haemophilus, Mycobacterium*, Spirochetes, Bordetella, Rickettsiae, *Chlamydia*.	7
	3.3. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**10hrs**
IV	4.1. General properties of viruses. Host interactions	1
	4.2. Pox viruses; Herpes virus, Hepatitis viruses and Human Immuno deficiency viruses (HIV)	2
	4.3. Fungal diseases- Epidemiology	2
	4.4. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens	2
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**9hrs**
V	5.1. Prevention and control : Antimicrobial therapy	2
	5.2. Various methods of drug susceptibility testing, antibiotic assay in body fluids	3
	5.3. Brief account on available vaccines and schedules; passive prophylactic measures	2
	5.4. Video clips, Animations, class tests, tutorials and term paper presentations	3
	Total hours	**10hrs**
	Total hours for Units I to V	**48 hrs**

Course Code & Course Title	**19MIBU0410 PRACTICAL IV: AGRICULTURAL MICROBIOLOGY Credits- 1**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To provide practical knowledge in the isolation and characterization of microbes important in agriculture. • To comprehend plant-pathogen interactions • To gain expertise in isolation of organisms that have the potential of biofertilizers • To provide skills for biofertilizer production • To impart training on Study of plant pathogens		

Practical	**Topics covered**	**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-VAM	6
8	Isolation of Phosphate solubilizing bacteria from soil	6
9	Isolation and identification of cyanobacteria	6
10	Isolation on *Trichoderma viride*	6
References	**References:** 1. Dubey, R.C and Maheswari, D.K., 2002. Practical Microbiology, 1st Ed., Chand and Company Ltd., India. 2. K. R. Aneja., 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.. New Delhi. India. 3. Sadasivam, S and Manikam, A., 1992. Biochemical methods for agricultural sciences. Wiley Eastern Ltd., New Delhi.	

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

Course Outcomes (COs)	PO					PSO					Mean Score of COs
	1	2	3	4	5	1	2	3	4	5	
CO1	3	3	3	1	3	3	3	2	3	3	2.7
CO2	3	2	3	1	3	3	3	2	3	3	2.6
CO3	3	2	3	1	3	3	3	2	2	3	2.5
CO4	3	2	3	1	3	3	3	2	2	3	2.5
CO5	3	3	3	1	3	3	3	3	2	3	2.7
										Mean Overall Score	2.6

PRACTICAL SCHEDULE

S.No.	Topic	No. of Hrs
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-VAM	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 hrs**

Course Code & Course Title	**19MIBU0411 PRACTICAL V: IMMUNOLOGY & MEDICAL MICROBIOLOGY**		**Credits- 1**
Class	M.Sc. Microbiology	Semester	**Third**
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart a practical knowledge on collection, transport and processing clinical specimens • To isolate, enumerate and identify pathogenic bacteria and fungi from clinical samples. • To perform different staining methods to identify pathogens • To elaborate agglutination tests to diagnose diseases • To carry out immuno-diffusion and immune-electrophoresis		

UNIT	**Content**	**No. of Hours**
	EXPERIMENTS: 1. Selection, collection, and transport of specimens, blood samples, sera for microbiological and immunological examinations 2. Fixation of Smears for microscopy by different methods 3. Different staining techniques a) Ziehl –Nielsen method for AFB b) Leishman's staining c) Albert's staining d) Giemsa's staining e) Special staining methods to demonstrate granules, capsules and spores 4. ABO Blood grouping and Rh typing 5. Agglutination tests a) WIDAL b) VDRL Test (RPR). c) ASO(Anti streptolysin 'O' Test). d) HBs Ag Test e) CRP 6. Precipitation Tests a) Immuno - diffusion test b) Immuno electrophoresis 7. Demonstration of ELISA (HIV & HBs Ag) 8. Visit to the diagnostic laboratory	42
References	**Text Books:** 1. 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. 2. Turgeon, M.L., 1990. Immunology and serology in laboratory medicine, St.Louis, C.V. Mosby Co. 3. Talwar G.P and Gupta S.K., 1992. A hand book of practical and clinical immunology. CBS Publication, New Delhi, India 4. E. D. Harlow, David Lane, 2014. Antibodies– A Laboratory Manual; 2nd Edn. CSHL Press **References:** 1. Horold J Benson, 1998. Microbiological Applications - Laboratory Manual in General Microbiology. Seventh International edition, Mc Grew-Hill, Boston. 2. Cappuccino, J. and Sherman, N. 2002. Microbiology: A Laboratory Manual, 6th Edn.Pearson Education Publication, New Delhi. **Web resources:** a) http://oew.mit.edu/courses/.../hst-176-cellular-and molecular. Immunology -fall-2005 b) https://www.omicsonline.org/medicalmicrobiology-diagnosis.php c) https://currentprotocols.onlinelibrary.wiley.com/ d) http://www.protocol-online.org/prot/Immunology/
Course Outcomes	**Upon completion of this practical course, students should be able to:** CO 1:Demonstrate collection, transport and processing clinical specimens CO 2:Isolate, enumerate and identify pathogenic bacteria and fungi from clinical samples CO 3:Explain different staining methods to identify pathogens CO 4: Perform agglutination tests to diagnose diseases CO5:Carry out immuno-diffusion and immune-electrophoresis

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	1	3	1	3	3	3	3	2	3	2.5
CO2	3	2	3	1	3	3	3	3	2	3	2.5
CO3	3	1	3	-	3	3	3	3	2	3	2.3
CO4	3	1	3	1	3	3	3	3	2	3	2.5
CO5	3	1	3	1	3	3	3	3	1	3	2.3
Mean Overall Score											2.42

LECTURE SCHEDULE

S. No.	Experiment	Hours
1	Selection, collection, and transport of specimens, blood samples, sera for microbiological and immunological examinations	6
2	Fixation of Smears for microscopy by different methods	6
3	Different staining techniques: a) Ziehl –Nielsen method for AFB, b) Leishman's staining, c) Albert's staining, d) Giemsa's staining, e) Special staining methods to demonstrate granules, capsules and spores	6
4	ABO Blood grouping and Rh typing	3
5	Agglutination tests: a) WIDAL, b) VDRL Test (RPR), c) ASO(Anti streptolysin 'O' Test) d) HBs Ag Test e)	6
6	Precipitation Tests: a) Immuno - diffusion test, b) Immuno electrophoresis	6
7	Demonstration of ELISA (HIV & HBs Ag)	3
8	Visit to the diagnostic laboratory	6
	Total hours	**42 hrs**

Course Code & Course Title	**19MIBU0512 FOOD MICROBIOLOGY** **Credits -4**		
Class	B.Sc	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To introduce the scope and development of food microbiology • To give an overview on food spoilage organisms- Food borne diseases. • To highlight fermentation technologies in the food processing industry. • To create awareness among the students about food preservation • To impart knowledge on quality and safety assurance in food industry.		

UNIT	Content	No. of Hours
I	**Microbiology of Foods:** History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic factors - Extrinsic factors – pH ,moisture, water activity, oxidation-reductionpotential,nutrientcontentsandinhibitorysubstances.	13
II	**Food poisoning and Food-borne diseases:** Food hygiene and sanitation. Food poisoning mycotoxins and bacterial toxins. Microbial contamination of foods –Food spoilage by microbes in meat, butter, vegetables and canned food. Food borne diseases.	13
III	**Microbial fermentations:** Fermented foods – Preparation pickled cucumber, saurkraut-soy sauce and bread. Fermented milk and dairy products – Yoghurt and cheese.	13
IV	**Food preservation:** Principles of food preservation. Methods of food preservations - Pasteurization - Freezing and Refrigeration Physical and chemical methods – Radiation- Organic acids, Nitrates Nitrites.	13
V	**Quality and safety assurance:** Quality control and quality assurance measures. Food standards. GMP, HACCP, FDA, BIS Laboratory services. Microbial standards for various products.	12
References	**Text 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 publishing Co., 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. **References:** 1. Britz, T.J. and Robinson, R.K., 2008 Advanced Dairy Science and Technology Blackwell publ.,U.K. 2. Hobbs,B.C.and Roberts,D., 1993. Food Poisoning and Food Hygiene, Edward Arnold (A Division of Hodder and Sloughton), London. 3. Salle, AJ., 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill, Publishing Co. Ltd., New York. pp: 710-793. 4. Robinson, R.K., 1990. Dairy Microbiology, Elsevier Applied Sciences, London Banwart,GJ. Basic Food Microbiology, CBS Publishers and Distributors. **Web resources:** 1. http://www.microbes.info 2. http://www.fsis.usda.gov/ 3. http://www.cdc.gov. 4. http://www.microbes.info/ resource/food microbiology 5. http://www.binewsonline.com/1/what is food microbiology.html
Course Outcomes	**On completion of the course, students should be able to:** CO 1: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.

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	1	3	3	-	-	2	3	1.5
CO2	3	1	2	1	3	3	1	1	2	3	2.0
CO3	3	3	2	1	3	3	2	2	2	3	2.4
CO4	3	1	2	1	3	3	2	2	2	3	2.2
CO5	3	1	1	1	3	3	1	1	1	3	1.8
										Mean Overall Score	1.98

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 History and Scope of microorganism in food.	4
	1.2 Factors affecting the growth and survival of microorganisms in foods-Intrinsic factors	3
	1.3 Extrinsic factors	3
	1.4 Video clips, class tests, tutorials and term paper Presentations	3
II	**Total Hours**	**13 hrs**
	2.1 Food hygiene and sanitation	3
	2.2 Food poisoning mycotoxins and bacterial toxins	2
	2.3 Microbial contamination of foods	3
	2.4 Food spoilage by microbes in meat, Butter, vegetables and canned food.	3
	2.5 Video clips	2
	Total Hours	**13 hrs**
III	3.1 Fermented food preparation	2
	3.2 Fermented foods-Preparation of pickled cucumber, sauerkraut	2
	3.3 Fermented soya sauce and bread	3
	3.4 Fermented milk and dairy products	3
	3.5 Video clips, Animations, class tests, tutorials and term paper presentations	3
	Total Hours	**13 hrs**
IV	4.1 Microbiology of food preservation	2
	4.2 Aseptic packaging	2
	4.3 Pasteurization, Freezing and Refrigeration	3
	4.4 Radiation-UV radiation	2
	4.5 Chemical preservatives- Organic acids, Nitrates Nitrites	3
	4.6 Video clips, class tests, tutorials and term paper presentations and demonstration	1
	Total Hours	**13 hrs**
V	5.1 Quality control in food and dairy industry	1
	5.2 Quality assurance in industry	1
	5.3 Good Manufacturing Practices(GMP),FDA	2
	5.4 Hazard analysis and critical control point, BIS	2
	5.5 Laboratory sciences	2
	5.6 Microbial criteria/standards for various products	2
	5.7 Video clips, class tests, tutorials and term paper presentations	2
	Total Hours	**12 hrs**
	Total hours for Units I to V	**64 hrs**

Course Code & Course Title	**19MIBU0513 INDUSTRIAL MICROBIOLOGY** **Credits -4**		
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To know industries and involving microbial technology • To understand screening methods for fermentative microbes • To know the media and industrial important microorganisms • To create a comprehensive knowledge on Industrial production of various microbial products • To get knowledge on the rules and regulation of industrial effluent disposal and bio safety		

UNIT	Content	No. of Hours
I	**History and Fermentor :** History concept of industrial microbiology. Fermentor principle and its types- Fermentation- upstream and downstream process – Filtration, Centrifugation.	13
II	**Screening methods for Industrial microbes:** Industrially important microbes - Screening methods - Strain selection and improvement - mutation and recombinant DNA technology	13
III	**Media and Biology of Industrial Microorganisms**: Single cell protein, *Saccharomyces*- Advantages and disadvantages- Raw materials used in media production, industrial sterilization, Large scale cultivation of Industrially important microbes.	13
IV	**Industrial production :** Industrial products derived from microbes, industrial enzymes-amylase,celluase production production of antibiotics penicillins, streptomycins, vitamins-riboflavin,cyanocobalamin.	13
V	**Regulations:** Noval approaches to Industrial effluent treatment and disposal. Institutional Bio-safety Committee.	12
References	**Text Books:** 1. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 3. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi. 4. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and	

	Distributors. 5. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited **References:** 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. **Web 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 media and biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial effluent disposal and bio safety

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	-	2	3	-	-	2	3	1.3
CO2	3	2	2	-	3	3	1	1	1	3	1.9
CO3	3	-	1	-	3	3	1	1	1	3	1.6
CO4	3	-	1	-	3	3	1	1	1	3	1.6
CO5	3	-	-	-	3	3	-	-	1	3	1.3
										Mean Overall Score	1.54

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Introduction, Historical background of Industrial Microbiology	2
	1.2 Fermentor - types –Principle	4
	1.3 Fermentation- upstream	3
	1.4 Fermentation- down stream	2
	1.5 Filtration, Centrifugation	2
	Total hours	**13 hrs**
II	2.1 Industrial important microbes	2
	2.2 Screening methods for Industrial microbes	3
	2.3 Strain selection	2
	2.4Strain improvement	2
	2.5 Mutation	2
	2.6 recombinant DNA technique for strain development	2
	Total hours	**13 hrs**
III	3.1Biology of Industrially important Microorganisms Single cell Protein, *Saccharomyces*	3
	3.2Advantagesanddisadvantages	2
	3.3 Raw material used for media preparation	3
	3.4 Media sterilization	3
	3.5 Large scale cultivation of Industrially important microbes.	2
	Total hours	**13 hrs**
IV	4.1 Industrial Products derived from microbes	2
	4.2 Industrial production of enzyme- Amylase and Cellulase	3
	4.3 Industrial production of Antbiotics – Penicillin, streptomycins,	3
	4.4 Industrial production vitamin - riboflavin, cyanocobalamin	3
	4.5 Video clips, tutorials	2
	Total hours	**13 hrs**
V	5.1 Industrial effluent - nature	3
	5.2 Novel Approaches to Industrial effluent treatment – disposal.	3
	5.3Approaches to Industrial effluent disposal.	3
	5.4 Class test and seminar	3
	Total hours	**12**
	Total hours for unit I-V	**64 hrs**

Course Code & Course Title	**19MIBU0514 MICROBIAL GENETICS AND MOLECULAR BIOLOGY** **Credits –3**		
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart information on the historical developments of molecular biology and molecules of life • To make the student knowledgeable on concepts and mechanism of DNA replication process • To expose the students on mechanisms of transcription and translation process in prokaryotes and eukaryotes. • To give an in-depth knowledge on mutagenesis • To enhance student's interest on bacterial genetics and gene transfer mechanisms.		

UNIT	Content	No.of Hours
I	**Basic concepts and DNA Replication** Discovery of genetic material-Structure, organization and types of DNA and RNA–Extra chromosomal DNA(Plasmid), DNA replication in prokaryotes, Mechanism and enzymology of replication, Rolling circle replication.	13
II	**Gene structure and expression** Organization of genes in prokaryotes & Eukaryotes. Molecular mechanism and Enzymology of Transcription in prokaryotes and 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.	13
III	**Mutations:** Spontaneous and induced, mutagens base pair changes, frame shifts, deletions, inversions and duplications, insertions, useful phenotypes (auxotrophic, conditional lethal, resistant), reversion vs suppression, Ames test. DNA repair mechanism.	13
IV	**Bacterial genetics:** Bacterial plasmids: structure and properties, replication, incompatibility, plasmid amplification. Bacteriophages: Life cycle of T4 and T7 phages -Single stranded DNA phages. Transposition: structure of bacterial transposons, types of bacterial transposons.	13

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. Microbial Genetics.Maloyet.al. 1994.Jones&BartlettPublishers. 2. Molecular genetics ofbacteria.J.W. Dale1994.JohnWiley &Sons. 3. Modern microbial genetics. 1991. Streips & Yasbin. Niley. Ltd. 4 Gardner, E. J,Simmons, M J&D P Snustard,1991, Principles of Genetics, 8th edition.John Wiley&Sons.NY. **References:** 1. Bejamin Lewin. 1999. GenesVII.Oxford UniversityPress. 1008pp. 2. David Freifelder .S, 1987 Microbial Genetics, Jones &Bartlett, Boston **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 fundamental concepts of molecules of life and explain the mechanisms of DNA replication & repair mechanisms CO2:Evaluate the differences of transcription and translation processes in prokaryotes and eukaryotes CO3:Discuss the various kinds of mutagenesis and their importance CO4:Delineate the importance of bacteriophages and transposable elements in bacterial genetics CO5: Describe the mechanisms of gene transfer and recombination in bacteria	

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	-	-	1	1	3	-	-	3	3	1.5
CO2	3	-	-	1	2	3	-	-	3	3	1.5
CO3	3	1	-	1	1	3	-	-	3	3	1.5
CO4	3	-	-	1	1	3	-	-	3	3	1.4
CO5	3	1	1	1	-	3	1	1	3	2	1.6
										Mean Overall Score	1.5

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Discovery of genetic material	2
	1.2. Structure, organization and types of DNA and RNA	3
	1.3. Extra chromosomal DNA (Plasmid)	2
	1.4. DNA replication in prokaryotes - Mechanism and enzymology of replication	3
	1.5. Rolling circle replication.	1
	1.6. Video clips, class tests, tutorials and term paper presentations	2
	Total Hours	**13hrs**
II	2.1.Organization of genes in prokaryotes & Eukaryotes.	2
	2.2.Molecular mechanism and Enzymology of Transcription in prokaryotes and Eukaryotes	2
	2.3. Post transcriptional modifications.	1
	2.4.Genetic code	2
	2.5.Molecular mechanism and Enzymology of Translation of proteins in prokaryotes and Eukaryotes	2
	2.6. Post translational modifications.	1
	2.7. Regulation of gene expression in prokaryotes – Operon concept – lac &trp Operon.	2
	2.8. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**13hrs**
III	3.1. Spontaneous and induced mutation	2
	3.2. Base pair changes, frame shifts, deletions, inversions, tandem duplications, insertions	2
	3.3. Useful phenotypes (auxotrophic, conditional lethal, resistant)	2
	3.4. Reversion vs. suppression, Ames test.	2
	3.5. DNA repair mechanism	3
	3.6. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**13hrs**
IV	4.1. Bacterial plasmids: structure and properties, replication, incompatibility, plasmid amplification.	3
	4.2. Bacteriophages: Life cycle of T4 and T7 phages	3
	4.3. Single stranded DNA phages.	3
	4.4. Transposition: structure of bacterial transposons, types of bacterial transposons	2
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	2
	Total hours	**13hrs**
V	5.1.Genetic analysis and Molecular basis of recombination in bacteria.	2
	5.2.Gene transfer mechanisms - Transformation: natural transformation, competence, DNA uptake, role of natural transformation, artificially induced competence, electroporation.	2
	5.3.Transduction (generalized and specialized).	2
	5.4. Conjugation: self-transmissible plasmids, F factor, tra genes, on T, F' and Hfr strains, steps in conjugation	2
	5.5.Chromosome mobilization, transfer systems in Gram Positive bacteria.	2
	5.6.Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**12hrs**
	Total hours for Units I to V	**64 hrs**

Course Code & Course Title	19MIBU0515 PRACTICAL VI : FOOD & INDUSTRIAL MICROBIOLOGY Credits- 1		
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To provide practical knowledge and skills in production as well as evaluate microbial quality of food products. • To make the modern technical capabilities to analyse food for specific microorganisms • To encourage development of skills in co-operative learning in small groups to design methods for microbial food analysis as a team and communicate the decisions of the design to peers • To extend knowledge on traditional fermented products to industrial fermentation products in the applied areas of food microbiology		

Practical	Topics covered	Hours
1	Sampling of microorganisms from food- direct cell count and direct viable cell count	3
2	Isolation of lactic acid bacteria and yeast	3
3	Assessment of milk quality by coli forms test methylene blue, phosphatase test reduction test	3
4	Alcohol fermentation from fruit juice (Wine production)- analysis of physiochemical parameters	3
5	Enumeration of anaerobic bacteria from food samples	3+3
6	Observation of food samples to study *Lactobacillus* and *Saccharomyes*	3+3
7	Isolation and identification of microorganisms from canned foods	3+3
8	Immobilization of yeast cell using sodium alginate	3
9	Production of Citric acid using *Aspergillus niger*	3+3
10	Starch (Amylase), casein (Protease) and lipid (Lipase) hydrolyses tests	3+3
11	Determination of invertase activity	3
	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. K. R. Aneja. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Prakashan.. New Delhi. India. 5. Kannan N, Handbook of laboratory culture media, Reagents, Stains and buffers. Panima Publishing Corporation, New Delhi. 2003.
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.

CO/PO	PO					PSO					Mean Score of COs
	1	2	3	4	5	1	2	3	4	5	
CO1	3	2	3	1	1	3	3	3	3	2	2.4
CO2	3	2	3	1	1	3	3	3	3	2	2.4
CO3	3	2	3	1	1	3	3	3	3	2	2.4
CO4	3	2	3	1	1	3	3	2	3	2	2.3
CO5	3	1	3	1	1	3	3	2	2	2	2.1
Mean Overall Score											2.32

Course Code & Course Title	**19MIBU0516 PRACTICAL III:MICROBIAL GENETICS AND MOLECULAR BIOLOGY** **Credits- 1**		
Class	B.Sc. Microbiology	Semester	**Third**
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart a practical knowledge on how to measure isolate single colony and checking genetic marker • To demonstrate antibiotic resistance mechanism • To conduct genetic mapping studies • To determine transposon mediated mutagenesis • To perform mutagenesis and isolate chromosomal and plasmid DNA		

UNIT	Content	No.of Hours
	EXPERIMENTS: 1. Single colony isolation and checking genetic markers. 2. Spontaneous and induced mutations-isolation of antibiotic resistant and auxotrophic mutants. 3. Selective enrichment of auxotrophic and antibiotic (tet^R) mutants. 4. Transposon mediated mutagenesis. 5. Isolation of chromosomal DNA from *E.coli.* 6. Estimation of DNA by spectrophotometry 7. Plasmid DNA isolation and restriction digestion. 8. Genetic mapping by conjugation and P1transduction.	48
References	1. Short course in bacterial genetics.J.H.Miller. 1992.CSHLaboratories. 2. Methods for General and molecular bacteriology. 1994. Murray et.al. ASM Press. 3. ExperimentswithGeneFusions.1994.T.Silhavy. Cold Spring Har bourLab.Press. 4. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 5. Breed and Buchanan2003. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) .	
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: Perform genetic mapping studies	

	CO 4: Determine transposon mediated mutagenesis CO5: Carry out mutagenesis and isolate chromosomal and plasmid DNA

Course Outcomes (COs)	PO					PSO					Mean Score of Cos
	1	2	3	4	5	1	2	3	4	5	
CO1	3	3	3	1	1	3	3	3	2	2	2.4
CO2	3	1	3	1	1	3	3	3	2	2	2.3
CO3	3	3	3	1	1	3	3	3	2	2	2.3
CO4	3	3	3	1	1	3	3	3	2	2	2.3
CO5	3	1	3	1	1	3	3	3	2	2	2.2
Mean Overall Score											2.3

LECTURE SCHEDULE

S. No.	Experiment	Hours
1	Single colony isolation and checking genetic markers.	3+3
2	Spontaneous and induced mutations - isolation of antibiotic resistant and auxotrophic mutants.	3+3
3	Selective enrichment of auxotrophic and antibiotic (tetR) mutants.	3+3
4	Transposon mediated mutagenesis.	3+3
5	Isolation of chromosomal DNA from E.coli.	3+3
6	Estimation of DNA by spectrophotometry	3
7	Plasmid DNA isolation and restriction digestion.	3+3
8	Genetic mapping by conjugation and P1 transduction.	3+3
	Total hours	**45 hrs**

Course Code & Course Title	19MIBU0617 ENVIRONMENTAL MICROBIOLOGY Credits- 4		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	The course aims • To understand the current views of microbial association in various environments; • To know an idea on Aero and Aquatic microbiology • To critically think the role of microbes in treatment of wastes/sewage • To impart information on microbial bioremediation • To study the concepts of bio safety and environmental monitoring		

UNITS	Content	No. of Hours
I	**Soil characteristics:** Historical view of soil – structure - component – microbial communities in soil. Microbial interaction – neutralism, commensalism, ammensalism, mutualism	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)	13
IV	**Bioremediation :** Pollutants- Polluted heterogeneous environment. Bioremediation – Types and uses - Microbes and Environmental clean up	13
V	**Environmental monitoring:** Environmental regulations - Biohazards - Types of hazardous emission – Bio safety measures	12

References	**Text Books:**
	1. Raina M. Maier, Ian L. Pepper and Charles P. Gerba. 2000. Environmental Microbiology. Academic Press. New York.
	2. Patel, A.H. 1996. Industrial Microbiology, Macmillan India Ltd., New Delhi
	3. Subba Rao, N. S. 1995. Soil Microbiology. IV Ed. Oxford & IBH Publishing Co. Pvt. Ltd.New Delhi. pp: 11-49; 292-301.
	4. Salle, A.J. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York. pp: 649-709;794-843.
	5. Atlas, R.M. and Bartha, R. 1992. Microbial Ecology: Fundamentals and Applications.III Ed., Benjamin Cummings, Redwood City.CA.
	References:
	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.
	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	**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

CO/PO	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	Mean Score of COs
CO1	3	2	-	1	1	3	1	1	2	2	1.6
CO2	3	2	-	1	1	3	1	2	2	2	1.7
CO3	3	1	2	1	1	3	2	2	2	2	1.9
CO4	3	-	-	1	1	3	1	-	2	2	1.2
CO5	3	1	1	1	2	3	1	1	2	2	1.7
										Mean Overall Score	1.62

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1Physio-chemical properties of soil	2
	1.2 Rhizosphere organisms	2
	1.3 Rhizoplane organisms	2
	1.4 Carbon cycle	2
	1.5 Nitrogen cycle	2
	1.6 Phosphorus cycle	1
	1.7 Sulphur cycle	1
	1.8 Video clips, class tests, tutorials and term paper presentations	1
	Total hours	**13 hrs**
II	2.1 Microbial analysis of drinking water	2
	2.2 Tests for coliforms (presumptive, confirmed and completed tests).	4
	2.3 Aeromicrobiology - Phylloplane microflora (morphological, physiological characters)	3
	2.5 Aquatic microbiology.	2
	2.6 Video clips, class tests, tutorials and term paper presentations	2
	Total hours	**13 hrs**
III	3.1 Type of waste	2
	3.2 Nature of solid and liquid waste pollutants	2
	3.2 solid waste treatment	2
	3.3 Nature of sewage and its composition.	2
	3.4Sewage Treatment - Primary and secondary	2
	3.5 Aanaerobic–methanogenesis	2
	3.7 Visit to sewage treatment plants	1
	Total hours	**13 hrs**
IV	4.1 Pollutants, Polluted heterogeneous environment.	3
	4.2 Microbes and Environmental clean up	3
	4.3Bioremediation – Types	3
	4.4 Bioremediation – uses.	2
	4.5 Seminar by students and class test	2
	Total hours	**13 hrs**
V	5.1.Environmental regulations	2
	5.2 Biohazards	2
	5.3Biohazards -Types of hazardous emission	3
	5.3Biosafety measures	3
	5.6 Video clips, class tests, tutorials and term paper presentations	2
	Total hours	**12hrs**
	Total hours for Units I to V	**64 hrs**

Course Code & Course Title	**19MIBU0618 MICROBIAL BIOTECHNOLOGY** **Credits –4**		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To introduce the basic concepts of microbial biotechnology and fermentation process • To gain an in depth knowledge on industrial production of citric acid, lactic acid and important enzymes • To impart basic knowledge on Microbial production of pharmaceutical compounds. • To give an insight on production of Bio-pesticides and Biofertilizers • to provide outline on Bio-mining and bioremediation		

UNIT	Content	No. of Hours
I	**Basic concepts and Fermentation:** Definition-scope of Microbial biotechnology – Isolation, screening, selection and strain development strategies for industrially important microorganism. Mode of culturing- Batch, Continuous and Fed-batch culture methods. Microbial growth kinetics – Monod equation, Stoichiometry of cell growth-mass and energy balances, yield coefficients, growth limiting substrate and yield factors, Formulation of fermentation media. Defined and undefined media, Factors affecting fermentation.	13
II	**Industrially important products:** Industrial production of citric acid, lactic acid, alpha amylase, lipase, protease, vitamins, acetic acid- production of biofuel-CH_4, alcohol. Genetic engineering of microorganisms – an overview.	13
III	**Microbial production of pharmaceutical compounds:** Production of pharmaceutical compounds through microbes – TPA, Insulin, Recombinant Vaccines – production of antibodies. Steroids. Production of antibiotics	12
IV	**Bio-pesticides and Biofertilizers:** Microbial production of bio-pesticides (*Bacillus thuriengiensis*). Microbial production of bio plastics. Microbial production of biofertilizers – *(Rhizobia, Azospirillum* and VAM). Single cell protein (algae and yeast)	13
V	**Bio-mining and bioremediation:** Extraction of Cu, Au, U from ore by microbes; -recovery of petroleum by microbes - Treatment of tannery effluents by microbes. Sewage Treatment. Microorganisms in bioremediation: Degradation of xenobiotics.	13

References	**Text Books:** 1. Biotechnological innovations in chemical synthesis. BIOTOL. Publisher: butter worth -Heinemann. 2. Industrial Microbiology, G.Reed (editor), CBS Publishers (AVI Publishing Company) 3. Biology of industrial microorganisms. A.L. Demain. 4. Genetics and biotechnology of industrial microorganisms. C.L.Hershnergev, S.W. Queener and Q.Hegeman. 5. Publisher: American Society of Microbiology. Ewesis. et.al. 1998. Bioremediation principles. McGraw Hill. **References:** 1. GlickBR,PasternakJJandPattenCL.MolecularBiotechnology4thedition,ASMPress. 2010. 2. Willey JM, Sherwood LM, WoolvertonCJ. Prescott, Harley and Klein's Microbiology,9th edition,McGrawHill Publishers.2014. 3. DemainALandDaviesJE.ManualofIndustrialMicrobiologyandBiotechnology,2nd Edition,ASM Press.1999. **Web resources** 1. https://www.khanacademy.org/science/biology/biotech-dna-technology 2. http://www.microbiologyonline.org.uk/links.html
Course Outcomes	**Upon completion of this course, students should be able to :** CO1:Under stand basic concepts of microbial biotechnology and fermentation process CO2:Explain the process of industrial production of citric acid, lactic acid and important enzymes CO3:Familiar with Microbial production of pharmaceutical compounds. CO4:Delineate the processes in production of Bio-pesticides and Biofertilizers CO5:Describe the aspects of Bio-mining and bioremediation

CO/PO	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	Mean Score of COs
CO1	3	1	1	1	1	3	1	1	2	2	1.6
CO2	3	1	1	1	1	3	1	1	3	2	1.7
CO3	3	1	2	1	1	3	2	1	2	2	1.7
CO4	3	1	2	1	1	3	2	2	2	2	1.9
CO5	3	2	1	1	1	3	1	1	2	3	1.8
										Mean Overall Score	1.74

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Definition-scope of Microbial biotechnology. Isolation ,screening, selection and strain development strategies for industrially important microorganism	3
	1.2. Mode of culturing-Batch, Continuous and Fed-batch culture methods	3
	1.3. Microbial growth kinetics – Monod equation, Stoichiometry of cell growth-mass and energy balances, yield coefficients, growth limiting substrate and yield factors	3
	1.4. Formulation of fermentation media. Defined and undefined media	2
	1.5. Factors affecting fermentation	1
	1.6. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**13 hrs**
II	2.1. Industrial production of citric acid, lactic acid, alpha amylase, lipase, protease, vitamins, acetic acid	4
	2.2. Production of biofuel-CH_4, alcohol	4
	2.3. Genetic engineering of microorganisms – an overview	3
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	2
	Total hours	**13 hrs**
III	3.1. Production of pharmaceutical compounds through microbes – TPA, Insulin	4
	3.2. Recombinant Vaccines. – production of antibodies, steroids	4
	3.3. Production of antibiotics	2
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**12hrs**
IV	4.1. Microbial production of bio-pesticides (*Bacillus thuriengiensis*)	3
	4.2. Microbial production of bioplastics	2
	4.3. Microbial production of biofertilizers – (*Rhizobia, Azospirillum* and VAM)	4
	4.4. Single cell protein (algae and yeast)	2
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	2
	Total hours	**13hrs**
V	5.1. Bio-mining and bioremediation: Extraction of Cu, Au, U from ore by microbes	3
	5.2. Recovery of petroleum by microbes	2
	5.3. Treatment of tannery effluents by microbes.	2
	5.4. Sewage Treatment	3

	5.5. Microorganisms in bioremediation: Degradation of xenobiotics	2
	5.6. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**13hrs**
	Total hours for Units I toV	**64 hrs**

Course Code, Title & Credits	**19MIBU0619 BIO-INSTRUMENTATION TECHNIQUES** **Credits – 4**		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K- 1 Knowledge, comprehension K-2 Application K -3 Analysis, synthesis, evaluation		
Course Objectives	**The course aims** • To understand the general laboratory procedures and maintenance of research equipments, principles of microscopes, construction of pH meter and preparation of buffers. • To study the isolation, fractionation and separation of cellular constituents. • To explain the principle and applications of centrifuge and centrifugation • To specify the principle and applications of various types chromatography techniques		

UNIT	Contents	No. of Hours
I	**Microscopy, pH** General Laboratory procedures - Microscopy- General principles – Phase Contrast Microscope - pH basic principles and construction of pH meter.	12
II	**Buffer** Principles and application of buffers- Mechanism of buffer action and preparation of common buffers- tris and phosphate- Application of buffers- pH measurements of soil.	13
III	**Isolation, Fractionation and Separation** Isolation, fractionation and separation of cellular constituents- Isolation of chloroplasts, mitochondria, nucleic acids.	13
IV	**Centrifugation** Centrifugation techniques- Basic principles, Different types of Centrifuges, Analytical and preparative ultra centrifugation methods	13
V	**Chromatography** Chromatography - Paper, thin layer - separation of amino acids and sugars- Gas chromatography.	13

References	**Text Books:** 1. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publising House, New Delhi. 2. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai.. 3. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani 4. Rodney Boyer 2001 Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India. 5. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. **References:** 1. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 2. Keith Wilson and John Walker 2002 Practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press. 3. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First dition – Chinnaa publications, Melvisharam, Vellore **Course url** 1. http://nptel.ac.in/syllabus.php?subject Id= 102107028. 2. http://b-ok.xyz/book/674611/288bc3 3. http://www.researchgate.net/publication/317181728- Lecture Notes on Laboratory Instrumentation and Techniques. 4. iiscs.wssu.edu/drupal/node/4673 5.http://www.studocu.com/en/search/research methodology?languages=language_en&type =document
Course Outcomes	**On completion of the course, students should be able to:** CO1 : Understand general laboratory procedures and maintenance of research equipments, microscopy, pH meter CO2: Know the preparation of buffers CO3 : Plan to isolate cellular constituents CO4 : Realise the principle and applications of centrifuge and centrifugation CO5: Separation of amino acids and sugars using chromatography

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1General Laboratory procedures	3
	1.2 Microscopy	3
	1.3 General principles – Phase Contrast Microscope	3
	1.4 pH basic principles and construction of pH meter.	3
II	**Total Hours**	**12 hrs**
	2.1Buffer	3
	2.2 Principles and application of buffers	3
	2.3 Mechanism of buffer action	3
	2.4 Preparation of common buffers- tris and phosphate	2
	2.5 Application of buffers- pH measurements of soil.	2
	Total Hours	**13 hrs**
III	3.1 Introduction to isolation and fractionation	3
	3.2 Isolation, fractionation and separation of cellular constituents	3
	3.3 Isolation of chloroplasts,	3
	3.4Isolation of mitochondria, nucleic acids.	3
	3.5 Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total Hours	**13 hrs**
IV	4.1 Centrifugation techniques	3
	4.2 Centrifugation – basic principles	2
	4.3 Different types of Centrifuges,	3
	4.4Analytical centrifugation methods	2
	4.5 Ultra centrifugation methods	2
	4.6Video clips, class tests, tutorials and term paper presentations and demonstration	1
	Total Hours	**13 hrs**
V	5.1Chromatography techniques	2
	5.2 Thin layer chromatography	2
	5.2 Paper chromatography	2
	5.3 Separation of amino acids and sugars	2
	5.4 Gas chromatography.	2
	5.6 Video clips, class tests, tutorials and term paper presentations	3
	Total Hours	**13 hrs**
	Total hours for Units I to V	**64 hrs**

Course Code & Course Title	19MIBU0620 PRACTICALVIII: ENVIRONMENTAL MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY Credits- 4		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Cou rse Objectives	**The course aims** • To understand the current views of microbial association in various environments; • To know an idea on air quality and aero microbiology • To know an idea on water quality • To impart skills for the preparation of buffers and determination of pH. • To analyse calcium and magnesium using flame photometer • To know an idea about molecular studies • To extend knowledge on industrial fermentation • To know an idea about immobilization		

UNITS	Content	No. of Hours
1.	Water analysis by MPN technique–presumptive, confirmed and completed coli form test.	3+3
	Microbial assessments of air quality–open plate technique.	3+3
2.	Isolation and Total viable count of faecal bacteria from water.	3
3.	Soil Analysis- pH, EC, chlorides, nitrate, calcium,	3+3
4.	magnesium and total phosphorus.	
5	Isolation of chromosomal DNA from bacteria	3+3
6	Demonstration of Agarose gel electrophoresis (to study DNA/ RNA)and SDS –PAGE (tostudyproteins).	3+3
	Demonstration of Southern and northern blotting techniques	3
7	Amylase production from *Bacillus* sp.	3+3
8	Immobilization of bacterial cell using sodium alginate	3
9		
	Total hours	**48 hrs**

References	**Text Books:**
	1. Atlas RM and Bartha R. Microbial Ecology Fundamentals and Applications, 3rd Ed., Benjamin and Cummings .Pub.Co.NewYork.1993.
	2. RajanS. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.2012.
	3. Rajan.S and Selvi Christy R. Experimental Procedures in Life Sciences. Anajanaa Book House, Chennai Monica Cheesbrough. District Laboratory Practice in Tropical Countries - Part I and II, 2nd edition, Cambridge University Press, NewDelhi.2011.
	4. Betty A Forbes, Daniel F Sahmand Alice S Weissfeld. Bailey and Scott's Diagnostic Microbiology, MosbyElsevier.12thEdition.2007.
	5. JamesGCappuccinoandNatalieSherman.Microbiology-ALaboratoryManual(4thedition).TheBenjaminpublishingcompany,NewYork. 1996
	6. Current protocols in molecular biology. 2000. Ausbel *et. al.*
	7. Molecular cloning Vol.1-lll. Sambrook & Russel. 2001. CSH press
	
	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 water CO 2: Evaluate air quality & microbial analysis CO 3: Demonstrate microbiological assessment of soil samples CO 4: Develop practical skill molecular and biotechnological techniques CO5: Produce microbial enzymes in lab scale

CO/PO	PO					PSO					
	1	2	3	4	5	1	2	3	4	5	Mean Score of Cos
CO1	3	2	3	1	1	3	3	3	2	2	2.3
CO2	3	2	3	1	1	3	3	3	2	2	2.3
CO3	3	2	3	1	1	3	3	3	2	2	2.3
CO4	3	3	3	1	2	3	3	3	3	2	2.6
CO5	3	2	3	1	1	3	3	3	2	2	2.3
Mean Overall Score											2.36

Course Code & Course Title	**19MIBU04E1 DAIRY MICROBIOLOGY** **Credits – 3**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • 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.	13
II	**Various dairy Products:** Fluid milk products and dried milk Products, condensed milk, skimmed milk powder, other dairy products: Ice Cream, Butter, Whey. Fermented milk products – Yoghurt, Cultured butter milk and Kefir.	13
III	**Sources of contamination:** Various sources of contamination-*Clostridium, Salmonella, Shigella, Staphylococcus* and *Campylobacter* and milk borne diseases	12
IV	**Plant Sanitation:** In-plant Hygiene –Cleaning of Dairy Equipment – Processing Plant Sanitation. Utilization and disposal of dairy by products – whey.	13
V	**Quality and safety assurance:** Quality control and quality assurance measures in dairy industries. Food standards -MBRT, Litmus milk, Phosphatase tests. HACCP, FDA, WHO,FSSAI, lSI and safety	13

References	**References:** 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. 6. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi. 7. Yarpar, WJ. and Hall, C.W. 1975.DairyTechnologyand Engineering AVI, Westport. 8. Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgraw Hill Publishing Co., New Delhi. 9. Adams. M. R and M. D Moss . 1995. Food Microbiology. New Age International limited. Roday. S. Food Hygeine and Sanitation. Tata McGraw Hill Publications.1998.
Course Outcomes	**Upon completion of this course, students should be able to :** 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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Introduction - Composition of milk.	1
	1.2 Starter cultures and their biochemical activities.	2
	1.3 Milk processing unit mode operations	2
	1.4 Pasteurization, UHT treatment,	2
	1.5 homogenization, storage, and transportation	1
	1.6 Judging and grading of milk and its products.	1
	Total hours	**9 hrs**
II	2.1 Fluid milk products	2
	2.2 Dried milk Products	2
	2.3condensed milk, skimmed milk powder,	2
	2.4Other dairy products:Ice Cream, Butter, Whey.	2
	2.5 Fermented milk products - Yoghurt, Cultured butter milk, Kefir	2
	Total hours	**10 hrs**

III	3.1 Various sources of contamination	1
	3.2 *Clostridium, Salmonella*	3
	3.3 *Shigella, Staphylococcus*	2
	3.4 *Campylobacter*	2
	3.5 milk borne diseases	2
	Total hours	**10 hrs**
IV	4.1In-plant Hygiene	2
	4.2 Cleaning of Dairy Equipment	2
	4.3 Processing Plant Sanitation.	3
	4.4 Utilization and disposal of dairy by products - whey	3
	Total hours	**10hrs**
V	5.1 Quality control and quality assurance measures in dairy industries	3
	5.2 Food standards -MBRT, Litmus milk, Phosphatase tests	2
	5.3 HACCP,FDA,WHO	2
	5.4 FSSAI, lSI and safety	2
	Total hours	**9 hrs**
	Total hours for unit I-V	**48 hrs**

Course Code & Course Title	**19MIBU04E2 MEDICAL PARASITOLOGY & ENTOMOLOGY** **Credits –3**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart information on the basics of entomology and disease transmission • To make the student knowledgeable on pathogenic parasites • To expose the students on classification of disease causing helminths • To give an in-depth knowledge on laboratory techniques involved in identification of parasites causing infection. • To enhance student's interest on parasitic infections in Immuno-compromised and HIV patients		

UNIT	Content	No.of Hours
I	**Entomology and disease transmission** Modern concepts of entomology. Biology and lifecycle of arthropod vectors- ticks, mites, fleas, mosquitoes and flies that are capable of transmitting diseases in humans and animals. Mechanism of disease transmission with particular References to vectors and diseases in India. Vector control measures.	10
II	**Parasitology:** General concepts and Protozoology: introduction to parasitology classification – host parasite relationships, pathogenic mechanisms, transmission and life-cycles protozoa- *Entamoeba*;*Leishmania, Trypanosoma, Giardia, Trichomonas, Balantidium, Toxoplasma, Cryptosporidium* and other protozoan parasites causing human infections.	10
III	**Helminthology:** Classification: Cestodes- *Taeniasolium, T. saginata, T. echinococcus*, Trematodes- *Fasciola hepatica, Fasciolopsisbuski, Paragonimuswestermanii,Schistosomes*. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides*and *Wuchereria*. Lifecycles, transmission and pathogenicity.	10
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	9

V	**Parasitic infections in Immuno-compromised patients:** Parasitic infections in immuno compromised hosts and AIDS patients, *Cryptosporidial*diarrhoea, *Giardiasis, Strongyloides,* infection and *Toxoplasmosis* – theirdiagnosis and treatment.	9
References	**Text Books** 1. Chatterjee, K. D. 1981. Parasitology. Chatterjee Medical Publishers. Pp: 1-106. 2. JayaramPanicker, CK (1995). Text Book of Parasitology, Orient Longmans. 3. Parija, SC (1996). Text book of Medical Parasitology. Orient longmans. 4. EaswariNayar (1974). HandBook on Medical Entomology, Kalpana PrintingHouse, Delhi **References:** 1. Schmidt, G.D. and Roberts, L.S. (1981) Foundations of Parasitology, 2nd Edn, Mosby, St.Louis. 2. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis 3. Arora, D.R. and Arora, B.(2002) Medical Parasitology, 1st Edn. CBS Publishers & Distributors, New Delhi. 4. Walter Beck, J. and Davies, J.E.(1976) Medical Parasitology, 2nd Edn. C.V. Mosby Company, St. Louis. 5. Robert Desowitz (1980) Ova and Parasites. Harper and Row Publishers, New York. 6. Levanthal, R. and Cheadle, R.S. (1979) Medical Parasitology. S.A. Davies Co., Philadelphia. 7. Chatterjee (1986) Medical Parasitology. Tata McGraw Hill, Calcutta. **Web 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	**Upon completion of this course, students should be able to:** CO1: Discuss the fundamentals of entomology and disease transmission. CO2: Explain classification and lifecycle of pathogenic parasites. CO3: Outline the various kinds of disease causing helminths. CO4: Delineate the laboratory techniques involved in identification of pathogenic parasites. CO5: Describe the parasitic infections in Immuno-compromised and HIV patients	

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Entomology and disease transmission: Modern concepts of entomology	1
	1.2. Biology and lifecycles of arthropod vectors- ticks, mites, fleas, mosquitoes and flies that are capable of transmitting diseases in humans and animals	4
	1.3. Mechanism of disease transmission with particular References to vectors and diseases in India	2
	1.4. Vector control measures	2
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**10hrs**
II	2.1. General concepts and Protozoology: Introduction to parasitology, classification	2
	2.2. Host parasite relationships	1
	2.3. Pathogenic mechanisms, transmission and life-cycles protozoa- *Entamoeba*; *Leishmania, Trypanosoma, Giardia, Trichomonas, Balantidium, Toxoplasma, Cryptosporidium* and other protozoan parasites causing human infections	4
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	2
	Total hours	**10hrs**
III	3.1. Cestodes- *Taeniasolium, T. saginata, T. echinococcus*Lifecycles, transmission and pathogenicity	3
	3.2. Trematodes- *Fasciola hepatica, Fasciolopsisbuski, Paragonimuswestermanii,Schistosomes* - Lifecycles, transmission and pathogenicity	3
	3.3. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides*and *Wuchereria*. Lifecycles, transmission and pathogenicity	3
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**10hrs**
IV	4.1. Examination of faeces for ova and cysts - worm burden, concentration methods	2
	4.2. Floatation and sedimentation techniques	2
	4.3. Staining by Iron haemotoxylin method, blood smear examinations- thick/thin smear	2
	4.4. Cultivation of protozoan parasites	1
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	2
	Total hours	**9hrs**

V	5.1. Parasitic infections in immuno compromised hosts and AIDS patients	3
	5.2. *Cryptosporidial*diarrhoea, *Giardiasis, Strongyloides,* infection and *Toxoplasmosis* – their diagnosis and treatment	4
	5.3. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**9hrs**
	Total hours for Units I toV	**48 hrs**

Course Code & Course Title	**19MIBU05E1 FERMENTATION TECHNOLOGY Credits-3**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart information on historical aspects of fermentation and its techniques • To make the student knowledgeable on screening methods for fermentative microbes • To expose the students on different types of fermentation media • To give an in-depth knowledge on various types of fermentation and product recovery. • To enhance student's interest on rules and regulation of industrial effluent disposal and biosafety		

UNIT	Content	No.of Hours
I	**History and Fermentor** History of development – Era of discovery of microbes. Pasteur and fermentation. Discovery of antibiotics. Scope and future prospects of fermentation microbiology and biotechnology.	9
II	**Microbiology of industrial fermentation** Chemical synthesis of bacterial protoplasm (or) Biomass – central and inter mediatory metabolism. Growth cycle. Industrial useful microbes- criteria of strain selection	10
III	**Fermentation media** Production media – characteristics 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 – Downstream processing- Recovery and purification of intracellular and extracellular products.	10
V	**Monitoring and control** 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 **References** 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. **Web 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	**Upon completion of this 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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 History of development	1
	1.2 Era of discovery of microbes.	2
	1.3 . Pasteur and fermentation.	2
	1.4 Discovery of antibiotics.	2
	1.5 Scope and future prospects of fermentation microbiology	1
	1.6 Scope and future prospects of biotechnology	1
	Total hours	**9 hrs**
II	2.1 Chemical synthesis of bacterial protoplasm (or) Biomass	2
	2.2 central and inter mediatry metabolism.	2
	2.3Growth cycle	2
	2.4 Industrial useful microbes	2
	2.5 criteria of strain selection	2
	Total hours	**10 hrs**

III	3.1 Production media	1
	3.2 characteristics of production media.	3
	3.3 Raw material, screening for production media.	2
	3.4 Pure culture method - plating method.	2
	3.5Maintaining culture.	2
	Total hours	**10 hrs**
IV	4.1Solidstatefermentation- Submerged fermentation	2
	4.2 Batch, Fed-Batch and continuous fermentation	2
	4.3 Recovery and purification of intracellular products.	3
	4.4 Recovery and purification of extracellular products.	3
	Total hours	**10hrs**
V	5.1 Control of industrial fermentation	3
	5.2 Industrial prospects.	2
	5.3 Monitoring and control strategies	2
	5.4 Bio safety in fermentation	2
	Total hours	**9 hrs**
	Total hours for unit I-V	**48 hrs**

Course Code & Course Title	**19MIBU04E4 COMMUNICABLE DISEASES Credits –3**		
Class	B.Sc. Microbiology	Semester	Fourth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable onthe concepts of infection and epidemiology • To give an outline on the diseases transmitted through Faecal-oral route • To give an in-depth knowledge on diseases of respiratory tract. • To highlight causative agents, symptoms, treatment, and prevention of sexually transmitted diseases. • To 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. 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:** Diseases of upper and lower respiratory tract: Pneumonia, Tuberculosis, Pertussis, Diphtheria, common cold, Influenza, Swine Flu, Avian Flu, Enterovirus, SARS, MERS – prevalence, causative agents, symptoms, treatment, prevention and control measures.	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. 4. Michael. J. Pelczar, JR, E.C.S. Chan, Noel R. Krieg. 2000. Microbiology. TATA McGraw Hill. pp: 673-763. 5. Greenwood D, Richard C.B. and PeuthererS.J.. 2000. Medical Microbiology. Churchill Livingstone. 6. D.C. Shanson, Wright PSG, Microbiology in Clinical Practice. 1982. 7. Baron EJ, Peterson LR and Finegold SM Mosby. Bailey and Scott's Diagnostic Microbiology, , 1990. **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. **Web resources:** 1. https://www.microbe.net/resources/microbiology/web-resources/ 2. https://www.omicsonline.org/medicalmicrobiology-diagnosis.php
Course Outcomes	**Upon completion of this 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.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Infection, Infectious Process, Host – Pathogen Interactions	1
	1.2. Infectious Disease – definitions, incubation periods, clinical forms	1
	1.3. Factors influencing disease transmission	2
	1.4. Epidemiology of communicable diseases – host, reservoir, carrier, vector	2
	1.5. Control measures of communicable disease – Control of sources, blocking the channels of transmission, protecting the susceptible host	2
	1.6. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**9hrs**
II	2.1. Prevalence, causes, symptoms, treatment and prevention of faecal-oral transmitted diseases: Cholera, Shigellosis, typhoid, viral diarrhoea, Amoebiasis, Giardiasis and Ascariasis	9
	2.2. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**10hrs**
III	3.1. Diseases of upper and lower respiratory tract	1
	3.2. Pneumonia, Tuberculosis, Pertussis, Diphtheria, common cold, Influenza, Swine Flu, Avian Flu. Enterovirus, SARS, MERS – prevalence, causative agents, symptoms, treatment, prevention and control measures	8
	3.3. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**10hrs**
IV	4.1. Prevalence, causative agents, symptoms, treatment, and prevention of STDs: Chlamydia, Chancroid, Syphilis, Gonorrhoea, Genital herpes, Hepatitis B, HIV, HPV, Trichomoniasis	9
	4.2. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**10hrs**
V	5.1. Diseases transmitted through vectors	1
	5.2. Chikungunya, Dengue fever, Zika, Japanese encephalitis, Lymphatic filariasis, Malaria and Leishmaniasis – prevalence, symptoms, causes, treatment and control measures	7
	5.3. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**9hrs**
	Total hours for Units I toV	**48 hrs**

MODULAR COURSES

Course Code & Course Title	**19MIBU06M1 MICROALGAL TECHNOLOGY** **Credits –2**		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on diversity and distribution of microalgae • To give an outline on the processes involved in mass cultivation of microalgae • To give an in-depth knowledge on harvesting methods of microalgae. • To highlight potential applications of microalgae. • To 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 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. Khan M. (1970). Algae today, Gajendra SG at Siva Printers, Dehra Dun, India 3. Amrik SA. (2003). Phycology: Principles, processes and applications. Daya Publishing House, Delhi. 4. Rajarao VN. (1990). Perspectives in Phycology, Today and Tomorrow Printers and publishers. 5. Steve P. (2009). Protozoans, Algae & amp; Other Protists - Capstone Press 6. Van den Hoek C, Mann DG and HM. Jahns. (1995). Algae, an introduction to phycology 7. Stephen JO. Brien. (1993). Bacteria, Algae, and Protozoa - Cold Spring Harbor Laboratory Press. 8. Algal Ecology- Fresh Water Benthic Ecosystems. Ed by Stevenson RJ, ML Bothwell, RL.Lowe Academic Press, (1996). 9. Ecology of Cyanobacteria-Their diversity in time and space- BA **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. Hitton, Berkley: University of California Press (1973). 4. Thajuddin N. and Dhanasekaran D. (2016) Phytoplankton: Diversityand Ecology. Pal R and Choudhury A, Springer. 5. Ismail R, Sanjay K. Gupta, Amritanshu S, Poonam S, Sheena K and Faizal B. (2016). Microalgae Applications in Wastewater Treatment. 6. International Publishing Switzerland Bux F and Chisti Y (eds.) Algae Biotechnology, Green Energy and Technology. 7. Biris ES, Maria T, Tania M, Radu M and Antonia O. (2016). Applications of Microalgae in Wastewater Treatments: a Review. ProEnvironment 8. Sonal D and Singh DP. (2015). Phycoremediation: Future Perspective of Green Technology. 9. 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 Outcomes	**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*.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. General characteristics of microalgae – Photosynthesis	2
	1.2. Diversity and distribution of microalgae – cyanobacteria – diatom. Freshwater – Marine	2
	1.3. Morphology – Reproduction – sexual – asexual – life cycle	2
	Total Hours	**6hrs**
II	2.1. Biological Principles and Technology of Mass Cultivation – Nutrients – Light –Temperature	2
	2.2. Laboratory Cultivation. Culture Monitoring and Maintenance	1
	2.3. Cultivation Systems - Open outdoor systems – artificial ponds, raceway ponds, pit method-Closed and semi closed outdoor photo bioreactors - Heterotrophic Fermenters	3
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**7hrs**
III	3.1. Microalgal biomass harvesting-Gravity Sedimentation, centrifugation, filtration, flotation, flocculation, Electrolytic Coagulation.	3
	3.2. Single cell proteins from microalgae	1
	3.3. Pigments – carotenoids – phycocyanin – phycoerythrin	2
	Total hours	**6hrs**
IV	4.1. Potential applications of microalgae – Nutraceuticals; Pharmaceuticals	2
	4.2. Biofertilizers; and Bioremediation. Biofuels – biodiesel – biobutanol – biohydrogen – Bioethanol	3
	4.3. CO_2 sequestration	1
	4.4. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**7hrs**
V	5.1. *Spirulina* cultivation technology: Biology of *Spirulina* - cultivation methods	2
	5.2. Post-harvest technology and single cell protein formulation	2
	5.3. Value added products	1
	5.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
	Total hours for Units I toV	**32 hrs**

Course Code & Course Title	**19MIBU06M2 MOLECULAR TECHNIQUES** **Credits -2**		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To give knowledge on working principle and applications of electrophoresis techniques • To develop interest to acquire latest information on molecular sequencing and its applications • To make knowledge on PCR techniques and its applications • To impart in-depth knowledge on Nucleic acid Hybridization techniques and their uses • To create interest on the importance of genome sequencing and physical mapping analysis		

UNIT	Content	No.of Hours
I	**Electrophoresis:** Principle and application: paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE)	6
II	**Molecular Sequencing** DNA sequencing –Enzymatic & chemical methods and new generation sequencing. Amino acid sequencing and analysis – MALDI-TOF.	7
III	**Nucleic acid Hybridization techniques** Microarray techniques – oligo nucleotide array and cDNA array and its applications. Southern and Northern blotting. Florescence in situ hybridization (FISH)	7
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	6
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.	6
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. 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 Outcomes	**Upon completion of this course, students should be able:** CO1:Outline the working principle and applications of electrophoretic techniques CO2:Explain molecular sequencing techniques CO3:Discuss PCR techniques and their applications CO4:Describe Nucleic acid Hybridization techniques and their uses CO5:Demonstrate methods involved for genome sequencing and physical mapping

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Electrophoresis: Principle and application	1
	1.2. Paper electrophoresis	1
	1.3. Agarose gel electrophoresis	1
	1.4. Polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE)	2
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**6hrs**
II	2.1. DNA sequencing –Enzymatic & chemical methods, New generation sequencing	4
	2.2. Amino acid sequencing and analysis -MALDI-TOF	3
	Total hours	**7hrs**
III	3.1. Microarray techniques – oligo nucleotide array and cDNA array and its applications.	3
	3.2. Southern and Northern blotting.	2

	3.3. Florescence in situ hybridization (FISH)	1
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**7hrs**
IV	4.1. Principle and applications- types of PCR - enzymology- primer types- methods	3
	4.2. PCR amplification for Detection of mutation, monitoring cancer therapy, detect bacterial & viral infections	2
	4.3. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
V	5.1. Genome sequencing and Physical mapping of genome analysis: Restriction fragment Length Polymorphism (RFLP) technique	2
	5.2. Random Amplified polymorphic DNA (RAPD) technique and 16S rRNA sequencing	2
	5.3. Methods and applications of Chromosome walking &Chromosome jumping	2
	Total hours	**6hrs**
	Total hours for Units I toV	**32 hrs**

Course Code & Course Title	**19MIBU06M3: RECOMBINANT DNA TECHNOLOGY** **Credits –2**		
Class	B.Sc. Microbiology	Semester	Sixth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on various techniques and enzymes used in recombinant DNA construction. • To give an outline on Cloning vectors and Gene libraries • To provide an in-depth knowledge on Gene transfer techniques. • To highlight the processes involved in expression of rDNA. • To 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.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Isolation of DNA and recombinant DNA construction	1
	1.2. Core techniques used in rDNA technology – Restriction digestion, ligation and transformation	3
	1.3. Enzymes used- Restriction enzymes, DNA ligases, reverse transcriptase, klenow fragment, Alkaline phosphatase, Polynucleotide kinase, terminal transferase, Dnase and Rnase	2
	1.4. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**7hrs**
II	2.1. Cloning vectors - plasmids, phages and cosmids	2
	2.2. Cloning strategies. Cloning and selection of individual genes	2
	2.3. Gene libraries: cDNA and genomic libraries	1
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**6hrs**
III	3.1. Specialised cloning strategies. Expression vectors, Promoter probe vectors, vectors for library construction, artificial chromosomes	3
	3.2. Gene transfer techniques – Transformation, transduction, electroporation, microinjection, Gene gun. Agrobacterium mediated gene transfer	2
	3.3. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
IV	4.1. Expression of rDNA	2
	4.2. 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	3
	4.3. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**6hrs**
V	5.1. Analysis of recombinant DNA: DNA sequencing Methods; dideoxy and chemical method	2
	5.2. Nucleic acid hybridization methods	2
	5.3. Microarray technique	2
	5.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**7hrs**
	Total hours for Units I toV	**32 hrs**

Course Code & Course Title	19MIBU06M4 BIOINFORMATICS (MICROBIAL GENOMICS AND PROTEOMICS) Credits -2		
Class	B.Sc. Microbiology	Semester	
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To study on Bioinformatics, microbial genomics and proteomics • To understand genome analysis, sequence analysis and protein analysis • To explain the tools used in Bioinformatics • To impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations • To know the aspects of 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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Overview of Bioinformatics	1
	1.2. Computer basics and it operations – servers, workstations, operating systems, Unix, Linux	1
	1.3. Internet – World Wide Web	1
	1.4. Search engines, biological databases - Pubmed – Entrez - Literature search	2
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**6hrs**
II	2.1. Sequence analysis: Computational methods, homology algorithms (BLAST) for proteins and nucleic acids	2
	2.2. Pair-wise alignment - BLAST, Dot plots	2
	2.3. Multiple alignment - ClustalW, ProbCons	2
	2.4. Public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB)	1
	Total hours	**7hrs**
III	3.1. Whole genome analysis	2
	3.2. Preparation of ordered cosmid libraries, bacterial artificial chromosome	2

	libraries, shotgun libraries and sequencing.	
	3.3. Sequence assembly – *denovo*, mapping	2
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**7hrs**
IV	4.1. DNA microarray printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper	3
	4.2. Analysis of single nucleotide polymorphisms using DNA chips	2
	4.3. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**6hrs**
V	5.1. Protein analysis and Proteomics	1
	5.2. Sequence analysis of individual protein spots by mass spectroscopy	2
	5.3. Protein microarray. Advantages and disadvantages of DNA and protein microarrays	2
	5.4. Introduction to docking	1
	Total hours	**6hrs**
	Total hours for Units I to V	**32 hrs**

SKILL BASED ELECTIVE COURSES

Course Code & Course Title	**19MIBU05S1 :MUSHROOM BIOTECHNOLOGY**		**Credits -3**
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To understand Mushroom Biotechnology • To make knowledge on mushroom cultivation • To impart information on edible mushrooms • To know the different methods of maintaining pure culture • To highlight the importance of mushroom as food and medicines		

UNIT	**Content**	**No. of Hours**
I	**Introduction to mushroom biology** Scope and Importance of Mushroom cultivation-Recent developments in Mushroom Technology.	8
II	**Characteristics of Edible Mushrooms** Characteristics of Edible Mushrooms-Types, Morphology, Mode of reproduction, Differentiation of edible mushrooms from non edible mushrooms.	10
III	**Nutritional and medicinal values of mushrooms** Nutritional and medicinal values of mushrooms-Protein, carbohydrates, minerals, vitamins, fibre content, moisture content and ash content-Preparation of different mushroom recepies. .	10
IV	**Mushroom Cultivation technology** Cultivation technology-Pure culture-Media preparation and maintenance of mother culture-Spawn production-Storage and transportation-Marketing value in India-Export value-Economics of different mushroom cultivation technology.	10
V	**Prospects mushroom cultivation technology** Types and Importance of Post harvest and handling of edible mushrooms-Mushroom contamination-Bioconversion of organic wastes into proteins, fodder, soil conditioner and compost. .	10

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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Scope and Importance of Mushroom cultivation	4
	1.2 Recent developments in Mushroom Technology	4
	Total hours	**8hrs**
II	2.1 Characteristics of Edible Mushrooms	3
	2.2 Types, Morphology, Mode of reproduction of Mushrooms	4
	2.3 Differentiation of edible mushrooms from non edible mushrooms	3
	Total hours	**10 hrs**
III	3.1 Nutritional and medicinal values of mushrooms	3
	3.2 Protein, carbohydrates, minerals, vitamins, fibre content, moisture content and ash content values of mushrooms	4
	3.3 Preparation of different mushroom recipies	3
	Total hours	**10 hrs**
IV	4.1 Mushroom cultivation technology	2
	4.2 Media preparation and maintenance of mother culture	2
	4. 3 Spawn production	1
	4.4 Storage and transportation	1
	4.5 Marketing value in India	1
	4.6 Export value	1
	4.7 Economics of different mushroom cultivation technology	2
	Total hours	**10 hrs**
V	5.1 Types and Importance of Post harvest and handling of edible mushrooms	4
	5.2 Contamination of Mushrooms	2
	5.3 Bioconversion of organic wastes into proteins, fodder, soil conditioner and compost .	4
	Total hours	**10 hrs**
	Total hours for Units I to V	**48 hrs**

Course Code & Course Title	**19MIBU05S2: CLINICAL LAB TECHNOLOGY**		**Credits –2**
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on the Collection of clinical specimens • To give an outline on the methods in urine examination • To give an in-depth knowledge on blood count • To make students learn Histo pathological Examination. • To 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** Examination of urine: Sample collection, physical and chemical tests, principles and methods, microscopic examination- crystals, sediments, pregnancy tests. Urine culture test.	6
III	**Analysis of Blood** Composition and function of blood, blood coagulation. Blood groups. Blood smear preparations: Staining- 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** Examination of Stool - Indication, Collection, Container, Transport, Preservation for different types of faecal analysis; Physical, Chemical and Microscopic examination and its significance. 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. **Web 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
Course Outcomes	**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 histo pathological sample preparation and examination. CO5: Describe the stool sample analysis.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Basic laboratory principles -Code of conduct -Safety measures	2
	1.2. Methods of collection of urine, blood, sputum, stool etc	1
	1.3. The techniques of preservation of samples – chemical preservatives	2
	1.4. Blood plasma and serum preparation – anticoagulants	1
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**7hrs**
II	2.1. Examination of urine: Sample collection, physical and chemical tests, principles and methods	2
	2.2. Microscopic examination- crystals, sediments, pregnancy tests	2
	2.3. Urine culture test	1
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**6hrs**

III	3.1. Composition and function of blood, blood coagulation	1
	3.2. Blood groups. Blood smear preparations	1
	3.3. Staining- TC,DC and WBC count-Peripheral blood smear examination and morphological abnormalities- Reticulocyte count- absolute eosinophil count	3
	3.4. E.S.R, P.C.V, Blood indices - Platelet count: BT, CT, - Prothrombin time	1
	3.5. Examination for malarial parasites	1
	Total hours	**7hrs**
IV	4.1. Microtome - Histopathology: Tissue reception, labelling, fixation for different tissue and sectioning	1
	4.2. Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking)- section cutting	2
	4.3. Preparation of common stain technique - Hematoxylin, eosin, congo red, methyl violet, Leishman stain	2
	4.4. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**6hrs**
V	5.1. Examination of Stool - Indication, Collection, Container, Transport	1
	5.2. Preservation for different types of faecal analysis	1
	5.3. Physical, Chemical and Microscopic examination and its significance	2
	5.4. Stool culture test	1
	5.5. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
	Total hours for Units I toV	**32 hrs**

Course Code & Course Title	**19MIBU05S3 SANITATION MICROBIOLOGY**		**Credits –2**
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on the concepts of sanitation and disinfection • To give an outline on the Airborne diseases and preventive measures • To provide an in-depth knowledge on waste water management • To highlight the practices in Solid waste management • To expose the students on the aspects of food sanitation		

UNIT	Content	No. of Hours
I	**General concept of sanitation and disinfection.** Sanitation of industrial and food processing units. Safe location of animal houses, hospitals, industrial fermentation units etc. Biosafety: Biosafety in hospitals and laboratories. Regulations and measures.	7
II	**Airborne diseases and preventive measures.** Air pollution – Types and sources. Ambient air quality. Methods of sampling air. Quantification of air microflora. Air sanitation – techniques and applications	6
III	**Water quality and Waste water management** Water supply standards. Microbiological analysis for water quality – indicator – coliforms – Enterococci – MPN. Treatment of municipal water supplies. Water borne diseases. Microbiology of municipal sewage and sewage treatment. BOD and COD. Treatment of Industrial effluent- waste water treatment – Mechanical and biological. Aerobic and anaerobic treatments.	7
IV	**Solid waste management** Solid waste disposal-sanitary landfills, composting, vermicompost. Disposal of animal and agricultural waste. Anaerobic digesters, Methanogenesis and biogas production	6
V	**Food sanitation** Food Sanitation: Good manufacturing practices – HACCP, Food safety standards. Personnel hygiene. Food borne illness.	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. **Web 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
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.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. General concept of sanitation and disinfection	1
	1.2. Sanitation of industrial and food processing units	2
	1.3. Safe location of animal houses, hospitals, industrial fermentation units etc	1
	1.4. Biosafety: Biosafety in hospitals and laboratories. Regulations and measures	2
	1.5. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**7hrs**
II	2.1. Airborne diseases and preventive measures	1
	2.2. Air pollution – Types and sources. Ambient air quality	1
	2.3. Methods of sampling air. Quantification of air microflora	2
	2.4. Air sanitation – techniques and applications	2
	Total hours	**6hrs**
III	3.1. Water quality and Waste water management	1
	3.2. Water supply standards. Microbiological analysis for water quality – indicator – coliforms – Enterococci – MPN	2
	3.3. Treatment of municipal water supplies	1
	3.4. Water borne diseases. Microbiology of municipal sewage and sewage treatment. BOD and COD	1
	3.5. Treatment of Industrial effluent- waste water treatment – Mechanical and biological. Aerobic and anaerobic treatments	2
	Total hours	**7hrs**
IV	4.1. Solid waste disposal-sanitary landfills	1
	4.2. Composting, vermicompost	1
	4.3. Disposal of animal and agricultural waste	1
	4.4. Anaerobic digesters, Methanogenesis and biogas production	2
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**6hrs**
V	5.1. Food Sanitation: Good manufacturing practices – HACCP	2
	5.2. Food safety standards. Personnel hygiene. Food borne illness	2
	5.3. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**6hrs**
	Total hours for Units I to V	**32 hrs**

Course Code & Course Title	**19MIBU05S4: ENTREPRENEUR MICROBIOLOGY** **Credits –2**		
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on the basic concepts of Entrepreneur development • To give an outline on the contributions of Government and financial institutions in entrepreneurial development. • To give an overview on production of fermented food and beverages. • To introduce mushroom cultivation as a start-up option. • To expose the students on the aspects of IPR and patent process		

UNIT	Content	No. of Hours
I	**Entrepreneurial development** Evolution of the concept of entrepreneur – Entrepreneurship Entrepreneur development – activity – Entrepreneurship to socio-economic improvements. Skills for entrepreneurs – Communication skills, problem solving skills. Development of business plan. Marketing – Market research, SWOT analysis, identifying competitors.	7
II	**Government and Financial Institutions** Institutions involved – Government contributions to entrepreneurs – Department of Science and Technology schemes. Financial plan– Financial support. Nationalized banks – other financial institutions – SIDBI, NSIC, NABARD, IDBI, IFCI and ICICI – risk assessment	6
III	**Production of fermented food and beverages** Bread – leavening – Baking process – Rye bread, San Francisco dough Bread. Cheese production – pasteurization, starter culture, rennet, probiotic culture, brine salting. Indian traditional alcoholic beverages – Brewing beer, Grape wine – wine from other fruits.	7
IV	**Mushroom cultivation** Mushroom cultivation – cultivation of *Agaricus campestris*, *Agaricus bisporus*, and *Volvariella volvaciae*, Compost preparation, filling tray beds, spawning, optimal temperature, casing, watering, harvesting, storage.	6
V	**Intellectual Property Rights** Intellectual Property Rights (IPR) – Definition. History of patenting, composition, subject matter and characteristics of a patent – Trademark, Trade secret, Copyrights, related rights, Geographical Indications and Industrial Designs. Inventor, infringement, cost of patent, Patent in India and other countries – IPO, WTO, WIPO.	6

References	**Text Books:** 1. Nagendra S., (2008) Entrepreneurship and management Sanguine technical publishers 2. Bhatia, B.S. and G.S Batra, (2003) Entrepreneurship and small business management. Deep and deep publications 3. Naidu, N.V.R, (2008) Management and entrepreneurship. I.K. International Pvt. Ltd. 4. Greene, (2000) Entrepreneurship ideas in action. Thomson learning 5. Gordon, E., Natarajan, K., & Arora, A. (2009). Entrepreneurship development (p. 16). Himalaya publishing house 6. Experiments in Microbiology, plant pathology Tissue culture and mushroom production technology – K.RAneja, New age international Publication S.Chand publication 6th Edition 7. Food microbiology – William C Frazler, Dennis C Weshoff (2013) – 5th edition (Food of Indian origin) **References:** 1. Ananthanarayanan. R. and C.K. Jayaram Panicker.1997. Textbook of Microbiology Orient Longman. 2. Philp.G.Miles shu-Ting Chang1997. Mushroom Biology, World Scientific publishing Co.,Pvt.Ltd.,Singapore. 3. Rajni Gupta,K.G.Mukerji,2001.Microbial Technology , A.P.H.Publication Corporation, New Delhi. 4. Geoffrey Kibly, Sean Milne, 1979. Mushroom and Toad Stools,Elsevier publishing Projects (UK)Ltd,Oxford. 5. R.C. Dubey 2005.A Text book of Biotechnology, S.Chand & Company Ltd., Ramnagar,New Delhi. **Web resources:** 1. https://microbiologysociety.org/uploads/assets/uploaded/37a6e73d-63e4-4411-88524eba20d849fe.pdf 2. https://www.nature.com/bioent/2004/041001/full/bioent831.html?referral=true 3. https://www.genengnews.com/a-lists/top-17-serial-bio-entrepreneurs/ 4. https://riidl.org/bio 5. http://www.dbtindia.nic.in/schemes-2/biotechnology-parksincubators-in-india/
Course Outcomes	**Upon completion of this course, students should be able to:** CO1:Discuss the concepts of basic concepts of Entrepreneur development. CO2:Outline the contributions of Government and financial institutions in entrepreneurial development. CO3:Explain the production of fermented food and beverages. CO4:Delineate the mushroom cultivation techniques. CO5:Describe the aspects of Intellectual Property Rights and patent process.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Evolution of the concept of entrepreneur – Entrepreneurship.	1
	1.2. Entrepreneur development – activity – Entrepreneurship to socio-economic improvements	1
	1.3. Skills for entrepreneurs – Communication skills, problem solving skills	1
	1.4. Development of business plan	2
	1.5. Marketing – Market research, SWOT analysis, identifying competitors	2
	Total Hours	**7hrs**
II	2.1. Institutions involved – Government contributions to entrepreneurs – Department of Science and Technology schemes	2
	2.2. Financial plan – Financial support. Nationalized banks – other financial institutions – SIDBI, NSIC, NABARD, IDBI, IFCI and ICICI – risk assessment	3
	2.3. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**6hrs**
III	3.1. Production of fermented food and beverages: Bread – leavening – Baking process – Rye bread, San Francisco dough Bread	2
	3.2. Cheese production – pasteurization, starter culture, rennet, probiotic culture, brine salting	2
	3.3. Indian traditional alcoholic beverages – Brewing beer, Grape wine – wine from other fruits	2
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**7hrs**
IV	4.1. Mushroom cultivation – cultivation of *Agaricus campestris*, *Agaricus bisporus*, and *Volvariella volvaciae*,	2
	4.2. Compost preparation, filling tray beds, spawning, optimal temperature, casing, watering, harvesting, storage	3
	4.3. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**6hrs**
V	5.1. Intellectual Property Rights (IPR) – Definition	1
	5.2. History of patenting, composition, subject matter and characteristics of a patent – Trademark, Trade secret, Copyrights, related rights, Geographical Indications and Industrial Designs	2
	5.3. Inventor, infringement, cost of patent	1
	5.4. Patent in India and other countries – IPO, WTO, WIPO	1
	5.5. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
	Total hours for Units I to V	**32 hrs**

Course Code & Course Title	**19MIBU05S5 MICROBIAL COMPOSTING**		**Credits –2**
Class	B.Sc. Microbiology	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To make the students knowledgeable on bioconversion of organic materials and factors influencing decomposition • To give an outline on the Decomposition of cellulose, hemi cellulose and lignin • To give an in-depth knowledge on factors affecting composting process and various composting methods. • To highlight the benefits of compost enrichment. • To expose the students on compost and crop productivity.		

UNIT	Content	No. of Hours
I	**Introduction to composting** Bioconversion of organic materials – litter composition, micro flora, factors influencing decomposition, process of decomposition – simple and products, humus and humic acid.	7
II	**Decomposition of cellulose, hemi cellulose and lignin** Microbial decomposition of cellulose, hemi cellulose and lignin – chemical composition, micro flora (aerobic, anaerobic, mesophilic and thermophilic) – process of decomposition.	6
III	**Factors affecting composting process** Composting – scope and benefits, waste availability, factors influencing – C:N and C:P relationship, other nutrients, moisture content, aeration, pH, particle size, substrate characteristics and microbes from natural sources. Composting methods – Indore method, Bangalore method, mixed compost and leaf compost.	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 *Azotobacter*, Phosphate solubilizing microorganisms – method of enrichment – chopped versus unchopped straw for compost enrichment.	7
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. **Web 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 Out comes	**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.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1. Bioconversion of organic materials – litter composition, micro flora	2
	1.2. Factors influencing decomposition	2
	1.3. Process of decomposition – simple and products, humus and humic acid	2
	1.4. Video clips, class tests, tutorials and term paper presentations	1
	Total Hours	**7hrs**
II	2.1. Microbial decomposition of cellulose, hemi cellulose and lignin – chemical composition	2
	2.2. Microflora (aerobic, anaerobic, mesophilic and thermophilic)	1
	2.3. Process of decomposition	2
	2.4. Video clips, animations, class tests , tutorials and term paper presentations	1
	Total hours	**6hrs**
III	3.1. Composting – scope and benefits, waste availability	1
	3.2. Factors influencing – C:N and C:P relationship, other nutrients, moisture	2

	content, aeration, pH, particle size, substrate characteristics and microbes from natural sources	
	3.3. Composting methods – Indore method, Bangalore method, mixed compost and leaf compost	2
	3.4. Video clips, Animations, class tests, tutorials and term paper presentations	1
	Total hours	**6hrs**
IV	4.1. Rapid and enriched compost – the role of compost activators/ inoculants	2
	4.2. Screening and mass multiplication of cellulolytic cultures	2
	4.3. Enrichment of compost using *Azotobacter*, Phosphate solubilizing microorganisms	1
	4.4. Method of enrichment – chopped versus un chopped straw for compost enrichment	1
	4.5. Video clips, Animations, class tests, tutorials and term paper presentations and demonstration	1
	Total hours	**7hrs**
V	5.1. Compost and crop productivity- Utilization of compost for crop production	2
	5.2. Waste disposal and management, legislation of environmental problems	2
	5.3. Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total hours	**6hrs**
	Total hours for Units I to V	**32 hrs**

NON-MAJOR ELECTIVES

Course Code & Course Title	**19MIBU00N1 DAIRY MICROBIOLOGY** **Credits – 3**		
Class	B.Sc. Microbiology	Semester	Fourth/Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • 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.	13
II	**Various dairy Products** Fluid milk products and dried milk Products, condensed milk, skimmed milk powder, other dairy products: IceCream, Butter, Whey. Fermented milk products – Yoghurt, Cultured butter milk, Kefir	13
III	**Sources of contamination** Various sourcesbof contamination-*Clostridium, Salmonella, Shigella,Staphylococcus* and *Campylobacter* and milk borne diseases	12
IV	**Plant Sanitation.** In-plant Hygiene –Cleaning of Dairy Equipment – Processing Plant Sanitation. Utilization and disposal of dairy by products – whey.	13
V	**Quality and safety assurance** Quality control and quality assurance measures in dairy industries. Food standards -MBRT, Litmus milk, Phosphatase tests. HACCP, FDA, WHO,FSSAI, lSI and safety	13

References	**References:** 10. DairyMicrobiologybyRobinsonR.K.1990Volume IIand I.Elsevier Applied Science, London. 11. Milk&Milk Products-Fourthedition clarencehenryeckles, TataMcGraw Hill publishing company Limited, NewDelhi, 1957 12. Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, NewDelhi. MaCrae 13. Robinson, R.K. (2 vol.set). 1986.Modern Dairy Technology Elsevier Applied Science, UK. 14. Rosenthal,I. 1991. Milk and Milk Products. VCH, New York. 15. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi. 16. Yarpar, WJ. and Hall, C.W. 1975.DairyTechnologyand Engineering AVI, Westport. 17. Frazier.W.CandD.CWesthoff.1978.FoodMicrobiology.3rded.TataMacgraw Hill Publishing Co., New Delhi. 18. Adams. M. R and M. D Moss . 1995. Food Microbiology. New Age International limited. Roday. S. Food Hygeine and Sanitation. Tata McGraw Hill Publications.1998.
Course Outcomes	**Upon completion of this course, students should be able to :** 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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Introduction - Composition of milk.	1
	1.2 Starter cultures and their biochemical activities.	2
	1.3 Milk processing unit mode operations	2
	1.4 Pasteurization, UHT treatment,	2
	1.5 homogenization, storage and transportation	1
	1.6 Judging and grading of milk and its products.	1
	Total hours	**9 hrs**
	2.1 Fluid milk products	2
	2.2 Dried milk Products	2
	2.3condensedmilk, skimmed milk powder,	2

II	2.4Other dairy products:Ice Cream, Butter, Whey.	2
	2.5 Fermented milk products - Yoghurt, Cultured butter milk, Kefir	2
	Total hours	**10 hrs**
III	3.1 Various sources of contamination	1
	3.2 *Clostridium, Salmonella*	3
	3.3 *Shigella, Staphylococcus*	2
	3.4 *Campylobacter*	2
	3.5 milk borne diseases	2
	Total hours	**10 hrs**
IV	4.1In-plantHygiene	2
	4.2 Cleaning of Dairy Equipment	2
	4.3 Processing Plant Sanitation.	3
	4.4 Utilization and disposal of dairy byproducts - whey	3
	Total hours	**10hrs**
V	5.1Quality control and quality assurance measures in dairy industries	3
	5.2 Food standards – MBRT,Litmus milk, Phosphatase tests	2
	5.3 HACCP,FDA,WHO	2
	5.4 FSSAI, lSI and safety	2
	Total hours	**9 hrs**
	Total hours for unit I-V	**48 hrs**

Course Code & Course Title	19MIBU00N2: BIOFERTILIZER AND BIOPESTICIDES Credits- 3		
Class	B.Sc. Microbiology	Semester	Fourth/Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To understand the current views on soil microorganisms • To know an idea on nitrogen fixing bacteria • To critically think the phosphate solubilising microorganisms • To impart information on biopesticides • To study the concept of the production of biofertilizer and biopesticides		

UNITS	Content	No. of Hours
I	**Soil microorganism** Microbial communities and significance ofs oil. Factors influencing the soil microbial population. Biogeochemicalcycle-Carbon, Nitrogen, Phosphorous and Sulphur.	10
II	**Nitrogen fixing bacteria** *Rhizobium*, Cyanobacteria, *Azospirillum* and *Azotobacter* - Isolation, identification, characterization, mass multiplication, formulation, field application and benefits.	10
III	**Phosphate solubilising microorganisms** Isolation,identification,characterization,masscultivation,formulation,fieldapplicationandbenefits of phosphate solubilizing bacteria – *Bacillus* Sp. and fungus – *Aspergillus* Sp.	10
IV	**Biopesticides** Isolation,identification,characterization,masscultivation,formulation,fieldapplicationandbenefits of *Trichoderma viride, Bacillus thuringiensis*	9
V	**Production and Development** National and Regional Biofertilizers Production and Development centers. Biofertilizers–carriermaterials-storage, shelf life,foliar applications,quality control and marketing.	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**L earning(P)Ltd.,NewDelhi.

3.DineshKMaheswari.BacteriainAgrobiology,SpringerHeidelberg,NewYork.2012.

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.
	
	References:
	1.Alexander,A.M.(1987). Introduction to Soil Microbiology. S'h Edition, JohnWiley and Sons.
	2.Hans G.Schlegel.(l993).GeneralMicrobiology.7thedition.CambridgeUniversitypress.
	3.Tilak KVBR, PalKK and Dey R. Microbes for sustainable agriculture, I.K. InternationalPublishinghouse,Pvt.Ltd.NewDelhi.2010.
	4.Reddy, S.M.et.al. (2002). Bioinoculants for sustainablea griculture and forestry, Scientific Publishers.
	web 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 soil microorganisms and biogeochemical cycling CO2: Predict the importance nitrogen fixing microorganisms its importance CO3:To know the phosphate solubilising microorganisms and its importance CO4:To impart the functioning and role of biopesticide CO5:To extend knowledge about biofertilizer, biopesticide carrier material and production centres

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Microbial communities of soil	2
	1.2 Microbial communities – significance of soil	2
	1.3 Factors influencing the soil microbial population.	1
	1.4 Biogeochemical cycle	1
	1.5 Carbon and Nitrogen cycle	2
	1.6 Phosphorous and Sulphur cycle	2
	Total hours	**10 hrs**
II	2.1 Nitrogen fixing microorganism	2
	2.2Isolation,identification,characterization,massmultiplication,formulation of *Rhizobium,* Cyanobacteria,	2
	2.3Isolation,identification,characterization,massmultiplication,formulation of *Azospirillum* and*Azotobacter*	2
	2.4 Field application and benefits of *Rhizobium,*	2
	2.5Field application and benefits of *Azospirillum* and *Azotobacter,* Cyanobacteria.	2
	Total hours	**10 hrs**

III	3.1 Phosphate solubilisng microorganism	2
	3.2Isolation,identification,characterization,massmultiplication,formulation of *Bacillus* Sp.	2
	3.3Isolation,identification,characterization,massmultiplication,formulation of *Aspergillus* Sp	2
	3.4 Field application and benefits of *Bacillus* Sp.	2
	3.5 Field application and benefits of *Aspergillus* Sp.	2
	Total hours	**10 hrs**
IV	4.1 Biopesticide	2
	4.2 Isolation,identification,characterization,massmultiplication,formulation of *Trichoderma viride*	2
	4.3 Isolation,identification,characterization,massmultiplication,formulation of *Bacillus thuringiensis*	2
	4.4 Field application and benefits of *Trichoderma viride*	2
	4.5 Field application and benefits of *Bacillus thuringiensis*	1
	Total hours	**09 hrs**
V	5.1 National and Regional Biofertilizers and Biopesticide Production and Development centers.	3
	5.2 carrier materials-storage, shelf life,	3
	5.3 Foliar applications, quality control	2
	5.4 Marketing strategies	1
	Total hours	**09**
	Total hours for unit I-V	**48 hrs**

Course Code & Course Title	19MIBU00N3 FOOD MICROBIOLOGY Credits -3		
Class	B.Sc	Semester	Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	The course aims • To introduce the scope and development of food microbiology • To give an overview on food spoilage organisms- Food borne diseases. • To highlight fermentation technologies in the food processing industry. • To create awareness among the students about food preservation • To impart knowledge on quality and safety assurance in food industry.		

UNIT	Content	No. of Hours
I	**Microbiology of Foods** History and important food microorganism. Factors affecting the microbial growth of a food- Intrinsic factors - Extrinsic factors - pH, moisture, water activity, oxidation-reduction potential, nutrient contents and inhibitory substances.	10
II	**Food poisoning and Food-borne diseases** Food hygiene and sanitation. Food poisoning mycotoxins and bacterial toxins. Microbial contamination of foods –Food spoilage by microbes in meat, butter, vegetables and canned food. Food borne diseases.	10
III	**Microbial fermentations** Fermented foods – Preparation pickled cucumber, saurkraut-soysauce and bread. Fermented milk and dairy products – Yoghurt and cheese.	10
IV	**Food preservation** Principles of food preservation. Methods of food preservations - Pasteurization - Freezing and Refrigeration Physicalandchemicalmethods – Radiation- Organic acids, Nitrates Nitrites.	10
V	**Quality and safety assurance** Quality control and quality assurance measures. Food standards. GMP, HACCP,FDA.BIS Laboratory services. Microbial standards for various products.	8
References	**Text 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. **Reference Books:** 5. Britz, T.J. and Robinson, R.K.2008 Advanced Dairy Science and Technology Blackwell publ.,U.K. 6. Hobbs,B.C.and Roberts,D. 1993.Food Poisoning and Food Hygiene, Edward Arnold (A Division of Hodder and Sloughton), London. 7. Salle, AJ. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill, Publishing Co. Ltd., New York. pp: 710-793. 8. Robinson, R.K. 1990. Dairy Microbiology, Elsevier Applied Sciences, London Banwart,GJ.Basic Food Microbiology, CBS Publishers and Distributors. **Web resources:** 6. http://www.microbes.info 7. http://www.fsis.usda.gov/ 8. http://www.cdc.gov. 9. http://www.microbes.info/ resource/food microbiology 10. 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.

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 History and Scope of microorganism in food.	3
	1.2 Factors affecting the growth and survival of microorganisms in foods-Intrinsic factors	3
	1.3 Extrinsic factors	2
	1.4 Video clips, class tests, tutorials and term paper Presentations	2
II	**Total Hours**	**10 hrs**
	2.1 Food hygiene and sanitation	2
	2.2 Food poisoning mycotoxins and bacterial toxins	2
	2.3 Microbial contamination of foods	2
	2.4 Food spoilage by microbes in meat, Butter, vegetables and canned food.	2
	2.5 Video clips	2
	Total Hours	**10 hrs**
III	3.1 Fermented food preparation	2
	3.2 Fermented foods-Preparation of pickled cucumber, saurkraut	2
	3.3 Fermented soya sauce and bread	2
	3.4 Fermented milk and dairy products	2
	3.5 Video clips, Animations, class tests, tutorials and term paper presentations	2
	Total Hours	**10 hrs**
IV	4.1 Microbiology of food preservation	2
	4.2 Aseptic packaging	2
	4.3 Pasteurization, Freezing and Refrigeration	2
	4.4 Radiation-UV radiation	2
	4.5 Chemical preservatives- Organic acids, Nitrates Nitrites	1
	4.6 Video clips, class tests, tutorials and term paper presentations and demonstration	1
	Total Hours	**10 hrs**
V	5.1 Quality control in food and dairy industry	1
	5.2 Quality assurance in industry	1
	5.3 Good Manufacturing Practices(GMP),FDA	1
	5.4 Hazard analysis and critical control point, BIS	1
	5.5 Laboratory sciences	1
	5.6 Microbial criteria/standards for various products	1
	5.7 Video clips, class tests, tutorials and term paper presentations	2
	Total Hours	**08 hrs**
	Total hours for Units I to V	**48hrs**

Course Code & Course Title	19MIBU00N4 INDUSTRIAL MICROBIOLOGY Credits -3		
Class	B.Sc. Microbiology	Semester	Fourth /Fifth
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • to know industries and involving microbial technology • the students able to understand screening methods for fermentative microbes • to know the media and industrial important microorganisms • to create a comprehensive knowledge on Industrial production of various microbial products • the students will be able to understand the rules and regulation of industrial effluent disposal and bio safety		

UNIT	Content	No. of Hours
I	**History and Fermentor** History concept of industrial microbiology. Fermentor principle and its types- Fermentation- upstream and downstream process – Filtration, Centrifugation.	10
II	**Screening methods for Industrial microbes** Industrially important microbes - Screening methods - Strain selection and improvement - mutation and recombinant DNA technology	10
III	**Media and Biology of Industrial Microorganisms** Single cell protein, *Saccharomyces*- Advantages and disadvantages – Raw materials used in media production, industrial sterilization, Large scale cultivation of Industrially important microbes.	10
IV	**Industrial production** Industrial products derived from microbes, industrial enzymes-amylase, celluase production-production of antibiotics penicillins, streptomycins, vitamins-riboflavin and cyanocobalamin.	10
V	**Regulations** Novel approaches to Industrial effluent treatment and disposal. Institutional Bio-safety Committee.	08
References	**Text Books:** 6. Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 7. Michael J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi. 8. Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.	

	9. Prescott and Dunn's. 1997. Industrial Microbiology. CBS publishers and Distributors. 10. Patel A.H. 1996. Industrial Microbiology, Macmillan India Limited **Reference Books:** 4. Stanbury, P.F., Whittaker, A. and Hali, S.J. 1995. Principles of Fermentation Technology, II Ed., Pergamon Press. 5. V. K. Joshi and Ashok Pandey. 1999. Biotechnology: Food Fermentation-Microbiology, Biochemistry and Technology. 6. Casida, L.E. 1986. Industrial Microbiology, Eastern Limited, New York. **Web 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 media and biology of Industrial Microorganisms CO4: Evaluate the Industrial production of various products CO5: Apply the rules and regulation of industrial effluent disposal and bio safety

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Introduction, Historical background of Industrial Microbiology	2
	1.2 Fermentor - types – Principle	2
	1.3 Fermentation- upstream	2
	1.4 Fermentation- down stream	2
	1.5 Filtration, Centrifugation	2
	Total hours	**10 hrs**
II	2.1 Industrial important microbes	1
	2.2 Screening methods for Industrial microbes	2
	2.3 Strain selection	2
	2.4 Strain improvement	2
	2.5 Mutation	1
	2.6 recombinant DNA technique for strain development	2
	Total hours	**10 hrs**
III	3.1 Biology of Industrially important Microorganisms Single cell Protein, *Saccharomyces*	2
	3.2Advantagesanddisadvantages	2
	3.3 Raw material used for media preparation	2
	3.4 Media sterilization	2
	3.5 Large scale cultivation of Industrially important microbes.	2
	Total hours	**10 hrs**
IV	4.1 Industrial Products derived from microbes	2
	4.2 Industrial production of enzyme- Amylase Cellulase	2
	4.3 Industrial production of Antbiotics – Penicillin, streptomycins,	2
	4.4 Industrial production vitamin - riboflavin, cyanocobalamin	2
	4.5 Video clips, tutorials	2
	Total hours	**10 hrs**
V	5.1 Industrial effluent - nature	2
	5.2 Novel Approaches to Industrial effluent treatment – disposal.	2
	5.3 Novel Approaches to Industrial effluent disposal.	2
	5.4 Class test and seminar	2
	Total hours	**08**
	Total hours for unit I-V	**48 hrs**

ALLIED COURSES

Course Code & Course Title	**19MIBU01A1: ALLIED BIOCHEMISTRY –I** **Credits –4**		
Class	B.Sc. Microbiology	Semester	First
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	The course aims • To understand the various biological molecules and their importance carbohydrates • To highlight the salient feature on the classification and structural properties of proteins • To create interest on the metabolism of lipids • To impart knowledge on vitamins • To acquire overall knowledge on nucleic acids		

UNIT	**Content**	**No. of Hours**
I	**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
II	**Proteins** Proteins- Sources, significance, structure (primary, secondary and tertiary), physical and chemical properties and classification of proteins. Amino acids-Essential aminoacids and Non Essential aminoacids and their roles.	13
III	**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	**Vitamins** Vitamins-Sources, significance-Water soluble vitamins (vitamin Riboflavin and vitamin Ascorbic acid), fat soluble vitamins (Vitamin A, D, E and K)-Functions and deficiency syndroms.	13

V	**Nucleic acids** Nucleic acids-Sources, significance, structure and functions of DNA (Watson and Crick model)-Structure and functions of RNA (mRNA, tRNA and rRNA).	12
References	**Text Books** 1. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles ofBiochemistry, 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. Nagarajand 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.https://en.wikipedia.org/wiki/Biochemistry 2.https://www.britannica.com/science/biochemistry	
Course Outcomes	On completion of the course, students should be able CO1: Explain the classification and structural properties of carbohydrates CO2: Discuss sources, significance and classification of protein CO3: Demonstrate the structure and the biological activities and lipids. CO4: Outline biochemical importance of vitamins. CO5: Describe the structure and the biological activities of Nucleic acid and	

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Sources of Carbohydrates	2
	1.2 Significance of Carbohydrates	2
	1.3 Structures of Carbohydrates	2
	1.4 Physical and chemical properties of Carbohydrates	3
	1.5 Classification of monosaccharides, glucose and fructose, disaccharides sucrose and lactose and polysaccharides starch and cellulose.	4
	Total Hours	**13hrs**
II	2.1 Sources of Proteins	1
	2.2 Significance of Proteins	1
	2.3 Structures (primary, secondary and tertiary) of Proteins	3
	2.4 Physical and chemical properties of Proteins	3
	2.5 Classification of proteins	2
	2.6 Amino acids-Essential amino acids and Non Essential aminoacids and their roles	3
	Total Hours	**13hrs**
III	3.1 Sources of Lipids	1
	3.2 Significance of Lipids	1
	3.3 Structures of Lipids	2
	3.4 Physical and chemical properties of Lipids	3
	3.5 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	6
	Total Hours	**13hrs**
IV	4.1 Sources of Vitamins	1
	4.2 Significance of Vitamins	2
	4.3 Water soluble vitamins (vitamin Riboflavin and vitamin Ascorbic acid)Functions and deficiency syndroms	5
	4.4 Fat soluble vitamins (Vitamin A, D, E and K) Functions and deficiency syndroms	5
	Total Hours	**13hrs**
V	5.1 Sources of Nucleic acids	2
	5.2 Significance of Nucleic acids	2
	5.3 Structure and functions of DNA	4
	5.4 Structure and functions of RNA (mRNA, tRNA and rRNA)	4
	Total Hours	**12hrs**
Total hours for Units I toV		**64 hrs**

Course Code &	**19MIBU01A2 ALLIED PRACTICAL-I:BIOCHEMISTRY – I**

Course Title			**Credits- 1**
Class	B.Sc. Microbiology	Semester	First
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart a practical knowledge on the estimation of Carbohydrates using various methods • To demonstrate the estimation of proteins • To identify unknown carbohydrates and proteins • To perform estimation of Amino acids • To estimate and quantify various biomolecules		

UNIT	Content	No.of Hours
1.	Estimation of Carbohydrates Anthrone method (total carbohydrates. Benedict's method (Glucose), Nelson's method (Glucose) and DNS method (Reducing sugars)	3
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. Strolv BA, Makavora VC. Laboratory manual in Biochemistry. MIR Publisher, Moscow. 1989. 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.Keith Wilson and John Walker. Principles and Techniques of Practical Biochemistry, 4th edition, Cambridge University press, Britain. 1995. 4. Oser BL Hawks. Physiological Chemistry, TATA Mc Graw Hill. 1965.
Course Outcomes	**Upon completion of this practical course, students should be able:** 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

PRACTICAL SCHEDULE

Practical	Topics covered	Hours
1.	Estimation of Carbohydrates Anthrone method (total carbohydrates. Benedict's method (Glucose), Nelson's method (Glucose) and DNS method (Reducing sugars)	3
2.	Reactions of carbohydrates	3
3.	Scheme for identification of unknown carbohydrates	3
4.	Estimation of Proteins	3
5.	Color 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
	Total hours	**45 hrs**

Course Code & Course Title	19MIBU02A3: ALLIED BIOCHEMISTRY -II Credits –4		
Class	B.Sc. Microbiology	Semester	Second
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	The course aims • To understand the classification, structure and functions-mechanism of enzyme action • To highlight the salient feature of metabolic pathways • To create interest on the blood and their functions • To impart knowledge on hormones • To 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-Glycolysis (EMP)-Kreb's cycle (TCA)- Pentose Phosphate Pathway HMP shunt and Electron Transport Chain (ETC).	13
III	**Blood** Blood-Introduction, composition, characterization, functions and coagulation of blood.	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, phycobilins and anthocyanins. Phytohormones-Definition, classification, structure and functions of auxins, gibberellins, cytokinins and abscissic acid.	13

References	**Text Books** 1. Charlotte W Pratt and Kathleen Comely. Essential Biochemistry, 3rd edition, Wileypublisher.2013. 2. Thomas M Devlin. Textbook of Biochemistry with Clinical Correlations, 7th edition,Wiley publisher. 2010. 3. Albert L Lehninger, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry, 2nd 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. Nagarajand Company Pvt ltd, India. 1998. **Reference Books:** 1. Denise R Ferrier. Biochemistry, 6th edition, LWW publishers. 2013. 2. Reginald H Garrett and Charles M Grisham. Biochemistry, 5th edition, Brooks Colepublishers. 2012. 3. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, UniversitiesPress, (India) Pvt. Ltd, Hyderabad, India. 2014. 4. Rajagopal G. Concise textbook of biochemistry, 2nd edition. Ahuja Publishing House.2010.5. 5.Sathyanarayana U and Chakrapani U. Biochemistry, 4th edition, Elsevierpublishers. 2013. **Web Resources** 1.https://www.thoughtco.com/enzyme-biochemistry 2.https://en.wikipedia.org/wiki/Enzyme 3.https://en.wikipedia.org/wiki/Plant_hormone 4.https://www.jagranjosh.com/general-knowledge/list-of-important-hormones-and-their-functions 5.https://www.medicalnewstoday.com/articles/196001.php 6.https://www.britannica.com/science/blood-biochemistry
Course Outcomes	On completion of the course, students should be able 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

LECTURE SCHEDULE

Unit	Topics covered	Hours
I	1.1 Enzymes-Definition, classification, structure and functions	1
	1.2 Mechanism of Enzyme action	1
	1.3 Factors affecting enzyme activity-pH, temperature and substrate concentration	1
	1.4 Michaleis Menton equation	1
	1.5 Enzyme inhibition-Competitive and Non competitive inhibition	1
	Total Hours	**13hrs**
II	2.1 Introduction to metabolism	1
	2.2 Glycolysis (EMP)	3
	2.3 Kreb's cycle (TCA)	3
	2.4 Pentose Phosphate Pathway, HMP shunt	3
	2.5 Electron Transport Chain (ETC)	3
	Total Hours	**13hrs**
III	3.1 Introduction to Blood	2
	3.2 Composition of Blood	2
	3.3 Characterization of Blood	3
	3.4 Functions of Blood	3
	3.5 Coagulation of blood	2
	Total Hours	**12hrs**
IV	4.1 Definition of Hormones	2
	4.2 Classification of hormones	2
	4.3 Human Endocrine hormones pituitary, thyroid, parathyroid, pancreas, adrenal, testis and ovary	5
	4.4 Diseases associates with deficiency of endocrine hormones.	4
	Total Hours	**13hrs**
V	5.1 Secondary metabolites and major/accessory plant pigments chlorophyll, carotenoids, phycobilins and anthocyanins. Phytohormones	5
	5.2 Definition of Phytohormones	3
	5.3 Classification, structure and functions of auxins, gibberellins, cytokinins and abscissic acid	5
	Total Hours	**13hrs**
Total hours for Units I to V		**64 hrs**

Course Code & Course Title	**19MIBU02A4 : ALLIED PRACTICAL –II : BIOCHEMISTRY- II** **Credits- 1**		
Class	B.Sc. Microbiology	Semester	Second
Cognitive Level	K-1 Knowledge and Comprehension K-2 Application K-3 Analysis, Synthesis and Evaluation		
Course Objectives	**The course aims** • To impart a practical knowledge on the estimation of blood sugar • To demonstrate the estimation of serum cholesterol • To identify blood urea, serum proteins, serum uric acids • To perform estimation of enzymes, amino acids and IAA • To estimate and quantify various chlorophyll in plant samples		

UNIT	Content	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

References	**Reference Books** 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	**Upon completion of this practical course, students should be able:** CO 1: Explain blood glucose estimation CO 2: Demonstrate and estimation of various biochemical reactions CO 3: Identify various biomolecules CO 4: Assess reactions occurring blood CO5: Estimate and quantify secondary metabolites of plants

PRACTICAL SCHEDULE

Practical	Topics covered	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
	Total hours	**45 hrs**