

Sadakathullah Appa College

(Autonomous)

(Reaccredited by NAAC at an 'A' Grade. An ISO 9001:2015 Certified Institution)

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

DEPARTMENT OF MICROBIOLOGY



CBCS SYLLABUS

Learning Outcomes-based Curriculum Framework for

Microbiology (M.Sc.)

**(Applicable for the students admitted from June 2021 as per
the Resolutions of the Academic Council Meeting held on 20.03.2021)**

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POSTGRADUATE DEPARTMENT OF MICROBIOLOGY
CBCS SYLLABUS
M.Sc. Microbiology (2021-2024)
COURSE STRUCTURE

I SEMESTER			II SEMESTER		
COURSE	H/W	C	COURSE	H/W	C
DSC –I	5	4	DSC –IV	5	4
DSC – II	5	4	DSC –V	5	4
DSC –III	5	4	DSC –VI	5	4
DSE-I	4	4	DSE-III	4	4
Practical-I	4	2	Practical – III	4	2
Practical-II	4	2	Practical - IV	4	2
IDC – I	2	2	SEC	2	2
Library Hour	1		Library Hour	1	
TOTAL	30	22	TOTAL	30	22
III SEMESTER			IV SEMESTER		
DSC-VII	5	4	DSC –X	5	4
DSC –VIII	5	4	DSC –XI	5	4
DSC –IX	5	4	Project	8	8
DSE –III	4	4	DSE -IV	4	4
Practical-V	4	2	Practical-VII	4	2
Practical-VI	4	2	Practical-VIII	4	2
IDC -II	2	2			
Library Hour	1				
TOTAL	30	22	TOTAL	30	24

DISTRIBUTION OF HOURS, CREDITS, NO. OF PAPERS & MARKS				
SUBJECT	HOURS	CREDITS	NO. OF PAPERS	MARKS
DSC+Project	63	52	12	1250
Practical	32	16	8	400
DSE	16	16	4	400
IDC	4	4	2	100
SEC-SWAYAM-NPTEL Course	2	2	1	50
Library Hour	3			
TOTAL	120	90	27	2200

POSTGRADUATE DEPARTMENT OF MICROBIOLOGY
M.Sc. Microbiology (2021-2024)
COURSE STRUCTURE

SEM	Course	Title of the Courses	Sub. Code	H/W	L*	T*	P*	C	Marks		
									I	E	T
I	DSC-I	General Microbiology and Bacteriology	21PCMB11	5	4	1	-	4	40	60	100
	DSC-II	Techniques in Microbiology	21PCMB12	5	4	1	-	4	40	60	100
	DSC-III	Microbial Diversity and Classification	21PCMB13	5	4	1	-	4	40	60	100
	DSE-IA	Agricultural Environmental and Marine Microbiology	21PEMB11A	4	3	1	-	4	40	60	100
	DSE-IB	Advanced Microbiology	21PEMB11B								
	DSE-IC	Bioethics, Biosafety and Intellectual Property Rights	21PEMB11C								
	P-I	Techniques in Bacteriology	21PCMB1P1	4	-	-	4	2	40	60	100/2
	P-II	Techniques in Agricultural, Environmental and Marine Microbiology	21PCMB1P2	4	-	-	4	2	40	60	100/2
	IDC	Microbiology and Human Health	21PIMB11	2	-	-	-	2	40	60	100/2
		Library Hour		1	-	-	-	-	-	-	100
II	DSC-IV	Microbial Biochemistry	21PCMB21	5	4	1	-	4	40	60	100
	DSC-V	Microbial Physiology and Metabolism	21PCMB22	5	4	1	-	4	40	60	100
	DSC-VI	Molecular Biology and Genetic Engineering	21PCMB23	5	4	1	-	4	40	60	100
	DSE-IIA	Virology	21PEMB21A	4	3	1	-	4	40	60	100
	DSE-IIB	Food Safety, Quality Control And Sensory Evaluation	21PEMB21B								
	DSE-IIC	Fermentation Technology	21PEMB21C								
	P-III	Techniques in Microbial Physiology	21PCMB2P1	4	-	-	4	2	40	60	100/2
	P-IV	Techniques in Biochemistry, Molecular Biology and Genetic Engineering	21PCMB2P2	4	-	-	4	2	40	60	100/2
	SEC	SWAYAM-NPTEL Course	21PSMB21	2	-	-	-	2	40	60	100/2

		Library Hour		1	-	-	-	-	-	-	-
III	DSC-VII	Immunology	21PCMB31	5	4	1	-	4	40	60	100
	DSC-VIII	Medical Microbiology	21PCMB32	5	4	1	-	4	40	60	100
	DSC-IX	Research Methodology and Biostatistics	21PCMB33	5	4	1	-	4	40	60	100
	DSE-III A	Quality assurance in Microbiology	21PEMB31A	4	3	1	-	4	40	60	100
	DSE-III B	Forensic Microbiology	21PEMB31B								
	DSE-III C	Veterinary Microbiology	21PEMB31C								
	P-V	Techniques in Immunology and Research Methodology	21PCMB3P1	4		-	4	2	40	60	100/2
	P-VI	Techniques in Medical and Quality assurance in Microbiology	21PCMB3P2	4	-	-	4	2	40	60	100/2
	IDC-II	Entrepreneurship in Microbiology	21PIMB31	2	-	-	-	2	40	60	100/2
		Library Hour		1	-	-	-	-	40	60	100
IV	DSC-X	Food and Dairy Microbiology	21PCMB41	5	-	-	-	4	40	60	100
	DSC-XI	Industrial and Pharmaceutical Microbiology	21PCMB42	5	-	-	-	4	40	60	100
	P	Project	21PPMB41	8	-	-	-	8	40	60	150
	DSE-IV A	Advances in Biotechnology	21PEMB41A	4	3	1	-	4	40	60	100
	DSE-IV B	Vermiculture Techniques and Mushroom Technology	21PEMB41B								
	DSE-IV C	Environment and Waste Management	21PEMB41C								
	P-VII	Techniques in Food and Dairy Microbiology	21PCMB4P1	4	-	-	4	2	40	60	100/2
	P-VIII	Techniques in Industrial and Pharmaceutical Microbiology	21PCMB4P2	4	-	-	4	2	40	60	100/2
			Total	120				90			2200

* L-Lecture Hours * T-Tutorial Hours * P-Practical Hours

M.Sc. Microbiology
Programme Learning Outcomes

PLO	Upon completion of M.Sc. Degree Programme, the graduates will be able to:
PLO 1	Disciplinary Knowledge <ul style="list-style-type: none"> Acquire in-depth scientific knowledge in the core areas of study.
PLO 2	Creative Thinking and Practical Skills / Problem Solving Skills <ul style="list-style-type: none"> Enrich skills of observation to draw logical inferences from scientific experiments/ programming and skills of creative thinking to develop novel ideas. Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PLO 3	Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship <ul style="list-style-type: none"> Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PLO 4	Ethical Awareness / Team Work / Environmental Conservation and Sustainability <ul style="list-style-type: none"> Equip them for conducting work as an individual or as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviours such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. Realise that the environment and humans depend on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PLO 5	Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning <ul style="list-style-type: none"> Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes

PSO	Upon completion of M.Sc. Microbiology Degree Programmes, the students will be able to:	PLOs Mapped
PSO-1	Understand and acquire the advanced level information in the field of Microbiology and study the vast array of microbes to their diversity, structure by influencing the world.	PLO 1,3
PSO-2	Keep abreast of the recent techniques in Microbiology and provide them with the basic laboratory skills required for a career either in applied or research Microbiology.	PLO 3,5
PSO-3	Help themselves to get through competitive examinations such as CSIR, NET, SET etc. by means of a thorough understanding of the syllabus prescribed.	PLO 4,1
PSO-4	Identify the different microbial processes used in industries and clinical laboratories.	PLO 3,4
PSO-5	Apply theories related to the various recent emerging areas of Microbiology and acquire the knowledge to analyze the Quality Laboratory Management (QLM) ethical issues regarding the modern Biology.	PLO 2,5

SEMESTER – I

Course Title	GENERAL MICROBIOLOGY AND BACTERIOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB11
Course Type	DSC-I
Creditss	4
Marks	100

General Objective:

The course helps to create curiosity in microbial world with the basic, advanced concepts of General Microbiology and Bacteriology.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the microbial world.
CO-2	Interpret the taxonomy and classification of bacteria.
CO-3	Analyze the origin, classification, characteristics and diversity of Eubacteria.
CO-4	Evaluate the methods of cultivation of bacteria.
CO-5	Create the advanced taxonomic tools for bacterial identification.

Unit I: Microbial World (15 hours)

Discovery of microbial world - Controversy over Spontaneous generation; Microbes and the Origin of Life on Earth; Germ Theory; Microbial Evolution. History of Microbiology and contributions of Antonie Von Leeuwenhoek, Lazzaro Spallanzani, Paul Ehrlich, Edward Jenner, Louis Pasteur, Hans Christian Gram, R. J. Petri, Robert Koch, Charles Lavarán, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming, Selman Waksman; Fanny Hesse, Kiyoshi Shiga, Emil Adolf von Behring, Sir Ronald Ross, Dimitri Ivanovski, Charles Louis Alphonse Laveran, Max Theiler, Selman Abraham Waksman, Kary Mullis.

Unit II: Taxonomy and Classification (15 hours)

Taxonomy and Classification - Introduction to the Bergey's Manual of Determinative Bacteriology. Concepts proposed by Carl Linnaeus, Ernst Haeckel, Herbert F. Copeland, Robert Whittaker, Carl Woese, Cavalier Smith and Ruggiero; Introduction to microbial biodiversity – distribution, abundance, ecological niche. Types - Bacterial, Archaeal and Eucaryal.

Unit III: Eubacteria (15 hours)

Eubacteria – Origin, Characteristics, Classification, Diversity, Association and Lifecycle. Morphology and Ultrastructure of Bacteria - Size, Shape and Arrangement of bacteria; Structure and Chemical composition of Cell Wall of Gram positive, Gram negative bacteria and archae; Wall-less Bacteria; Structure, Composition and Function of Cell membrane, Cytoskeleton (FtsZ, MreB, Crescentin), Capsule, Flagella, Pili, Gas vesicles, Cytoplasmic matrix, Reserve food materials, Chromosomes, Inclusions - Carbon storage, Inorganic storage, Non-storage functions (Magnetosomes), Nucleoid and Endospores.

Unit IV: Cultivation of Bacteria (15 hours)

Cultivation of bacteria - Aerobic, Anaerobic, Microaerophilic, Capnophilic; Culture Media - types based on the state - liquid, solid, semisolid; composition and use. General-purpose media/basic media (Peptone-water, nutrient broth, and nutrient agar), Enriched medium (Blood Agar, Chocolate Agar), Selective medium (Thayer Martin Agar, Mannitol Salt Agar, MacConkey's Agar, Cetrimide Agar, EMB Agar, TCBS Agar), Enrichment media (Selenite F broth, Tetrathionate Broth and Alkaline Peptone Water), Transport media (Cary Blair transport medium, Venkatraman Ramakrishnan (VR) medium), Anaerobic media (Robertson Cooked Meat (RCM) medium, Thioglycollate broth), Assay media (antibiotic assay media); pH indicators, Inoculation methods and instruments.

Unit V: Advanced Taxonomic Tools for Bacterial Identification (15 hours)

Polyphasic Taxonomy - Phenotypic methods - Classical phenotypic analysis, Numerical analysis. Genotypic methods -DNA-DNA Hybridization, rRNA Homology, DNA-based typing. Whole-Cell Fatty acid analysis, MALDI- TOF.

TEXTBOOKS:

1. Aneja K. R., Jain P. & Aneja R. *A text book of basic & applied Microbiology*, New Age Int. Publ, New Delhi, 2008.
2. Pelczar Jr., M.J., Chan E.C.S. and Kreig, N.R. *Microbiology*. McGraw Hill Inc., New York, 1993.
3. Talaro K.P. and Talaro A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College Woolverton, 2007.

REFERENCE BOOKS:

1. Berg J. M., Tymoczko J. L. and Stryer, L. *Biochemistry* 6th Ed. W.H. Freeman and Company, New York, 2007.
2. Nelson D. and Cox M. M. *Principles of Biochemistry* 5th Ed. W.H. Freeman and Company, New York, 2009.
3. Prescott L.M., Harley J.P. and Klein D. A. *Microbiology* (11th edition). McGraw Hill, New York, 2020.
4. Wilson K. and Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 6thEd. Cambridge University Press, 2008.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Discuss the fundamental concepts of Microbial world.	1	Understanding
CO-2	Interpret the modern trends in the classification of microbes.	2,3	Applying
CO-3	Analyze the morphology and ultra structure of Bacteria.	1,4	Analyzing
CO-4	Assemble the nutritional types of Bacteria, growth kinetics of different Bacteria.	4	Evaluating
CO-5	Conclude the general characters and classification of Archae and Eubacteria.	5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
I	21PCMB11	GENERAL MICROBIOLOGY AND BACTERIOLOGY					75	4		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓	✓		✓		✓
CO-2	✓	✓		✓	✓		✓	✓		✓
CO-3	✓	✓			✓	✓	✓		✓	✓
CO-4		✓	✓	✓	✓		✓	✓		✓
CO-5	✓	✓		✓	✓	✓		✓	✓	✓
	Number of matches (✓) = 36 Relationship = High Low (If the No. of matches are less than 25) Medium (If the No. of matches are between 25 and 33) High (If the No. of matches are more than 33)									

SEMESTER – I

Course Title	TECHNIQUES IN MICROBIOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB12
Course Type	DSC-II
Creditss	4
Marks	100

General Objective:

The course builds a sound knowledge in molecular techniques by helping themselves in gathering information in microbial techniques.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the basic principles of microscopy.
CO-2	Demonstrate the principles and methods of sterilization.
CO-3	Analyze the various culture techniques.
CO-4	Collect the knowledge of the applications of Spectrophotometry.
CO-5	Assess the applications of Radiotherapy.

Unit I: Microscopy and Staining techniques (15 hours)

Basic Principles for the examination of microbes by Light, Dark field, Phase contrast, Confocal, Fluorescent and Electron (transmission and scanning) microscopy, Micrometry. Specimen Preparation and basic Principles of Simple, Gram, Capsule, Endospore, Flagella, Acid fast, Flurochrome staining, metachromatic , Nuclear/ Geimsa's staining.

Unit II: Sterilization Techniques (15 hours)

Basic principles and methods of sterilization - Control of microorganisms by Physical methods- Heat (Dry, Moist heat), Pastuerization, Tyndallization, Filtration and Radiation; Chemical methods: Phenolics, Alcohols, Halogens, Heavy metals, Quaternary ammonium compounds, Aldehydes and Sterilizing gases; Evaluation of Antimicrobial agent and disinfectants effectiveness. Principle and functioning of LAF.

Unit III: Culture Techniques (15 hours)

Morphological variations of Bacteria in Nutrient broth and agar. Biochemical characterization of bacteria: IMViC, Catalase Test. Coagulase Test, TSI test, Urease Test, Carbohydrate Fermentation test, CAMP test, Nitrate test. Pure culture techniques, Pour plate Spread plate method and Streak plate, Maintenance of Pure culture; Methods of Preservation of various microbes. Growth: Growth curve - batch, continuous and synchronous culture – factors influencing growth.

Unit IV: Spectroscopy (15 hours)

Basic Principles and Applications of Spectrophotometry- Beer-Lambert law; Interaction of radiation with matter, Absorption of radiation, Emission of radiation; UV-Vis Spectrophotometry, Flame photometry and atomic absorption Spectrophotometry; Chromatography (Paper, Thin layer, column, gel filtration), GLC, HPLC and FPLC.

Unit V: Molecular Techniques (15 hours)

Principles and Applications of Radiotherapy. PCR, Electrophoresis AGE and PAGE; X-Ray diffraction; Centrifugation; Ultracentrifugation; Dialysis, Ultrafiltration; Lyophilization and immobilization.

TEXT BOOKS:

1. Dubey, R.C. and Maheshwari, D.K., *A Text Book of Microbiology*, Revised Edition, S. Chand & Company Ltd., New Delhi, 2010.
2. Prescott, L.M., Harvey, J.P. and Klein, D.A., *Microbiology*, Ninth Edition, Wm. C. Brown Publications, Iowa, 2015.
3. Talaro K. P. and Talaro A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College Dimensi, 2006
4. Tortora, J.G., Funke, R.B. and Case, C.L., *Microbiology: An Introduction*, Twelfth Edition, Pearson Education. Inc., San Francisco, 2016.

REFERENCE BOOKS:

1. Berg J. M., Tymoczko J. L. and Stryer, L, *Biochemistry* 6th Ed. W.H. Freeman and Company, New York, 2007.
2. Nelson D. and Cox M. M. *Principles of Biochemistry* 5th Ed. W.H. Freeman and Company, New York, 2009.
3. Potter G. W. H. and Potter G. W. *Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques*, Kluwer Academic Publishers, 1995.
4. Willey J., Sherwood L. and Woolverton C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill, 2007.
5. Wilson K. and Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 6th edition. Cambridge University Press, 2008.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Explain the fundamental concepts of the different types of microscope.	1	Understanding
CO-2	Substantiate the various principles and methods of sterilization.	2	Applying
CO-3	Appraise the basic principles and methods of media preparation.	5	Analysing
CO-4	Evaluate the unknown compound by using Chromatography and Spectrophotometry.	3, 4	Evaluating
CO-5	Revise the knowledge of biomolecules quantification by electrophoresis method.	3, 4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PCMB12	TECHNIQUES IN MICROBIOLOGY				75	4			
Course Outcomes (COS)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO2	PLO3	PLO4	PLO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO-1	✓	✓	✓	✓	✓		✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3	✓	✓			✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓	✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 37 Relationship = High									

SEMESTER – I

Course Title	MICROBIAL DIVERSITY AND CLASSIFICATION
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB13
Course Type	DSC-III
Creditss	4
Marks	100

General Objective:

The course creates knowledge on number of different species of microbes present in their distribution, morphology and functions of microorganisms.

Course Objectives:

CO No.	The learners will be able to
CO-1	Review the fundamental concepts of microbial diversity.
CO-2	Infer the modern trends in the classification of microbes.
CO-3	Classify the morphology and ultra-structure of Algae, Fungi and Protozoa.
CO-4	Categorize the classification, characteristics and applications of Archae and Eubacteria.
CO-5	Construct the knowledge of the general characters and classification of Space Microbiology.

Unit I: Phycology (15 hours)

General characteristics, thallus structure and life cycle of algae; Classification: by Fritsch (1945) and Lee (2009). Cyanophyceae (Nostoc), Chlorophyceae (Volvox), Xanthophyceae (Vaucheria), Bacillariophyceae (Pinnularia), Phaeophyceae (Sargassum), Rhodophyceae (Polysiphonia); Environmental as well as commercial applications of algae. Algal culture: isolation, cultivation, maintenance and preservation of micro- and macro-algae.

Unit II: Mycology (15hours)

General characteristics, principles of classification of Alexopoulos (1962) - Major Groups of Fungi - Chytridiomycota (chytrids), Zygomycota (bread molds), Ascomycota (yeasts and sac fungi) and Basidiomycota (club fungi), Deuteromycetes (Fungi imperfect) Fungal reproduction, Spore forms; fungal physiology, nutrition, and growth. Ultrastructure of fungal cell and composition. Genetics and Cell cycle in yeast. Environmental as well as commercial applications of fungi.

Unit III: Parasitology (15 hours)

Characteristics, Morphology and lifecycle; Classification of Protozoa by Hyman and Hickman. Based On Locomotion - Amoeboids (Sarcodina), Flagellates (Mastigophora), Ciliates (Ciliophora), Sporozoa; Branches of Protozoology - Soil Protozoology (Characteristics of Soil Protozoa), Medical Protozoology (Parasitic Protozoa) and Veterinary Protozoology.

Unit IV: Archaeobacteria (15 hours)

Classification, Characteristics and Applications of Archae - Thermophiles: (*Thermococcus*). Methanogens: (*Methanobacterium*, *Methanomicrobium*); Alkalophiles and Acidophiles (*Acidobacteria*, *Acetobacter*); Classification, alkaline environment (soda lakes), life at low pH, acidotolerance, Halophiles (*Halobacterium*, *Chromohalobacter*) - Barophiles (*Halomonas*, *Moritella*); Adaptations of Archaeal cell walls and membranes, commercial aspects and applications of extremozymes.

Unit V: Space Microbiology (15 hours)

Space Microbiology: Aims and objectives of Space research. Microbiological studies in the space environment or using facilities simulating conditions of outer space, Role of Gravity in Basic Biological Processes, Interactions of Microgravity and Radiation in Microorganisms. Survival of Microorganisms in Outer Space; Microorganisms in the spacecraft environment. Antarctica as a model for Mars. Search for life on Mars, Monitoring of astronauts microbial flora.

TEXT BOOKS:

1. Dubey, R.C. and Maheshwari, D.K., *A Text Book of Microbiology*, Revised Edition, S. Chand and Company Ltd., New Delhi, 2010.
2. Dubey, H.C. *A text book of Fungi, Bacteria and virus*, Agrabios India, 2007.
3. Mehrotra R.S. and Ashok Agarwal. *Plant Pathology*, Revised Edition, McGraw Hill publishing company, New Delhi, 2017.

REFERENCE BOOKS:

1. Gerald R. Taylor., *Space Microbiology*, Life Sciences Directorate, LB. Johnson Space Centre. Houston, Texas, 1974.
2. Prescott, L.M., Harvey, J.P. and Klein, D.A., *Microbiology*, Ninth Edition, Wm. C. Brown Publications, Iowa, 2015.
3. Talaro K. P. and Talaro A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College Dimensi, 2006.
4. Tortora, J.G., Funke, R.B. and Case, C.L., *Microbiology: An Introduction*, Twelfth Edition, Pearson Education. Inc., San Francisco, 2016.
5. Willey J., Sherwood L. and Woolverton C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill. 2007.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize the concepts of Microbial classification.	1,2	Understanding
CO-2	Illustrate the economic importance of algae, cultivation & maintenance of algae.	3,4	Applying
CO-3	Categorize the true fungi, habit, habitat and their adaptive strategies.	1,5	Analyzing
CO-4	Construct the Parasitology, biological relationship and types of parasitism.	1,4	Evaluating
CO-5	Compare the structural similarities and differences among the bacteria/archaea and space microbes.	2	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
I	21PCMB13	MICROBIAL DIVERSITY AND CLASSIFICATION					75	4		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	CO-1	✓		✓	✓	✓	✓		✓	✓
	CO-2	✓	✓		✓	✓	✓		✓	✓
	CO-3	✓	✓		✓	✓		✓	✓	✓
	CO-4		✓		✓	✓	✓		✓	✓
	CO-5	✓	✓		✓	✓		✓	✓	✓
	Number of matches (✓) = 38 Relationship = High									

SEMESTER – I

Course Title	AGRICULTURAL, ENVIRONMENTAL AND MARINE MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB11A
Course Type	DSE-I-A
Creditss	4
Marks	100

General Objective:

The course creates curiosity about plant diseases, Aero, Aquatic Microbiology and disposal of wastes by providing the fundamental knowledge on Agricultural, Environmental and Marine Microbiology.

Course Objectives:

CO No.	The learners will be able to
CO-1	Summarize the characteristics of soil and biogeochemical cycle.
CO-2	Relate the microbial interaction and diseases of plants.
CO-3	Classify the microbes in Air and Aquatic Microbiology.
CO-4	Manage the use of the benefits of Marine Microbiology.
CO-5	Score the knowledge in the marine bio resources.

Unit: I Characteristics of Soil and Nitrogen Cycle (12 hours)

Soil – Nature medium for Plant growth, Physical and Chemical Properties of Soil, Soil Structure, Soil Microorganisms-Bacteria, Actinomycetes, Fungi, Algae, Protozoa. Methods used in Soil Microbiological Studies. Biological Nitrogen fixation- Nitrogen Bacteria (Free living and Symbiotic) - mechanism of nitrogen fixation (biochemistry of nitrogenase) - genetics of nitrogen fixation - Rhizobium-Legume Association - Nitrogen fixation by non-leguminous plants. Mycorrhizae- Ecto, Endomycorrhizae, Arbuscular Mycorrhizae.

Unit II: Microbial Interaction and Diseases of Plants (12 hours)

Microbial Interaction: Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation- (rhizosphere, rumen, lichens, mycorrhiza, bioluminescence) Microbe-Plant Interactions (Phyllosphere leguminous plant-*Rhizobium*); VAM. Mechanism of pathogenesis, symptoms and control measures of the following plant

diseases- red rot of sugar cane, late blight of potato, bunchy top of banana and little leaf of brinjal. Management of plant diseases.

Unit III: Air and Aquatic Microbiology (12 hours)

Aerobiology: Composition of air- aerial environment – microbial propagules in air- Indoor and Outdoor flora of air. Seasonal and diurnal periodicities of air. Air sampling techniques: Settle plate method - Anderson sampler and impingers. Significance of air flora. Aquatic Microbiology: Detection of water borne pathogens - sewers swab method - membrane filter techniques - multiple tube fermentation test. Sewage and effluent treatment: Physical, chemical and biological treatment process of sewage. Disposal of treated sewage: Irrigation, composting and land filling. DO, BOD and COD. Impact of eutrophication.

Unit IV: Marine Microbiology (12 hours)

Milestones in Marine Microbiology, Classification of Marine Environment, Properties of seawater. Microbes in the Marine Environment, Marine Actinobacteria: origin, Distribution, Role and importance in the Marine Environment. Marine microbial habitats: Deep Sea, hydrothermal vents, Estuaries, Mangroves, Salt marshes, Beach, coastal ecosystems and coral reefs. Culture-based methods for isolation and identification of microbes: Enrichment culture, Phenotypic testing, Analysis of microbial components. Novel Bioreactors for Culturing Marine Organisms.

Unit V: Marine Bioresources (12 hours)

Marine Bioresources: Marine microbes as Food and Biomedical sources, Fishery products-Fish meal and Fish oil. Phycocolloides: Agar Agar, Algin. Dinoflagellates as sources of bioactive molecules. Chemistry and Pharmacology of marine toxins - Saxitoxin, Tetrodotoxin. Bioremediation Survival at extreme environments. Microbial consortia and genetically engineered microbes in bioremediation of polluted marine sites - heavy metals and crude oil. Biofouling and their control.

TEXT BOOKS:

1. Mitchell R and Kirchman DL. *Microbial Ecology of the Oceans*, Wiley Blackwell Publishers, 1982.
2. Munn C. *Marine Microbiology: ecology and applications*, Garland Science, Taylor and Francis group, NY, 2011.
3. Prescott LM, Harley JP. Klein, *Microbiology*, WCB, Mc Grow Hill Publications, 1999.

4. Raina M. Maier, Ian L. Pepper, Charles, P. Gerba. *Environmental Microbiology*, Academic press, 2006.
5. Stephen J. Jordan,. *Estuaries Classification, Ecology and Human impacts*. Nova Science Publishers, Inc. New York, 2011.

REFERENCE BOOKS:

1. Atlas,R.M., and Bartha.M. *Microbial Ecology –Fundamentals and applications*. Benjamin – Cummings, Mento Park, California, 2003.
2. Martin Alexander. *Introduction to Soil Microbiology*, Wiley eastern Ltd., New Delhi, 1983.
3. Se-Kwon Kim,. *Marine Microbiology Bioactive Compounds and Biotechnological Applications*. Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr.12, 69469 Weinheim, Germany, 2013.
4. Shiva Aithal, C. *Modern approaches in Soil, Agricultural and Environmental Microbiology*. Himalaya Publishers, New Delhi, 2010.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Predict the fundamental concepts of Agricultural Microbiology.	1	Understanding
CO-2	Illustrate skills in the management of plant diseases.	2,3	Applying
CO-3	Appraise the fundamental concepts, composition of air and aerial environment.	1,5	Analysing
CO-4	Design the water borne pathogens and waste water treatment.	2,4	Evaluating
CO-5	Write the general characters and classification of marine environment.	2,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEMB11A	AGRICULTURAL, ENVIRONMENTAL AND MARINE MICROBIOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓		✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3	✓	✓		✓	✓	✓		✓	✓	✓
CO-4		✓	✓		✓	✓	✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 37 Relationship = High									

SEMESTER – I

Course Title	ADVANCED MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB11B
Course Type	DSE-I-B
Creditss	4
Marks	100

General Objective

Acquired skills and an initial understanding of recent developments of host-microbe interactions, synthetic biology, viable but non-culturable forms of microorganism.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the salient characteristics of genomes of representative microorganisms.
CO-2	Interpret the concept and importance of metagenomics.
CO-3	Analyze the molecular basis of host-Microbe interaction
CO-4	Evaluate the systems and synthetic biology of microorganisms.
CO-5	Create an awareness about microbiomes and importance of microbial communities.

Unit I: Evolution of Microbial Genomes (12 hours)

Evolution of Microbial Genomes: Salient features of sequenced microbial genomes, core genomepool, flexible genomepool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit II: Metagenomics (12 hours)

Metagenomics: Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using Metagenomics Basic knowledge of viral metagenome, meta transcriptomics, metaproteomics and metabolomics.

Unit III: Molecular Basis of Host-Microbe Interaction (12 hours)

Molecular Basis of Host-Microbe Interaction: Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

Unit IV: Synthetic Biology (12 hours)

Systems and Synthetic Biology: Networking in biological systems, Quorum sensing in bacteria, Coordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

Unit V: Microbiomes (12 hours)

Microbiomes and importance of microbial communities, VBNC (viable but not culturable bacteria). Genetically modified organisms and their uses. Modern methods of rapid identification of microbes (PCR, mass spectrometry, fluorescence based techniques). CRISPR-Cas system.

REFERENCE BOOKS

1. Dubey, R. C. A - Text Book of Biotechnology (4 th Edition) S.Chand & Company Limited, New Delhi.
2. Gupta, P.K. Elements of Biotechnology. Rastogi Publications, Meerut.
3. Jogdand, S. N . Gene Biotechnology (5th Edition) Himalaya Publishing House

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Predict the fundamental concepts of microbial genomes	1	Understanding
CO-2	Illustrate skills in the metagenomic approach	2,3	Applying
CO-3	Develop the host microbe interaction.	4	Creating
CO-4	Determine the synthetic biology networking	1	Evaluating
CO-5	Write the general characters of microbial communities.	2,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEMB11B	ADVANCED MICROBIOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓		✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3	✓	✓		✓	✓	✓		✓	✓	✓
CO-4		✓	✓		✓	✓	✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 37 Relationship = High									

SEMESTER – I

Course Title	BIOETHICS, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB11C
Course Type	DSE-I-C
Creditss	4
Marks	100

General Objective:

To adhere to the ethical practices appropriate to the discipline at all times and to adopt safe working practices relevant to the bioindustries & field of research.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the Bioethics, Biosafety and Intellectual Property Rights in Microbiology.
CO-2	Interpret the Intellectual Property Rights (IPRs) to take measure for the protecting their ideas.
CO-3	Analyze the devise business strategies by taking account of IPRs.
CO-4	Evaluate to assists in technology upgradation and enhancing competitiveness.
CO-5	Create the more advanced insights into the regulatory affairs.

UNIT I: Introduction to Bioethics (12 hours)

Introduction to Bioethics. Social and ethical issues in Microbiology. Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release in to the environment. Special procedures for r-DNA based products, Transgenic plants and Animals.

UNIT II: Regulatory Affairs (12 hours)

Regulatory Affairs: Regulation, national and international guidelines of Biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP and GMP.

UNIT III: Intellectual Property Rights (12 hours)

Intellectual Property Rights : Intellectual property rights and protection, patents and methods of application of patents, Trade Secrets

copyrights, Trade Marks, legal implications, farmer's rights, plant breeder's rights. International and National conventions on biotechnology and related areas, WTO guidelines.

UNIT IV: Responsibilities and Rights (12 hours)

Safety, Responsibilities and Rights: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk – the three mile island and case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights.

UNIT V: Global Issues (12 hours)

Global Issues : Multinational corporations - Environmental ethics - computer ethics - weapons development and bioterrorisms - engineers as managers consulting engineers - engineers as expert witnesses and advisors - moral leadership-sample code of Ethics.

TEXT BOOKS:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, " Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCEBOOKS:

1. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.
2. Sasson A. Biotechnologies in developing countries present and future, UNESCO publishers, 1993. 7. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001. 9. Singh K. "Intellectual Property Rights on Biotechnology", BCIL, New Delhi.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyze the Social and ethical issues.	1	Analyzing
CO-2	Infer the modern regulation, national and international guidelines of Biosafety.	3	Understanding
CO-3	Determine the International and National conventions on Microbiology.	1	Evaluating
CO-4	Classify and assess the safety and risk	4	Analyzing
CO-5	Develop the knowledge of the Global Issues.	4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEMB11C	BIOETHICS, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓		✓		✓		✓
CO-2	✓	✓		✓	✓		✓	✓		✓
CO-3	✓	✓			✓		✓		✓	
CO-4		✓		✓	✓		✓	✓		✓
CO-5	✓	✓		✓	✓			✓	✓	✓
	Number of matches (✓) = 35									
	Relationship = High									

SEMESTER – I

Course Title	TECHNIQUES IN BACTERIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB1P1
Course Type	Practical - I
Creditss	2
Marks	100/2

General Objective:

The courses describe the practical knowledge on general concepts of aseptic techniques used in laboratory preparation and analyze the classification of bacteria based on morphological and cultural characteristics.

Course Objectives:

CO No.	The learners will be able to
CO-1	Discuss essentials of laboratory precautions.
CO-2	Demonstrate the different sterilization techniques.
CO-3	Categorize the staining, motility and pure culture techniques.
CO-4	Organize the various maintenance activities and preservation of techniques.
CO-5	Assess Fungi isolation and cultivation.

1. a) Laboratory Precautions.
b) Washing and cleaning of glass wares.
c) Biological safety cabinets.
2. Hay mount to show different types of microbes.
3. Motility Test (Hanging drop and Soft agar).
4. Staining techniques:
 - a) Gram's staining
 - b) Acid fast staining
 - c) Spore staining
 - d) Capsule staining.
5. Preparation of culture media.
6. Techniques for pure culture of microorganisms by serial dilution technique.
7. Determination of bacterial numbers:
 - a) Pour plate method
 - b) Spread plate method

- c) Streak plate method
- d) Enumeration of bacteria – water and soil samples.
- 8. Counting Microbial cells using Haemocytometer.
- 9. Maintenance and preservation of bacteria (Mineral oil, Lyophilisation)
- 10. Cultivation of anaerobic microorganisms – Pyrogallol method.
- 11. Cultivation and morphology of molds – Lacto phenol cotton blue staining.
- 12. Fungal slide culture technique.

REFERENCE BOOKS:

1. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*. 10th Edition. Pearson education Limited, 2014.
2. Gunasekaran. P. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi, 1996.
3. Jayaraman, J. *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi, 1985.
4. Kannan.N.. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani, 1995.
5. Rajan.S., and Selvi Christy. R. *Experimental procedure in Life sciences*. Anjanaa Book House, 2012.
6. Sundararaj, T. *Microbiology – Laboratory Manual*. (First Edition) Publn. Chennai, 2005.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Identify the microorganisms based on their morphological and biochemical reactions.	1,2	Understanding
CO-2	Examine the unknown microorganisms from different types of samples.	2,4	Applying
CO-3	Differentiate the basic principles and methods of media preparation.	3,5	Analysing
CO-4	Justify the different techniques of pure culture.	4	Evaluating
CO-5	Evaluate the concepts of cultivation and morphology of molds.	3,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
I	21PCMB1P1	TECHNIQUES IN MICROBIAL DIVERSITY AND BACTERIOLOGY					4	2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓	✓		✓	✓	✓
CO-2		✓	✓		✓		✓	✓	✓	✓
CO-3	✓	✓		✓	✓	✓	✓		✓	✓
CO-4	✓		✓	✓	✓	✓		✓	✓	✓
CO-5		✓	✓		✓	✓	✓	✓		✓
	Number of matches (✓) = 40 Relationship = High									

SEMESTER – I

Course Title	TECHNIQUES IN AGRICULTURAL, ENVIRONMENTAL AND MARINE MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB1P2
Course Type	Practical - II
Creditss	2
Marks	100/2

General Objective:

The course strengthens the practical knowledge on sample collection, isolation, identification and enumeration of microorganisms from various environments besides characterizing the plant associated beneficial, pathogenic and aquatic microbes.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify microbial population from various samples.
CO-2	Practice to isolate the <i>Rhizobium</i> species from root nodules.
CO-3	Analyse the amount of BOD and COD in water samples.
CO-4	Collect <i>Vibrio</i> sp and <i>Aeromonas</i> sp from marine products.
CO-5	Value the quality of water and air.

1. Enumeration of microbial population in soil-bacteria, fungi, actinomycetes.
2. Isolation of *Rhizobium* sp from root nodules of leguminous plants.
3. Isolation of *Azotobacter* sp, *Azospirillum* sp from soil.
4. Isolation of bacterial pathogen and fungal pathogen from diseased plant parts.
5. Determination of BOD.
6. Determination of COD.
7. Enumeration of faecal and total coliform by MPN technique.
8. Enumeration of Microorganisms in water sample by Membrane filter technique.
9. Enumeration of Microorganisms using Open plate and Air Sampler Method.
10. Isolation and identification of Luminescent bacteria from marine fish.
11. Isolation and enumeration of *Vibrio* sp and *Aeromonas* sp from marine products.

REFERENCE BOOKS:

1. Aneja, K.R. *Experiments in Microbiology Plant pathology and Biotechnology*, Fourth edition, New age international (p) Limited, Publishers, 2002.
2. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*. 10th Edition. Pearson education Limited, 2014.
3. Dubey R.C. and Maheswari. *Practical Microbiology* S. Chand & Co. Ltd., New Delhi, 2002.
4. Kannan. N. *Laboratory Manual in General Microbiology*. Palani Paramount Publication, Palani, 1996.
5. Mitchell R and Kirchman DL. *Microbial Ecology of the Oceans*, Wiley Blackwell Publishers. 1982.
6. Munn C. *Marine Microbiology: ecology and applications*, Garland Science, Taylor and Francis group, NY. 2011.
7. Sundaraj, T. AswathySundararaj, *Microbiology laboratory manual* Chennai, 2002.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Recognize soil and nature medium for plant growth.	1,4	Understanding
CO-2	Examine the different types of <i>Mycorrhizae</i> .	1,2	Applying
CO-3	Analyze the quality of air and water.	4,5	Analyzing
CO-4	Compare different types of bacteria in marine products.	1,3	Evaluating
CO-5	Design skills on isolation and identification of plant pathogens.	3,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PCMB1P2	TECHNIQUES IN AGRICULTURAL, ENVIRONMENTAL AND MARINE MICROBIOLOGY				60	2			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓	✓			✓	✓
CO-2		✓	✓		✓		✓	✓		✓
CO-3		✓	✓	✓	✓	✓	✓		✓	✓
CO-4	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO-5	✓	✓	✓		✓	✓	✓		✓	✓
	Number of matches (✓) =38 Relationship = High									

SEMESTER – I

Course Title	MICROBIOLOGY AND HUMAN HEALTH
Total Hrs	40
Hrs/Week	2
Sub.Code	21PIMB11
Course Type	IDC-I
Creditss	2
Marks	100/2

General Objective:

The course introduces the normal flora, its benefits, pathogens, transmission, diagnosis, treatment and preventive measures.

Course Objectives:

CO No.	The learners will be able to
CO-1	Report about significance of public health.
CO-2	Demonstrate the diseases caused by Bacteria.
CO-3	Categorize the knowledge in important human Viral, Fungal diseases.
CO-4	Organize to know about the Bacterial and Viral vaccines.
CO-5	Assess the knowledge of human Protozoan diseases.

Unit I: Normal Flora (8 hours)

Introduction to public health: definition, scope, concept and importance of public health microbiology – roles of microbiologist in public health. Normal flora of human body, Role of the resident flora. Brief account of major air, water and food borne diseases of microbial origin and their preventive and control measures.

Unit II: Bacteriology (8 hours)

Introduction - major human bacterial diseases, transmission, diagnosis and treatment: caused by *Staphylococcus*, *Streptococcus*, *Neisseria*, *Bacillus*, *Corynebacterium*, *Clostridium*, *Pseudomonas*, *Yersinia*, *Haemophilus*, *Mycobacterium*, Antibacterial agents and susceptibility test, Bacterial vaccines.

Unit III: Virology (8 hours)

Introduction - major human viral diseases, transmission, diagnosis and treatment: Coronavirus, Mumps, Measles, Influenza, Enterovirus, Rhinovirus, Poxvirus, Hepatitis virus; Herpesvirus, AIDS, Antiviral drugs, viral vaccines.

Unit IV: Mycology (8 hours)

Introduction - major human fungal diseases transmission, diagnosis and treatment: Candidiasis, Dermatophytosis, Aspergillosis, Cutaneous and subcutaneous mycoses, Systemic mycoses, Opportunistic mycoses, Antifungal agents.

Unit V: Parasitology (8 hours)

Introduction - major human Protozoal diseases, transmission, diagnosis and treatment: Entamoeba, Giardia, Trichomonas. Blood and tissue protozoa; Plasmodium, Trypanosoma, Leishmania, Taenia, Schistosoma, Nematodes: Ascaris, Filariasis, , antiparasitic agents.

TEXT BOOKS:

1. Atlas R. M. *Principles of Microbiology*, II Ed., McGraw Hill, 1997.
2. Ghimire P. and Parajuli K. *A Text Book of Microbiology*, Vidhyarthi Pustak Bhandar Publication, Kathmandu, 2005.
3. Parija. *Textbook of Microbiology and Immunology*. ELSEVIER, ISBN: 978-81-312-2810-4., 2012.
4. Talaro K. P. and Talaro A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College. Dimensi, 2006.
5. Willey J., Sherwood L. and Woolverton C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill, 2007.

REFERENCE BOOKS:

1. Brownson, R.C., Baker, E.A., Leet T.L. and Follespie K.N. *Evidence Based Public Health*, Oxford University Press, 2003.
2. Greenwood D. *Medical Microbiology*, 4th Ed., I.K. International, 2007.
3. Harvey, R.A., Champe, P.C. and Fisher, B.D. *Lippincott's Illustrated Reviews: Microbiology*, 2007.
4. Nester E. W., Anderson D. G. and Nester M. T. *Microbiology: A Human Perspective*, McGrawHill, 2006.
5. Willey J., Sherwood L. and Woolverton C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill, 2007.
6. Engelkirk P.G. and Duben-Engelkirk J. Burton's. *Microbiology for the Health Sciences*, 10th Edn. Wolters Kluwer Health, 2015.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Identify the fundamental concepts of public health.	1,5	Understanding
CO-2	Schedule the human diseases caused by bacterial pathogens and disease management.	1,2	Applying
CO-3	Test the basic concepts of human viral diseases and disease management.	2,5	Analysing
CO-4	Arrange the systemic mycoses, opportunistic mycoses and antifungal agents.	4	Evaluating
CO-5	Compare the severity of human protozoan diseases, prevention and control measures.	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
I	21PIMB11	MICROBIOLOGY AND HUMAN HEALTH					40	2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3		✓	✓		✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓	✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓		✓
	Number of matches (✓) = 37 Relationship = High									

SEMESTER – II

Course Title	MICROBIAL BIOCHEMISTRY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB21
Course Type	DSC - IV
Creditss	4
Marks	100

General Objective:

The course focuses to understand the basic concept of biochemistry, gain knowledge on various biomolecules and also helps to gather information in enzyme kinetics.

Course Objectives:

CO No.	The learners will be able to
CO-1	Summarize the laws of thermodynamics.
CO-2	Interpret the Basic knowledge on Carbohydrates.
CO-3	Distinguish the classification and chemistry of Lipids.
CO-4	Formulate the structure and properties of proteins.
CO-5	Score knowledge in Different forms DNA and RNA.

UNIT I: Carbohydrates (15 hours)

Chemistry of Life: Evolution of organisms-atom structure - chemical bonds- water structure and properties - laws of thermodynamics. Classification- Properties- Optical and Chemical Structure of Glucose, Ring structure, Haworth and Fischer's projection, Pyranose, Furanose Isomers. Mutarotation, Triose, Pentose, Hexose, Heptose - Example and Structures, Derived Monosaccharide - Glycosides, Furanoacids, Sugar, Uronic acids, Sugar alcohol, Disaccharides- Glycosidic linkage, Lactose, Maltose, Sucrose, Oligosaccharide, Trisaccharides, Structure of raffinose- Polysaccharide- Homopolysaccharide, Heteropolysaccharide Structure, Starch, Cellulose, Mucopolysaccharide and Biological Significance.

UNIT II: Lipids (15 hours)

Classification, Components and Chemistry of Lipids, Fatty acids and Glycerals, Types of Fatty acids: Essential, Non Essential and Unsaturated, Saturated fatty acids, Triglycerides, Saponification, Sterols, Cholesterol, Prostaglandins, Glycolipids, Phospholipids, Lipoproteins and Functions of lipids.

UNIT III Proteins (15 hours)

Classification of amino acids, Properties, Peptide bond, Formation and properties of proteins. Classification, Elemental composition, Structure of Primary, Secondary, Tertiary and Quarternary Protein, Ramachandran plot-domains.

UNIT IV: Nucleic acids (15 hours)

Structure of Nitrogen bases and base pairing, Structure of Nucleosides, Nucleotides, Ribose, Deoxyribose sugar. Components, Types, Tautomeric Forms, Nomenclature & analogs. Different forms, structure and functions of DNA & RNA.

UNIT V: Enzymes (15 hours)

Enzymes- Concept, Definition, Nature, Active site, Properties, Classification, Physico- Chemical properties. Factors affecting the enzyme synthesis and activity. Enzyme kinetics. Allosterism – Determination of Michaelis Menten constant – Factors affecting Km Value – Mode of Enzyme action (Lock and Key model and Induced fit model)- Coenzymes – Cofactors – Isozymes and Inhibitors. Vitamins - Water and fat soluble vitamins and functions.

TEXT BOOKS

1. Jain. J.L. *Fundamental of Biochemistry*, S. Chand & company Ltd, New Delhi, 2012.
2. Kanai L. Mukherjee, *Medical Laboratory Technology – A procedure manual for routine diagnosis tests*, Tata McGraw – Hill Publishing Co., Ltd., New Delhi. Vol.I-III,2014.
3. Palanivelu, P. *Analytical Biochemistry and Separation Techniques*, Second edn, 2001.
4. Santhyanarayana. U. *Essentials of Biochemistry*. (1st Edition) Books and Allied Ltd., Kolkata, 2002.

REFERENCE BOOKS:

1. Deb A.C. *Concepts of Biochemistry*. (7st Education), Books and Allied (P) Ltd., Kolkata, 1999.
2. Donald Voet and Judith Voet. *Biochemistry*. John Wiley and Sons, New York, 1990.
3. Georges N. Cohen. *Microbial Biochemistry*-2nd Edition - Springer, Feb 2, Science, 2011.
4. Lehninger. *Principle of Biochemistry*. 3rd editions by Nelson and Cox (Worth), 2009.
5. Stryer, L. *Biochemistry*. Ed. W.H. Freeman and company, New York, 1995.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Discuss the fundamental concepts of biomolecules.	1,2	Understanding
CO-2	Interpret structure, classification and function of lipids.	3,5	Applying
CO-3	Categorize the peptide bond, formation and its types.	3,4	Analyzing
CO-4	Formulate the structure of nucleosides, nucleotides.	2,5	Evaluating
CO-5	Measure and determine Michaelis Menton constant.	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	21PCMB21	MICROBIAL BIOCHEMISTRY				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓		✓		✓	✓
CO-2	✓	✓			✓	✓	✓			✓
CO-3	✓		✓	✓	✓	✓		✓	✓	✓
CO-4		✓	✓	✓	✓	✓	✓			✓
CO-5	✓	✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) =37 Relationship = High									

SEMESTER – II

Course Title	MICROBIAL PHYSIOLOGY AND METABOLISM
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB22
Course Type	DSC-V
Creditss	4
Marks	100

General Objective:

The course creates knowledge on physiology, metabolism, nutritional requirements, microbial photosynthesis and bioluminescence of microorganisms.

Course Objectives:

CO No.	The learners will be able to
CO-1	Relate the basic knowledge in Respiratory metabolism.
CO-2	Arrange about Classification of Microbial metabolism.
CO-3	Construct the microbial growth rate.
CO-4	Compare types of microbial photosynthesis.
CO-5	Review the mechanisms of Nutritional uptake.

Unit I: Nutrients uptake of cell (15 hours)

Nutritional requirements of major groups of microbes (bacteria & fungi): Nutritional uptake; transport across the membranes and cell wall (diffusion, passive diffusion, active transport, group translocation iron uptake, Proton Motive Force, and PTS) Role of permeases in transport. Transport of aminoacids, inorganic ions in microorganisms and their mechanisms.

Unit II: Microbial Respiratory metabolism (15 hours)

Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, Glycolysis, Embden Meyerhoff pathway, Kreb's cycle, Entner-Duodoroff pathway, Phosphoketolase pathway; Pentose phosphate pathway; Electron transport chain; phosphorylation; Oxidative and Substrate level phosphorylation, Gluconeogenesis, Glyoxylate cycle, Fermentation of Carbohydrates, Homo and Hetero Lactic fermentation.

Unit III: Biosynthesis of essential compounds (15 hours)

Microbial metabolism: Anabolism, Catabolism - Biosynthesis of Essential amino acid, Sulphur metabolism, Biosynthesis of purines and

pyrimidines. Lipid metabolism: Biosynthesis of fatty acids and phospholipids. Beta (palmitic acid), Alpha, omega and peroxisomal oxidation of fatty acids and their energetics. Oxidation of odd chain fatty acids.

Unit IV: Microbial Growth (15 hours)

Measurement of growth (biomass, turbidity, dry weight and protein content); Physical and Chemical factors affecting microbial growth; control of microbes by Physical and Chemical agents. Microbial Metabolites- Primary and Secondary. Energy from inorganic compounds

Unit V: Photosynthesis (15 hours)

Introduction : Absorption of light, photosynthetic and accessory pigments (Chlorophyll, Bacteriochlorophyll, Carotenoides, Phycobilliproteins); Oxygenic and Anoxygenic photosynthesis in prokaryotes, Calvin cycle; effect of Light, Temperature, pH and CO₂ on photosynthesis; Photosynthetic yield and Photorespiration. Bioluminescence: mechanism and application.

TEXT BOOKS:

1. Dubey, R.C. and Maheshwari, D.K. *A Text Book of Microbiology*, Revised Edition, S. Chand & Company Ltd., New Delhi, 2010.
2. Potter G. W. H. and Potter, Geoffrey W. *Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques*, Kluwer Academic Publishers, 1995.
3. Talaro K. P. and Talaro A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College, 2006.

REFERENCE BOOKS:

1. Berg J. M., Tymoczko J. L. and Stryer, L. *Biochemistry*, 6th Ed. W.H. Freeman and Company, New York, 2007.
2. Joanne Willey and Kathleen Sandman., *Principles of Microbiology*, IInd Ed., McGraw Hill, 2007.
3. Nelson D. and Cox M. M. *Principles of Biochemistry*, 5th Ed. W.H. Freeman and Company, New York, 2009.
4. Willey J., Sherwood L. and Woolverton C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill. 1997.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize the nutritional types, mode of intake of nutrients and metabolic activity of microorganisms.	2,4	Understanding
CO-2	Illustrate the study of photosynthetic yield and photorespiration.	3,5	Applying
CO-3	Relate various theories on microbial metabolism and pathways.	1,2	Analysing
CO-4	Assemble the biosynthesis of purines and pyrimidines.	3,5	Evaluating
CO-5	Value the electron transport chain.	1,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	21PCMB22	MICROBIAL PHYSIOLOGY AND METABOLISM				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	CO-1	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CO-2	✓	✓		✓	✓	✓		✓	✓
	CO-3	✓		✓	✓	✓		✓	✓	✓
	CO-4		✓		✓	✓	✓			✓
	CO-5	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Number of matches (✓) = 40 Relationship = High									

SEMESTER – II

Course Title	MOLECULAR BIOLOGY AND GENETIC ENGINEERING
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB23
Course Type	DSC-VI
Creditss	4
Marks	100

General Objective:

The course teaches the concept of genetic materials, molecular mechanism involved in transcription, translation and also helps to understand the significance of genetic engineering.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the experimental evidences in genetic material.
CO-2	Signify central dogma of gene action.
CO-3	Categorize the molecular mechanisms involved in transcription and translation.
CO-4	Collect the concept of operon mechanism.
CO-5	Score the concepts in genetic engineering.

Unit I: Deoxyribonucleic Acid (15 hours)

DNA as Genetic material - Oswald Avery, Colin MacLeod, Maclyn McCarty, Frederick Griffith, Watson and Crick model; DNA; Types of DNA (A, B, Z); Models of DNA replication and experimental evidences - Semi-conservative, Conservative, Dispersive. Various modes of replication - d-loop replication and rolling circle; DNA replication in prokaryotes and eukaryotes - initiation, elongation, termination. Differences between prokaryotic and Eukaryotic DNA replications.

Unit II: Ribonucleic Acid (15 hours)

RNA types and Structure - mRNA, rRNA, tRNA. Transcription – initiation, elongation & termination. Types of RNA polymerase. Inhibitors of RNA synthesis, Post transcriptional modification (RNA processing) - capping, polyadenylation and splicing – spliceosome, Alternative splicing; Difference between prokaryotic and Eukaryotic transcription; Translation - steps involved, Post translational modification of proteins, inhibitors of translational process. Salient features of genetic code.

Unit III: Gene operon (15 hours)

Regulation of Gene Expression - Transcriptional control- promoters, terminators, attenuators. Regulation of gene expression in prokaryotes; operon concept; positive regulation in *E. coli* (Arabinose operon) and negative regulation in *E. coli* (lac operon), inducers and repressors, regulation by attenuation (trp operon).

Unit IV: Genetic Engineering (15 hours)

Genetic Engineering – Basics of r-DNA technology: Enzymes employed - DNA ligase, DNA polymerase, DNase, Klenow fragment, reverse transcriptase, terminal transcriptase, exonuclease, restriction endonuclease, nuclease, Ribonuclease-H, alkaline phosphatase, polynucleotide kinase and dephosphatases.

Unit V: Genetic recombination (15 hours)

Genetic recombination processes - Conjugation, Transformation, Transduction; Role of rec proteins in homologous recombination. Conjugation - Discovery and Mechanism; F⁺, F⁻ and Hfr cells; F⁺ and F⁻ and Hfr and F⁻ genetic crosses. Sexduction (F⁻-duction: F' x F⁻), conjugational transfer of colicinogenic and resistance transfer factors; Mechanism of Transformation; Transduction – mechanism and types – generalized, specialized and lateral.

TEXT BOOKS

1. Gupta. PK *A text book of Molecular biology*, Rastogi Publication, 2018.
2. Kishore R. Pawar, Ashok E. Desai, B. M. Deore., *A Book of Genetics and Molecular biology*, Revised Edition, Nirali Prakashan Publication Ltd., New Delhi, 2010.
3. Lizabeth A. Allison. *Fundamental Molecular biology*, Revised Edition, Blackwell publishing company, Austria, 2007.

REFERENCE BOOKS:

1. Brown T.A. *Gene Cloning*. Blackwell Publishing, 2006.
2. Harvey Lodish , Arnold Berk , Chris A. Kaiser, Monty Krieger , Hidde Ploegh, Angelika Amon, Matthew P. Scott. *Molecular Cell Biology*, Recent edition, WH Freeman publishers, 2005.
3. Lewin. *Gene VII*. Oxford University Press, 2000.
4. Nicholl D. S. T. *An Introduction to Genetic Engineering*, Cambridge University Press, 2008.

5. Old and Primrose. *Principles of Gene Manipulation*. Blackwell Scientific Publication, 2001.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Discuss molecular cell biology.	1,4	Understanding
CO-2	Relate the structure and function of DNA and RNA.	1,2	Applying
CO-3	Solve central cell biological processes	3,5	Analyzing
CO-4	Formulate the regulation of operons.	1,4	Evaluating
CO-5	Rate the study of enzymes and application of recombinant DNA technology.	3,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	21PCMB23	MOLECULAR BIOLOGY AND GENETIC ENGINEERING				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓		✓	✓		✓
CO-2	✓		✓	✓	✓	✓	✓	✓		✓
CO-3	✓	✓		✓	✓	✓			✓	✓
CO-4		✓	✓	✓	✓	✓		✓	✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) =39 Relationship = High									

SEMESTER – II

Course Title	VIROLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB21A
Course Type	DSE-II-A
Creditss	4
Marks	100

General Objective:

The course able to insights on history, development, classification, taxonomy, replication of virus also familiarize with the culture methods and assay of virus.

Course Objectives:

CO No.	The learners will be able to
CO-1	Discuss the Classification and taxonomy of viruses.
CO-2	Demonstrate the methods of Cultivation and Assay of virus.
CO-3	Distinguish the plant virus classification, transmission and Impacts.
CO-4	Compose knowledge about human and animal viruses.
CO-5	Write about different types of vaccines.

UNIT I: Basics of Virology (15 hours)

History, brief outline and discovery of viruses. Classification and taxonomy of viruses - based on host, nucleic acids and structure; Evolution of Viruses. Bacterial Viruses – taxonomy of bacterial viruses (ØX 174; M 13; Lambda and Mu). DNA and RNA containing Viruses – Structure – Replication (Lytic and Lysogeny). Viroids and prions.

UNIT II: Cultivation of viruses (15 hours)

Growth of viruses in chick embryonated egg, in experimental animals and in cell cultures-primary, secondary, Diploid and continuous cell culture. Susceptible cell lines. Assay of viruses: physical and chemical methods of assay, (protein, nucleic acid, radioactivity tracers, electron microscopy, infectivity assay of animal virus (plaque method, pock counting, end point method) and infectivity assay of plant viruses.

UNIT III: Plant viruses (15 hours)

Plant viruses - Classification, Transmission of Plant Viruses and Viroids (Vegetative Propagules, Seed Pollen Contact and Mechanical, Water, Vectors, Arthropod vectors). Impact of virus and viroid Diseases on Crop Yields (Spice Crops, Bio Fuel Crops, Edible Oil Seed Crops). Tobacco Mosaic viruses (TMV). Cauliflower mosaic virus (CaMV). Cynophages, Mycophages.

UNIT IV: Human and Animal Viruses (15 hours)

Ultra structure of major human and animal viruses: Picorna virus: Polio disease, Herpes virus: Herpes Simplex virus, Human Papiloma virus: Cervical Cancer, Toga virus: Chikungunya, Flavivirus: Dengue fever, Retro virus: HIV. Hepatitis B Animal viruses – SV 40, Adeno viruses, Swine flu, Bird flu, Rota Virus.

UNIT: V Control of Viruses and Emerging Viruses (15 hours)

Strategies of anti-viral agents and viral vaccination. Antiviral chemotherapy and agents: Acyclovir, Ganciclovir, Ribavirin, Zidovudine and Lamirudine. Vaccination: Types, protein and peptides vaccines, DNA vaccines. Emerging viruses: Nipah henipavirus, SARS (Corona), Phage therapy. Biosafety and containment facility in virology lab.

Text Books:

1. Biswas and Biswas. *An Introduction to Viruses*, 1995.
2. Christopher J. Burrell, Colin R. Howard, Frederick A. Murphy. *Fenner and White's Medical Virology*. Academic Press, 2016.
3. Dimmock, N. J., A. J. Easton, K. N. Leppard. *Introduction to Modern Virology*, 6th ed. Blackwell Scientific Publ, 2007.
4. Khan J.A, J. Dijkstra. *Plant Viruses as molecular pathogens*. CBS publishers and Distributors, New Delhi, 2000.
5. Waginer and M. Hewlett. *Basic Virology*, Blackwell Science Publ, 1999.

Reference Books:

1. Dimmock N.J, Primrose S.B. *Introduction to Modern Virology*, IV edition. Blackwell Scientific Publications, Oxford, 1994.
2. Fields. B.N. Fields, D.M. Knipe, B. Roizman and S.E. Straus, *Virology* Vol I and II Lippincott-Raven, Philadelphia, PA, 2007.
3. Frankel Conrat et al, *Virology*, 3rd ed. Prentice Hall, 1994.
4. Prescott L.M., Harley J.P. and Klein D.A. *Microbiology* (7th edition). McGraw Hill, New York, 2008.
5. Roger Hull. *Mathew's Plant Virology*, (4th edition). Academic press. A Harcourt Science and Technology company, New York, 2002.
6. Roger Hull. *Plant Virology*, 5th Edition. Academic Press, 2013.

Course Outcomes

CO. No.	Upon the completion of the course, the students will be able to	PSO addressed	Cognitive level
CO1	Review the fundamental concepts of Virology.	1,2	Understanding
CO2	Interpret the isolation and purification of viruses	2,4	Applying
CO3	Experiment the quantitative assay and immunodiagnosis of virus.	3,4	Analyzing
CO4	Manage animal and plant viruses.	3,5	Evaluating
CO5	Revise the Strategies of anti-viral agents and viral vaccination.	5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	21PEMB21A	VIROLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓	✓	✓	✓		✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓	✓		✓	
CO-5	✓	✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) =38									

SEMESTER – II

Course Title	FOOD SAFETY, QUALITY CONTROL AND SENSORY EVALUATION
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB21B
Course Type	DSE-II-B
Creditss	4
Marks	100

General Objective:

To introduce the principles, methods of Food Quality Control, assurance, selection of panel lists for sensory evaluation and Quality Management System.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the principles of Food hazards and HACCP
CO-2	Interpret the Physical, chemical and biological parameter for food.
CO-3	Analyze the Quality and different standards of foods.
CO-4	Evaluate the food based on sensory evaluation.
CO-5	Create an awareness sanitation and hygiene in quality assurance in different food industries.

UNIT-1: Food safety (12 hours)

Food safety: Characterization and risk analysis- Food hazards: Physical, Chemical and biological systems for food safety. Hazard Analysis Critical Control Point (HACCP) and its implementation.

UNIT-II: Physico chemical methods for food analysis (12 hours)

Physico chemical methods for food analysis - Moisture and Total solids, Carbohydrates, Proteins, Fats, Fiber, Ash and its types, Minerals, Vitamins. Enzymatic methods. Biological methods of food analysis - Standard plate count; Plate loop method; Spiral plate; Droplet technique; Dye reduction; Catalase test and ELISA. Testing of food for organisms such as *B. cereus*, *C. botulinum*, *E. coli*, *L. monocytogenes*, *S.aureus*, *Salmonella* and *Shigella*.

UNIT-III: Quality Assurance (12 hours)

Theoretical and practical considerations, description of different systems: GAP, GMP,TQM,ISO. Indian food standards- Voluntary and

Obligatory standards (PFA,FPO,MMPO,AGMARK etc.) Codex alimentarius, Worldwide food safety issues.

UNIT-IV: Sensory evaluation (12 hours)

Requirements and methods. Sensory parameters: Colour, flavour, texture, taste, aroma, general acceptability. Subjective and Objective test of sensory parameters. (Differential test, Descriptive test, Rating test, Sensitivity threshold test).

UNIT V: Clean In Place (CIP) (12 hours)

Different sanitizers and detergents- Sanitation and hygiene in quality assurance in different food industries (Fruits and vegetables, Meat, Milk, Cereal Based).Cost of Quality, Supplier development.

TEXT BOOKS

1. Amerine MA, Pangborn RM & Rosslos EB. 1965. Principles of Sensory Evaluation of Food. Academic Press.
2. Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Furia TE.1980. Regulatory status of Direct Food Additives. CRC Press.
4. Ranganna S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill.
5. Export/Import policy by Govt. of India.

REFERENCE BOOKS:

1. Jellinek G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
2. Krammer A & Twigg BA.1973. Quality Control in Food Industry. Vol. I, II. AVI Publ.
3. Macrae R, Roloson R & Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XVI. Academic Press.
4. Piggot J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyze the characterization of food and risk factors.	1,4	Analyzing
CO-2	Infer the modern techniques in food analysis.	3,5	Understanding
CO-3	Determine the out sensory evaluation of a newly developed product.	1,2	Evaluating
CO-4	Classify the sanitation and hygiene in quality assurance in different food industries	4,5	Analyzing
CO-5	Develop the knowledge in critical control points of different existing production processes.	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEMB21B	FOOD SAFETY, QUALITY CONTROL AND SENSORY EVALUATION				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓		✓		✓	✓	✓
CO-2	✓	✓		✓	✓		✓	✓		✓
CO-3	✓	✓			✓	✓	✓		✓	
CO-4		✓		✓	✓		✓	✓		✓
CO-5	✓	✓	✓	✓	✓	✓		✓	✓	✓
	Number of matches (✓) = 35 Relationship = High									

SEMESTER – II

Course Title	FERMENTATION TECHNOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB21C
Course Type	DSE-II-C
Creditss	4
Marks	100

General Objective:

To introduce the principles of fermentation and various technologies.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the principles and various types of Fermentor
CO-2	Interpret the different online monitoring techniques in fermentation process.
CO-3	Analyze the medium formulation in various fermentation
CO-4	Evaluate the role of microbes in fermentation products
CO-5	Create an awareness in current fermentation technology.

UNIT -I: Introduction to fermentation technology (12 hours)

Fermentation, principle of fermentation, Fermentation –Types, batch ,fed batch , continuous fermentation. Factors that influences fermentation process, advantage and disadvantage of fermentation.

UNIT –II: Bioreactors (12 hours)

Definition of fermentor or bioreactors – Design and construction of fermentor , sterilization of fermentor, Types of fermentors- Air lift fermentor, Continuous stirred tank fermentors, Packed bed fermentors, Bubble column fermentors and Fluidized bed fermenters

UNIT-III: Microorganisms used in fermentation technology (12 hours)

Microorganisms used in fermentation technology , medium used in fermentation technology, Medium formulation,(carbon sources ,energy sources, nitrogen sources, PH, buffers, minerals, water, oxygen requirements, antifoams).

UNIT-IV: Food fermentation (12 hours)

Definition of food fermentation – microbes used in food fermentation – fermented food products – bread , vinegar, wine , fermented milk products and fermented meat products.

UNIT-V: Application of fermentation technology (12 hours)

Uses and Application of fermentation technology, Current development of fermentation technology, Fermentation economics.

TEXT BOOKS:

1. Dubey, R. C. A. *Text Book of Biotechnology*. (4th Edition) S. Chand & Company Limited, New Delhi, 2007.
2. Gupta, P.K. *Elements of Biotechnology*. Rastogi Publications, Meerut, 2003.
3. Jogdand, S. N. *Gene Biotechnology*; (5th Edition) Himalaya Publishing House, 2000.
4. Reed. G. Prescott and Dunn. *Industrial Microbiology*. Macmillian Publication., 1982.

REFERENCE BOOKS:

1. Hugo W. B and Russell A.D. *Pharmaceutical Microbiology*. Sixth Edition, The Black well Science Ltd., UK, 1998.
2. Stanbury., P.F.A. Whitaker and Hall. *Principles of Fermentation Technology*, 2002.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyse the Fermentation process and principles.	1,3	Analyzing
CO-2	Infer the design and construction of fermentor.	3,5	Understanding
CO-3	Determine the various parameter require for fermentation process.	1,2	Evaluating
CO-4	Classify the different fermented food products.	4,5	Analyzing
CO-5	Develop the knowledge in Fermentation economics.	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEMB21C	FERMENTATION TECHNOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓	✓		✓	✓	✓
CO-2	✓	✓	✓		✓		✓	✓		✓
CO-3	✓	✓		✓		✓			✓	
CO-4		✓	✓		✓		✓	✓		✓
CO-5	✓	✓	✓	✓	✓	✓	✓		✓	✓
	Number of matches (✓) = 36 Relationship = High									

SEMESTER – II

Course Title	TECHNIQUES IN MICROBIAL PHYSIOLOGY AND VIROLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB2P1
Course Type	Practical-III
Creditss	2
Marks	100/2

General Objective:

The course helps to Hands on experience in Biochemical and to determine the bacterial growth curve and thermal death time and also the Biochemical identification of bacteria.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify coli phage from sewage.
CO-2	Practice and observation of Virus infected Plant.
CO-3	Experiment of Virus-Chick Embryo Method.
CO-4	Combine the Bacterial growth curve and thermal death time.
CO-5	Choose the Biochemical tests for different Bacteria.

1. Bacterial Growth curve (Turbidity method).
2. Effect of pH, Temperature and Oxygen on bacterial growth.
3. Thermal Death Time
4. Biochemical tests for Identification of Bacteria-
 - a) IMViC
 - b) Triple sugar iron test
 - c) H₂S test
 - a) Urease test
 - b) Catalase test
 - c) Nitrate reduction
 - d) Oxidase Test
5. Carbohydrate fermentation test- a) Glucose, b) Lactose
6. Production of Extra cellular enzyme by microorganisms:

- a) Starch hydrolysis
 - b) Casein hydrolysis
 - c) Gelatin hydrolysis
 - d) Lipid hydrolysis
7. Isolation of coli phage from sewage.
 8. Study and observation of Virus infected Plant (Leaf).
 9. Cultivation of Virus-Chick Embryo Method (Demonstration).

REFERENCE BOOKS:

1. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*, 10th Edition. Pearson education Limited, 2014.
2. Kannan. *Laboratory Manual in General Microbiology*, Palani Paramount Publications, Palani, 1996.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Restate the knowledge on phage titration.	1,3	Understanding
CO-2	Practise the various stages of bacterial growth curve.	2,3	Applying
CO-3	Examine the biochemical identification of bacteria.	4,5	Analyzing
CO-4	Compare the production of enzymes using various hydrolysis.	1,4	Evaluating
CO-5	Compose the physiological requirements for bacterial growth.	2,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
II	21PCMB2P1	TECHNIQUES IN MICROBIAL PHYSIOLOGY AND VIROLOGY				60	2			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓		✓	✓		✓
CO-2	✓		✓	✓	✓	✓	✓			✓
CO-3		✓		✓	✓	✓	✓	✓	✓	✓
CO-4		✓	✓	✓	✓	✓		✓	✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) =38 Relationship = High									

SEMESTER – II

Course Title	TECHNIQUES IN BIOCHEMISTRY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB2P2
Course Type	Practical-IV
Creditss	2
Marks	100/2

General Objective:

The course performs the practical knowledge on estimation of various types of biomolecules and also chromatographic techniques.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify Carbohydrates and Lipids.
CO-2	Examine amino acids and proteins.
CO-3	Test the proteins by SDS –PAGE.
CO-4	Design the Mutagenesis.
CO-5	Rate to Know the Genetic Techniques.

1. Estimation of Proteins by Lowry's method.
2. Estimation of Sugar by Anthrone method.
3. Estimation of Ascorbic Acid.
4. Separation of amino acid by paper chromatography.
5. Separation of amino acid by thin layer chromatography.
6. Separation of Protein by SDS- PAGE.
7. Induced Mutagenesis – UV
8. PCR (DEMO).
9. Restriction Enzyme digestion and ligation of DNA
10. Conjugation.
11. Transformation.
12. Replica plate method- Auxotrophs.
13. Gradient plate technique.

REFERENCE BOOKS:

1. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*, 10th Edition. Pearson education Limited, 2014.
2. Kannan. *Laboratory Manual in General Microbiology*, Palani Paramount Publications, Palani, 1996.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Report the protein by Lowry's method.	1,3	Understanding
CO-2	Examine the sugar by using Anthrone method.	2,3	Applying
CO-3	Relate the techniques in separation of amino acid by paper and thin chromatography.	2,5	Analyzing
CO-4	Compose the Separation of Protein by SDS- PAGE.	4,5	Evaluating
CO-5	Convince about PCR.	3,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
II	21PCMB2P2	TECHNIQUES IN BIOCHEMISTRY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING					60	2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-2	✓	✓		✓	✓	✓	✓			✓
CO-3		✓	✓	✓	✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓	✓		✓	✓
CO-5	✓	✓	✓		✓		✓	✓	✓	✓
	Number of matches (✓) =39 Relationship = High									

SEMESTER – II

Course Title	SWAYAM – NPTEL ONLINE CERTIFICATION COURSE
Total Hrs	30
Hrs/Week	2
Sub.Code	21PSMB21
Course Type	SEC
Creditss	2
Marks	100/2

SWAYAM-NPTEL ONLINE CERTIFICATION COURSES

GUIDELINES AND INSTRUCTIONS

1. National Programme on Technology Enhanced Learning (NPTEL) provides e-learning through online web and video courses in Engineering, Science and Humanities streams through its portal <https://swayam.gov.in/ncdetails/NPTEL>.
2. Enrollment to all the courses is FREE.
3. Enrollment to courses and Examination Registration can be done ONLINE only. The link is available on NPTEL Website <http://nptel.ac.in/>
4. SWAYAM– NPTEL Online Certification Courses are mandated for the students in the PG Programmes from the Academic year 2021-2022.
5. Candidates must have completed Examination Registration successfully within the prescribed time to receive hall tickets and to write examinations.
6. Any Eight – Week, Two-Credit Course in any discipline to offer for two hours a week be chosen by the respective Departments in the second semester of the Postgraduate Programmes.
7. The SWAYAM–NPTEL Online Certification Courses offered during the December – April Semester be chosen by the Departments. The courses may be handled by the Department Mentor or by any teacher in the respective Departments.
8. The allocation of marks for the online examination conducted by the respective IITs is 25:75 for each course.

9. A candidate should obtain a minimum of 40 marks on 100 marks (a minimum of 10 marks for Assignment and 30 marks in the final examination) to pass the Online Courses.
10. If a student fails in the Online Examination conducted by the respective IITs he/she would be permitted to write a Supplementary Examination for 75 marks by the Controller of Examinations of our College.
11. Those who registered for the Online Courses, obtained Assignment marks, appeared for the Online Examination and failed in the courses alone are eligible to apply for the Supplementary Examinations conducted by the College.
12. If a candidate fails in the Supplementary Examinations conducted by the College, the norms followed for taking an Arrear Examination will be adopted.
13. A provision is given to candidates to reappear for Supplementary/Arrear Examinations in the same semester to facilitate them to receive their Degrees.
14. The Question paper in Multiple Choice Question Pattern for 75 marks shall be framed by the respective faculty/ by an External Examiner for conducting the Supplementary Examinations.
15. The Supplementary Examinations would be conducted for three hours.
16. Course Completion Certificate will not be issued by the respective IITs for the candidates who clear the Online Courses through the Supplementary Examinations conducted by the College. The two credits the candidate earns, if passed, would be added in the Consolidated Statement of Marks issued by the Controller of Examinations.

SEMESTER – III

Course Title	IMMUNOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB31
Course Type	DSC-VII
Creditss	4
Marks	100

General Objective:

The course helps to understand the fundamentals of Immunology, the importance of immunization and various diagnostic methods.

Course Objectives:

CO No.	The learners will be able to
CO-1	Summarize the significance of immunology.
CO-2	Relate the different types antigens.
CO-3	Classify the Immunoglobulins.
CO-4	Plan about Vaccines and Immunization.
CO-5	Compare the knowledge on different pathways of complement system.

Unit I: Immune System (15 hours)

Historical background and scope of immunology -Introduction to the immune system, Innate immunity- anatomic, physiological, phagocytic & inflammatory barriers. Adaptive immunity - natural and artificial immunity. Cells involved in immune response: lymphoid lineage (producing B and T lymphocytes) and Myeloidlineage (phagocytes: macrophages, neutrophils and eosinophils, Auxillary cells, basophils, mast cells and platelets). Organs involved in immune system: primary and secondary lymphoid organs.

Unit II: Antigens and Immunoglobulins (15 hours)

Antigens: Types and properties of antigens- Haptens, Super antigens and clusters of differentiation molecules (CDs); Preparation of antigens, Processing and presentation of antigens. Immunoglobulins: Structure, Types, Functions of immunoglobulins, & genetic diversity of immunoglobulins, catalytic antibodies. B-cell biology and T-cell biology (major his to compatibility complex (MHC) molecules) HLA and H-2 systems.

Unit III: Immunization (15 hours)

Vaccines and Immunization: Types of Vaccines (DNA, Recombinant DNA, Synthetic Peptide and Multivalent vaccine) and their characteristics, Immunization of test animals, Hyperimmunization, Prophylactic immunization. Immune disorders, Hypersensitivities, Autoimmune diseases, Transplantation (tissue) Rejection, Immunodeficiencies.

Unit IV: Complement System (15 hours)

Complement: Classical, alternative and lectin pathway of complement activation, Regulation of complement system, biological consequence of complement activation. Cytokines, Interferons, TNF, interleukins (1-16), Hematopoietins & Chemokines, Regulation of immune response. Tumor immunology - tumour specific antigen - immunodiagnosis of tumors.

Unit V: Immunological reactions (15 hours)

Clinical Microbiology: Clinical sample collection and serological testing for important pathogens (bacterial, viral and fungal). Antigen-Antibody reactions in vitro; agglutination reactions (Widal, Haemagglutination), Precipitation reactions (Immunodiffusion, Immunoelectrophoretic method), Immunoblotting, ELISA, RIA, fluorescence immunosorbent assay, immunoelectronmicroscopy Hybridoma technology, applications of monoclonal antibodies.

TEXT BOOKS:

1. Ananthanarayanan, R and Panicker C.K. *Text Book of Microbiology*, 7th Edition. Oriental Longman Publications, Hyderabad, 2005.
2. Annadurai, B. *A Textbook of Immunology and Immunotechnology*, 1st Edition. S Chand and Co. Ltd., New Delhi, 2008.
3. Greenwood, D. *Medical Microbiology*, 4th Ed., I.K. International. 2007.
4. Murray P.R., Tenover F.C., and Tenover F.C., and Tenover F.C. *Clinical Microbiology*, ASM Press. 2007.
5. Rao. C.V., *Immunology*, 2nd Edition, Narosa Publishing House Pvt. Ltd., 2012.

REFERENCE BOOKS

1. Claus, D. *Immunology- Understanding of Immune System*. Wiley - Liss, New York. 1996.
2. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. *Kuby Immunology*. Freeman and Co. New York, 2007.
3. Riott, I. M. *Essentials of Immunology*. Blackwell Scientific Publishers, London, 1998.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Discuss the physical, chemical and physiological components of the immune system.	1,3	Understanding
CO-2	Demonstrate the Major Histocompatibility Complex (MHC).	2,3	Applying
CO-3	Classify the essential elements of the immunization and immune disorder.	4,5	Analyzing
CO-4	Combine different types of complement pathway.	4	Evaluating
CO-5	Revise the important serological tests.	3,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PCMB31	IMMUNOLOGY				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓	✓	✓
CO-2	✓	✓	✓		✓	✓	✓		✓	✓
CO-3	✓			✓	✓	✓		✓	✓	✓
CO-4		✓	✓	✓	✓	✓	✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓		✓
	Number of matches (✓) = 38 Relationship = High									

SEMESTER – III

Course Title	MEDICAL MICROBIOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB32
Course Type	DSC-VIII
Creditss	4
Marks	100

General Objective:

The course helps to comprehend the collection of clinical samples and laboratory diagnosis of various viral diseases and antimicrobial agents.

Course Objectives:

CO No.	The learners will be able to
CO-1	Explain the Historical developments in medical microbiology.
CO-2	Apply their knowledge on major human diseases.
CO-3	Analyse clinical sample collections and diagnosis.
CO-4	Manage about bacterial, fungal and viral human pathogens.
CO-5	Assess the diseases caused by intestinal and urogenital protozoa.

Unit I: Basics in Medical Microbiology (15 hours)

Historical developments in medical microbiology, Normal flora of human body, Role of the resident flora, Collection of clinical samples and laboratory diagnosis of important bacterial infections, Pathogenic microorganisms. Brief account of major air, water and soilborne diseases of microbial origin and their preventive and control measures.

Unit II: Bacteriology (15 hours)

Introduction- Important human diseases caused by *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Bacillus*, *Corynebacterium*, *Clostridium*, *Pseudomonas*, *Yersinia*, *Haemophilus*, *Mycobacterium*, Antibacterial agents and susceptibility test, Bacterial vaccines.

Unit III: Virology (15 hours)

Introduction - Collection of clinical samples and laboratory diagnosis of important viral diseases - Mumps, Measles, Influenza, Adenovirus, Enterovirus, Rhinovirus, Poxvirus, Hepatitis virus; Herpesvirus, AIDS, Antiviral drugs, Viral vaccines, Interferons, Tumorviruses, antiviral agents and susceptibility test.

Unit IV: Mycology (15 hours)

Introduction - Classification of medically relevant fungi, Collection of clinical samples and laboratory diagnosis of important human fungal diseases : Candidiasis, Dermatophytosis, Aspergillosis, Otomycosis, Cutaneous and subcutaneous mycoses, Systemic mycoses, Opportunistic mycoses, Antifungal agents (specific to disease to included in course) and their susceptibility test.

Unit V: Parasitology (15 hours)

Introduction - Important diseases caused by intestinal and urogenital protozoa: *Entamoeba*, *Giardia*, *Trichomonas*. Blood and tissue protozoa; *Plasmodium*, *Trypanosoma*, *Leishmania*, *Cestodes*, *Taenia*, *Trematodes*, *Schistosoma*, *Paragonimus*, Nematodes: *Ascaris*, *Ancylostoma*, *Necator*-laboratory diagnosis, treatment and prevention, antiparasitic agent and susceptibility test.

TEXT BOOKS:

1. Greenwood, D. *Medical Microbiology*, 4th Ed., I.K. International, 2007.
2. Murray P.R., Tenover F.C., and Tenover F.C., and Tenover F.C. *Clinical Microbiology*, ASM Press, 2007.
3. Talaro K. P. and Talaro, A. *Foundations in Microbiology* (6th Ed.), McGraw-Hill College, Dimensi, 2006.

REFERENCE BOOKS:

1. Atlas, R. M. *Principles of Microbiology*, II Ed., McGraw Hill, 1997.
2. Harvey, R.A., Champe, P.C. and Fisher, B.D. *Lippincott's Illustrated Reviews : Microbiology*. 2009.
3. Lippincott Williams and Wilkins, New Delhi/New York. 2006.
4. Nester, E. W., Anderson, D. G. and Nester, M. T. *Microbiology: A Human Perspective*, McGraw Hill, 2006.
5. Willey, J., Sherwood, L. and Woolverton, C. *Prescott/Harley/Klein's Microbiology*, McGraw Hill, 2007.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize the role of normal flora in human body.	1,3	Understanding
CO-2	Interpret various clinically important bacteria and their mode of infection.	3,5	Applying
CO-3	Distinguish the comprehensive theoretical knowledge of pathogenic viruses.	2,4	Analyzing
CO-4	Evaluate the epidemiology and lab diagnosis	1,5	Evaluating
CO-5	Organize the different causative agents of the infectious diseases to find new.	2,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
III	21PCMB32	MEDICAL MICROBIOLOGY					75	4		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-2	✓	✓			✓		✓		✓	✓
CO-3	✓	✓	✓		✓	✓		✓		✓
CO-4		✓		✓	✓	✓	✓		✓	✓
CO-5	✓			✓	✓	✓	✓		✓	✓
	Number of matches (✓) =36 Relationship = High									

SEMESTER – III

Course Title	RESEARCH METHODOLOGY AND BIOSTATISTICS
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB33
Course Type	DSC -IX
Creditss	4
Marks	100

General Objective:

The course creates knowledge in writing research articles and paves a way to interpret the statistical results.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify the various research areas.
CO-2	Practise the Presentation in Seminars and Conferences.
CO-3	Experiment the Research methods in biological sciences.
CO-4	Collect the Basics in Biostatistics.
CO-5	Evaluate the Different forms Measures of central tendency.

UNIT I: Basics of Research (15 hours)

Introduction – importance - identification of research areas. Review of Literature- Research design and experimentation-Preparation of research report. Guidelines for preparing an article -ISSN, ISBN impact factor, citation index, h-index, I-index, Google scholar, Scopus. Computers in biological research-methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

UNIT II: Article Publication (15 hours)

Presentation in Seminars and Conferences - Writing scientific paper- Organization of scientific paper - Importance of title -abstract –key words, Introduction, Materials and methods, Results, Discussion. Acknowledgements and References - Publication in research journals - Standards of Research journals- Peer - Review – Impact factor - Citation index - Preparation of manuscript – Proof correction - Proof correction marks- Method of correcting proof- Writing chapters in books -Preparation of Research proposal and funding agencies – Research fellowships.

UNIT III: Research and Project writing methods (15 hours)

Research-Definition, Objectives, Types and Importance - Research methods in biological sciences - Research process- Literature survey - Sources -Scientific databases- Research report writing - Parts of Thesis and Dissertation -Title, certificate, declaration, acknowledgements, contents, List of tables, figures, plates & abbreviations, Introduction, Review of literature, Materials and methods-Results - Presentation of data - Tables, figures, map, graphs, photographs - Discussion - Summary, Bibliography/ References and Appendix.

UNIT IV: Basics in Biostatistics (15 hours)

Basic definitions and applications Biostatistics - Statistical methods - Basic principles. Variables - measurements, Functions, Limitations and Uses of Statistics. Collection of data primary and Secondary - Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods graphical representation by histogram, polygon, ogive curves and pie diagram.

UNIT V: Measures of central tendency (15 hours)

Mean, Median, Mode, Geometric mean - Merits and Demerits. Measures of dispersion - Range, Standard deviation, standard error, range, Mean deviation, Quartile deviation - Merits and Demerits; Co-efficient of variations. Correlation - Types and methods of Correlation, Regression, Simple Regression equation, Statistical inference - Hypothesis - Simple hypothesis - Student 't' test - Chi square test ANOVA, one and two way classification.

REFERENCE BOOKS:

1. Vijayalakshmi, G. and C. Sivapragasam. *Research Methods (Tips and Techniques)*. MJP Publishers, Chennai, 2008.
2. Gurumani, N. *Research Methodology for Biological Sciences*. MJP Publishers, Chennai, 2006.
3. Ramamurthi and Geetha Bali. *Bioethics and Biosafety*. APH Publishing, New Delhi, 2007.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Report the general laboratory procedures and maintenance of research equipments.	1,2	Understanding
CO-2	Illustrate the techniques of isolation, fractionation and separation of cellular constituents.	4,3	Applying
CO-3	Relate the various spectroscopic techniques.	4,2	Analyzing
CO-4	Evaluate projects using gained knowledge through research and project writing methods.	5,1	Evaluating
CO-5	Prepare and present research papers in seminar, conferences and writing scientific paper in research journals.	5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PCMB33	RESEARCH METHODOLOGY AND BIOSTATISTICS				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓	✓	✓
CO-2	✓	✓		✓	✓	✓	✓		✓	✓
CO-3	✓			✓	✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓	✓			✓
CO-5	✓	✓		✓	✓		✓	✓		✓
	Number of matches (✓) = 36 Relationship = High									

SEMESTER – III

Course Title	QUALITY ASSURANCE IN MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB31A
Course Type	DSE-III-A
Creditss	4
Marks	100

General Objective:

The course helps the learners to cognize of laboratory hazards, quality assessment and disposal of waste.

Course Objectives:

CO No.	The learners will be able to
CO-1	Discuss the good laboratory practices and quality standards.
CO-2	Apply the quality control methodology
CO-3	Test the quality of equipment, chemicals, glass wares and laboratory environment.
CO-4	Construct the Quality assurance.
CO-5	Rate the Ethics of waste Products.

UNIT I: Good Laboratory Practices and Quality standards (12 hours)

Introduction – Management of laboratory hazards and knowledge in First aid procedures. Bioethics –Introduction, Social and ethical issues in Microbial biotechnology. Definition of Biosafety, Biosafety for human health and environment. Quality benchmarking, details of international standards (ISO, GMP, GLP, TGM, VAN, FDA, FSSAI, AGMARK, HACCP and ISI) and fact sheet evaluation.

UNIT II: Quality Control (12 hours)

Introduction and overview – Definition, Designing microbiology laboratory - Quality Control and its Applications. Regulatory Affairs: Regulation, national and international guidelines of Biosafety, rDNA guidelines, Regulatory requirements for drugs and Biologics GLP and GMP.

UNIT III: Quality assessment (12 hours)

Quality assessment of Equipment, Chemicals, Glasswares and Laboratory environment –Variance – Quality control calculations – Quality management – Maintenance of records and reports. International and

National conventions on Microbiotechnology and related areas, WTO guidelines.

UNIT IV: Quality assurance (12 hours)

Quality assurance in Sterilization and Disinfection - Preservation of stock cultures, media and diagnostic kits – Quality control of media and stains. Safety, Responsibilities and Rights: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk – the three mile island and case studies.

UNIT V: Ethics of waste Products (12 hours)

Quality assessment of disposal, decontaminated matters and other biological effluents. Quality management in transportations of cultures. National control of Biological references and standards. Microbial quality control of pharmaceutical products. Global Issues: Environmental ethics - computer ethics and bioterrorisms. Sample code of Ethics.

TEXT BOOKS:

1. Harvey, R.A., Champe, P.C. and Fisher, B.D. *Lippincott's Illustrated Reviews: Microbiology*, 2009.
2. Muherjee, L.K. *Medical Lab Technology* – 3 Volumes; 2001.
3. Rajesh Bhatia and Rattan lallchhpujani. *Quality assurance in Microbiology*, I ed; 1995.

REFERENCE BOOKS:

1. Edmund G Seebauer and Robert L Barry. *Fundamentals of Ethics for Scientists and Engineers*, Oxford University Press, Oxford, 2001.
2. Singh, K. *Intellectual Property Rights on Biotechnology*, BCIL, New Delhi, 2009.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Acquire management skills in laboratory hazards.	1,5	Understanding
CO-2	Sketch a microbiological laboratory.	1,4	Applying
CO-3	Calculate the quality assessment of the equipments, chemicals, glass wares and laboratory environment.	1,3	Analyzing
CO-4	Formulate the preservation of stock cultures, media and diagnostic kits.	3,4	Evaluating
CO-5	Review and judge the quality assessment of disposal, decontaminated matters and other biological effluents.	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PEMB31A	QUALITY ASSURANCE IN MICROBIOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓	✓	✓
CO-2	✓	✓		✓	✓	✓	✓		✓	✓
CO-3	✓		✓		✓	✓		✓	✓	✓
CO-4	✓	✓		✓	✓	✓	✓		✓	✓
CO-5		✓	✓		✓		✓	✓	✓	✓
	Number of matches (✓) =38 Relationship = High									

SEMESTER – III

Course Title	FORENSIC MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB31B
Course Type	DSE-III-B
Creditss	4
Marks	100

General Objective:

To introduce the basic principles and practical applications of Forensic Science.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the organizational Structure of Forensic Science laboratory
CO-2	Interpret the different crime scene and clues.
CO-3	Analyze the strategies forensic psychology
CO-4	Evaluate the fingerprints pattern and formation of ridges
CO-5	Create an awareness in collection, evaluation and tests for identification of forensic samples.

UNIT I: Forensic Science (12 hours)

Definition, Introduction , Basic Principles & Significance, History & Development of Forensic Science in India and World, Organizational Structure of Forensic Science laboratory ,Different divisions and units of Forensic Science Laboratory , Organizational Structure of Forensic Science teaching Institution.

UNIT II: Crime (12 hours)

Crime: - Definition & causation, crime scene, types of crime, processing of crime scene, protection and recording of crime scene, search of physical clues, collection and preservation, packing and forwarding of physical clues to Forensic Science Laboratory. (including photography and sketching)

UNIT III: Forensic Psychology (12 hours)

Basics of Forensic Psychology:- Definition and fundamental concepts of forensic psychology and forensic psychiatry. Psychology and law. Ethical issues in forensic psychology. Assessment of mental competency. Mental disorders and forensic psychology.

UNIT IV: Basics of Fingerprinting (12 hours)

Basics of Fingerprinting:- Introduction and history, with special reference to India. Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns.

UNIT V: Importance of Forensic Science (12 hours)

Forensic Importance of Body fluids :-Common body fluids. Composition and functions of blood. Collection and preservation of blood evidence. Distinction between human and non-human blood. Determination of blood groups. Antigens and antibodies. Forensic characterization of bloodstains. Typing of dried stains. Blood enzymes and proteins. Semen. Forensic significance of semen. Composition, functions and morphology of spermatozoa. Collection, evaluation and tests for identification of semen. Individualization on the basis of semen examination. Composition, functions and forensic significance of saliva, sweat, milk and urine. Tests for their identifications.

TEXT BOOKS:

1. W.G. Eckert and S.H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
2. G.T. Duncan and M.I. Tracey in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
4. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

REFERENCE BOOK

1. Bruce Budowle, Steven Schutzer, Roger Breeze, Microbial Forensics 1st Edition - May 16, (2005)
2. David O. Carter , Jeffery K. Tomberlin , M. Eric Benbow , Jessica L. Metcalf , Forensic Microbiology, Wiley publications, April 2017

3. Tom Bevel , Tom Gardner , David R. Fisher, Techniques of Crime Scene Investigation (Forensic and Police Science),CRC Press, June 2012

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyse the development of forensic units	1,3	Analyzing
CO-2	Infer the processing and preservation of clues	3,4	Understanding
CO-3	Determine the law and ethical issues in forensic science	1,4	Evaluating
CO-4	Classify the different finger print pattern	4,5	Analyzing
CO-5	Develop the knowledge in importance of body fluids	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
I	21PEM31B	FORESENIC MICROBIOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓			✓		✓		✓	✓	✓
CO-2	✓	✓	✓		✓		✓	✓		✓
CO-3	✓	✓		✓		✓	✓		✓	
CO-4		✓	✓		✓	✓	✓	✓	✓	✓
CO-5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Number of matches (✓) = 38 Relationship = High									

SEMESTER – III

Course Title	VETERINARY MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB31C
Course Type	DSE-III-C
Creditss	4
Marks	100

General Objective

Acquired skills on the laboratory identification of disease causing microbes, antibiotic sensitivity testing of microbial etiology for animals and the vaccines available for animal immunization..

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the history and development of microbiology
CO-2	Interpret the physiochemical and biological characteristics of microorganisms
CO-3	Analyze the microbial technique in veterinary microbiology
CO-4	Evaluate the sources of infection in animals.
CO-5	Create awareness about veterinary diseases and prevention.

Unit I: Microbial world (12 hours)

History of microbiology and introduction to the microbial world. Microorganisms and fermentation, Germ theory of diseases, Development of various Microbiological techniques and golden era of microbiology. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit II: Characteristics of microorganisms (12 hours)

Physiochemical and biological characteristics of microorganisms (including viruses). Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Bacterial structure, Nutritional requirements of bacteria, Types of media, Physical conditions required for bacterial growth, Bacterial growth curve, methods of measurement of bacterial growth

Unit III: Microbial techniques (12 hours)

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria,. Buffers in culture medium. Cultivation of fungi, actinomycetes, yeasts, Cultivation of anaerobes. Optical and Electron microscope (Structure and function),

Unit IV: Sources of infection (12 hours)

Sources and routes of infection, Transmission of pathogens, portals of entry of pathogen, Microorganisms and animal host interactions, Toxins (endo and exo)

Unit V: Animal diseases and its etiology (12 hours)

Study of following animal diseases with respect to etiology, symptoms, mode of transmission, prophylaxis and control: Q fever FMD, swine flu, bird flu, Rabies, bovine tuberculosis, Common cattle disease Bovine Respiratory Disease Complex (BRDC), Clostridial Disease, or "Blackleg" , BRSV (Bovine Respiratory Syncytial Virus) BVD (Bovine Viral Diarrhea) (Infectious Bovine Rhinotracheitis), (Parainfluenza Type III), Pasteurella haemolytica and Pasteurella multocida.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyse the development of various Microbiological techniques	1,2	Analyzing
CO-2	Infer the physiochemical and biological characteristics of microorganisms	3,4	Understanding
CO-3	Evaluate the various Microbial techniques in Veterinary Microbiology	1,4	Evaluating
CO-4	Classify the Microorganisms and animal host interactions	4,5	Analyzing
CO-5	Develop the knowledge in animal diseases with respect to etiology especially the domesticated animals.	3,4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PEM31C	VETERINARY MICROBIOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓		✓		✓		✓	✓	✓
CO-2	✓	✓	✓	✓	✓		✓	✓		✓
CO-3	✓	✓		✓	✓	✓			✓	✓
CO-4	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO-5	✓	✓	✓	✓	✓	✓		✓	✓	✓
	Number of matches (✓) = 39									
	Relationship = High									

SEMESTER- III

Course Title	TECHNIQUES IN IMMUNOLOGY AND RESEARCH METHODOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB3P1
Course Type	Practical-V
Creditss	2
Marks	100/2

General Objective:

The Course helps to create practical knowledge in blood grouping, serological tests and assists to gather information in statistical interpretation.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify the Blood Grouping and various serological tests.
CO-2	Practice the Antigen- Antibody reaction.
CO-3	Experiment the data collection and writing research papers.
CO-4	Construct skill in Sample and Data collection for the Project work.
CO-5	Evaluate the Variance by using ANOVA.

1. Blood Grouping.
2. WIDAL test- Qualitative and Quantitative.
3. ASO.
4. CRP.
5. VDRL.
6. Antigen- Antibody reaction – Ouchterlony technique.
7. Antigen- Antibody reaction – Single radial Immunodiffusion.
8. ELISA- (DEMO).
9. Sample and Data collection of the Project work.
10. Calculation of Mean, Mode, Median.
11. Calculation of Standard Deviation and Standard Error.
12. Analysis of Variance (ANOVA).

REFERENCE BOOKS:

1. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*. 10th Edition. Pearson education Limited. 2014.
2. Kannan. *Laboratory Manual in General Microbiology*. Palani Paramount Publications, Palani, 1996.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize various test of immunology.	1,3	Understanding
CO-2	Interpret the applications of assays in the diagnosis of microbial diseases.	4,2	Applying
CO-3	Analyse knowledge in various Antigen- Antibody reaction	2,1	Analyzing
CO-4	Compare the various steps in statistical tools (ANOVA) in biostatistics.	2, 1	Evaluating
CO-5	Design the practical skill in Calculation of Mean, Mode, and Median.	5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
III	21PCMB3P1	TECHNIQUES IN IMMUNOLOGY AND RESEARCH METHODOLOGY					60	2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓		✓
CO-2	✓	✓		✓	✓	✓	✓		✓	✓
CO-3	✓	✓	✓		✓	✓		✓	✓	✓
CO-4	✓	✓		✓	✓	✓	✓		✓	✓
CO-5		✓	✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 38 Relationship = High									

SEMESTER-III

Course Title	TECHNIQUES IN MEDICAL AND QUALITY ASSURANCE IN MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB3P2
Course Type	Practical -VI
Creditss	2
Marks	100/2

General Objective:

The course hands on diagnosis of various pathogens from clinical samples, and facilitates to gather information of laboratory hazards.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify the various clinical samples
CO-2	Practise self-confidence
CO-3	Experiment the Fungal Pathogen from dandruff.
CO-4	Plan a knowledge in Design of microbiology laboratory
CO-5	Rate the knowledge in First aid procedures

1. Isolation of normal micro flora of skin and throat.
2. Isolation and identification of UTI causing Pathogen from urine.
3. Isolation and identification of Pathogen from wound and pus.
4. Isolation and identification of Pathogen from sputum.
5. Isolation and identification of bacterial and Fungal Pathogen from dandruff.
6. Antibiotic sensitivity test- Well diffusion method and Disc Diffusion Method.
7. Management of laboratory hazards and knowledge in First aid procedures.
8. Designing of microbiology laboratory.

REFERENCE BOOKS:

1. Cappuccino, J.G. and Sherman N. *Microbiology: A Laboratory Manual*. 10th Edition. Pearson education Limited, 2014.
2. Kannan. *Laboratory Manual in General Microbiology*. Palani Paramount Publications, Palani, 1996.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Explicates the methods on medical microbiology.	2,1	Understanding
CO-2	Substantiates the isolation and identification of clinically important pathogens.	4,2	Applying
CO-3	Analyse the antibacterial sensitivity test by using disc and well diffusion methods.	5,1	Analyzing
CO-4	Collect the fungal pathogen from dandruff.	1,5	Evaluating
CO-5	Value the minimum inhibitory concentration of antibiotics.	2,3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PCMB3P2	TECHNIQUES IN MEDICAL AND QUALITY ASSURANCE IN MICROBIOLOGY				60	2			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓		✓	✓	✓	✓
CO-2	✓	✓		✓	✓	✓	✓		✓	✓
CO-3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO-4	✓	✓		✓	✓	✓	✓			
CO-5		✓	✓	✓	✓	✓	✓	✓	✓	
	Number of matches (✓) = 40 Relationship = High									

SEMESTER – III

Course Title	ENTREPRENEURSHIP IN MICROBIOLOGY
Total Hrs	40
Hrs/Week	2
Sub.Code	21PIMB31
Course Type	IDC-II
Creditss	2
Marks	100/2

General Objective:

The course helps to gain the important concepts of entrepreneurship such as Planning, decision making, leadership, organizations and authority establishing a bio-based start-up and company.

Course Objectives:

CO No.	The learners will be able to
CO-1	Explain Entrepreneur and Entrepreneurship.
CO-2	Relate the Production of microbiological products.
CO-3	Analyse the Production of Biofertilizer.
CO-4	Assemble the various Marine resources
CO-5	Choose the Marine resources cultivation and harvesting methods.

UNIT I: Entrepreneur (8 hours)

Definition, Characteristics, Function, Types, Entrepreneurship: Definitions - concept, Factors affecting Entrepreneurial growth, Entrepreneurial motivation, Entrepreneurial competencies– Role of Entrepreneurship in Economic Development.

UNITII: Production of microbiological products (8 hours)

Introduction - Fermented dairy products, Food-SCP (Algae, Spirulina, Yeast, Mushroom, Bacterial probiotics). Commercial SCP Products in the market.

UNIT III: Biofertilizer (8 hours)

Introduction- (Cyanobacteria, *Rhizobium*, *Azospirillum*, *Azotobacter*, *Frankia*, VAM). Vermicompost, Bioinsecticide (*Bacillus thuriengensis*). Panchakavya, Fish Amino acids.

UNIT IV: Marine resources (8 hours)

Sea weed, Sea grass, Coral reefs- Types, cultivation and harvesting methods and products. Spirulina

UNIT V: Finance and Support to Bio entrepreneurs (8 hours)

Introduction - Government initiatives and Schemes. DST, CSIR, ICMR, DBT-BIRAC, BIG scheme, SIPCOT. Nationalized banks and other financial institutions. Marketing Management.

TEXT BOOKS:

1. Gordon E and Natarajan K. *Entrepreneurship Development*. 5th Edition. Himalaya Publishing House, New Delhi. 2005.
2. Khanka SS., *Entrepreneurial Development*. S Chand Publishing, New Delhi. 2006.
3. Naidu NVR and Krishnarao T., *Management and Entrepreneurship*. I.K. International Pvt. Ltd, New Delhi. 2008.
4. Venkataraman G.S., *Algal Biofertilizers and Rice Cultivation*. Today and Tomorrow's Printers and Publishers, New Delhi. 1972.

REFERENCE BOOKS:

1. Bhatnagar, B. and A. Budhiraja. *Entrepreneurship Development and Small Business Management*. Vayu Education of India, New Delhi, 2011.
2. Gupta, C.B. and N.P. Srinivasan. *Entrepreneurial Development in India*. Sultan Chand & Sons, New Delhi, 2014.
3. Hisrich, R.D, M.P. Peters and D.A. Shepherd. *Entrepreneurship*. 6th Edition, Mc Graw Hill; Irwin, 2005.
4. Tilak, KVBR. *Bacterial Biofertilizers*. IARI Publications, New Delhi, 1990.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Cognize and explain the skills for entrepreneurs and finance management.	1,5	Understanding
CO-2	Demonstrate the production of fermented dairy products.	3,4	Applying
CO-3	Compare different types of biofertilizers and bioinsecticides.	1,2	Analyzing
CO-4	Value the importance of cultivation of marine resources.	4,5	Evaluating
CO-5	Prepare the products from marine resources like sea weed, sea grass, coral reefs.	4,3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
III	21PIMB31	ENTREPRENEURSHIP IN MICROBIOLOGY				40	2			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1		✓	✓	✓	✓		✓	✓		✓
CO-2	✓			✓	✓	✓	✓		✓	✓
CO-3	✓	✓	✓		✓	✓		✓		✓
CO-4	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO-5		✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) =38 Relationship = High									

SEMESTER – IV

Course Title	FOOD AND DAIRY MICROBIOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB41
Course Type	DSC-X
Creditss	4
Marks	100

General Objective:

The course discuss how to gain knowledge using various methods of microbial analysis of food and dairy products and to understand the Government regulatory practices and policies.

Course Objectives:

CO No.	The learners will be able to
CO-1	Discuss the factors affecting the growth and survival of microorganisms in foods.
CO-2	Demonstrate the food-borne diseases and food poisoning by microbial agents.
CO-3	Differentiate the Fermented Food products.
CO-4	Collect the knowledge in dairy Products and Probiotics.
CO-5	Compare the Regulatory Policies for Dairy products.

UNIT I: Basics in Food Microbiology (15 hours)

Factors affecting the growth and survival of microorganisms in foods- Intrinsic factors- Nutrient content, pH, E_h , Antimicrobials and a_w , Extrinsic factors- Relative humidity, Temperature and Gaseous atmosphere. Methods for studying microbes and their products in food stuffs, Spoilage of fruits and Vegetables, Fresh and Processed Meats and Poultry and Miscellaneous foods such as eggs, bakery products, dairy products, beers and wines, fermented solid-substrate foods and canned foods.

UNIT II: Food Borne diseases (15 hours)

Food-borne diseases and food poisoning by microbial agents- *Aeromonas*; *Brucella*; *Clostridium perfringens*; *Salmonella*; *Shigella*; *Staphylococcus aureus*; Protozoa (*Giardia*, *Entamoeba*), Toxigenic algae (dianoflagellates), Toxigenic fungi (*Aspergillus*) and Foodborne viruses (polio, hepatitis A and E and gastroenteritis viruses).

UNIT III: Fermented Food products (15 hours)

Dairy products: - Production of starter cultures; Cheese - principles of cheese making. Cheddar Cheese, Swiss Cheese, Surface ripened Cheeses; Mold ripened Cheeses. General principles of manufacture of Yogurt, acidophilus milk, Kefir, Koumiss. Fermented foods: Soy sauce, Miso, Sufu, Natto, Idli, fermented fish products. Fermented vegetables: Sauerkraut, pickles, Olives. Fermented sausages.

Unit IV: Dairy Products and Probiotics (15 hours)

Fermented dairy products: Cheese - yogurt/yoghurt - Kefir. Antimicrobial systems in milk. Prevention and control: Role of personnel and environmental hygiene at the level of production and processing. - Microbiological quality of fat rich products: Cream and butter. Frozen dairy products: Ice-cream. Prebiotic and Probiotic. Lactic acid Bacteria (LAB) as probiotics in development of health foods. Antibacterial activity and therapeutic property of probiotic cultures. LAB as nutraceutical ingredients.

UNIT V: Regulatory Policies for Dairy products (15 hours)

Importance of Total Quality Management (TQM) in dairy industry - Current role of modified packaging for extending the shelf stability of indigenous dairy products, Antimicrobial packaging, controlled and modified atmosphere (CAP / MAP) based technologies. The hazard analysis and critical control point (HACCP), concept in controlling microbiological quality of foods. Government regulatory practices and policies: WHO – FDA – EPA - FSSAI. Food safety: Safety of dairy products.

TEXT BOOKS:

1. Adams, M.R. and M.O. Moss. *Food Microbiology*, 2ed (Royal Society of Chemistry); 2000.
2. Doyle, M.P. and L.R. Beuchat. *Food Microbiology: Fundamentals and Frontiers*, 3ed. 1995.
3. Knorr, D. *Food Biotechnology*. Marcel Dekker, New York, 1982.

REFERENCE BOOKS:

1. Brennan, J.G., Bulters, J.R., and Lilly, A.E.V., *Food Engineering Operations*, 2nd Edition, Applied Science Publishers, 1979.
2. Heldman, D.R., *Food Process Engineering*, 2nd Edition, AVI., 1977.
3. Paul, J.K., Noyer., *Genetic Engineering Applications for Industry, Corporation*, New Jersey, 1981.
4. 4. Rehm, H.J. and Reed,G, Verlag Chemie, Wainheim. *Biotechnology*, VI-VIII, 1983.
5. Toledo, R.T., *Fundamentals of Food Process Engineering*, AVI Publishing Co., USA, 1980.

Course Outcomes

CO. No	Upon the completion of the course, the students will be able to	PSO addressed	Cognitive level
CO1	Recognize the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in food and dairy	1,2	Understanding
CO2	Illustrate the spoilage mechanisms in foods and dairy and thus identify methods to control deterioration and spoilage	2,5	Applying
CO3	Relate awareness in food borne diseases	3,2	Analyzing
CO4	Rank use of food safety measurement for the quality of food stuffs.	5,1	Evaluating
CO5	Compose the probiotic its Antibacterial activity and therapeutic property of probiotic cultures.	3, 1	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
IV	21PCMB41	Food and Dairy Microbiology				75	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	CO-1	✓		✓	✓		✓	✓	✓	✓
	CO-2	✓	✓		✓	✓	✓	✓	✓	✓
	CO-3	✓	✓	✓		✓		✓		✓
	CO-4		✓		✓	✓		✓	✓	✓
	CO-5		✓	✓	✓	✓	✓	✓	✓	✓
	Number of matches (✓) = 38 Relationship = High									

SEMESTER – IV

Course Title	INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY
Total Hrs	75
Hrs/Week	5
Sub.Code	21PCMB42
Course Type	DSC-XI
Creditss	4
Marks	100

General Objective:

The course imparts the role of microbes in industrial production, designing bioreactors and gain knowledge in role of microorganism producing essential components of Pharmacy.

Course Objectives:

CO No.	The learners will be able to
CO-1	Express the Historical account of industrial microbiology.
CO-2	Interpret the information in Microbial production.
CO-3	Appraise the biopesticides and biofertilizers production and its importance.
CO-4	Plan the applications in human therapeutics, antimicrobial agents, and Pharmaceutical Formulation.
CO-5	Compare the types of spoilage, and factors pharmaceutical products.

UNIT1: History of Industrial Microbiology (15 hours)

Historical account of microbes in industrial microbiology, Sources and Characters of industrially potent microbes; their Isolation, Screening and Purification of useful strains; Culture Collections; Primary Screening and Secondary Screening, Strain improvement. Microbial growth kinetics in Batch, Continuous and Fed-batch fermentation process. Bioreactor-Principles and Designing, Types of bioreactors, Types of fermentation process, Primary and Secondary metabolites. Upstream and Downstream processing - methods employed.

UNIT II: Microbial Product (15 hours)

Microbial production of commercially important products: Vitamins (Cyanocobalamine, Riboflavin), Antibiotics (Penicillin, Semisynthetic

Penicillin, Streptomycin, Hormones (Gibberellins, Auxins), solvents (Alcohol, Acetone), enzymes (Microbial Rennets), acids (Lactic acid, Citric acid), enzymes (Protease, Amylase, and Lipase) and Steroid bioconversions. Methods of immobilization and applications. Production of proteins in bacteria and Yeast (Chymosin production) Recombinant and synthetic vaccines.

UNIT III: Biopesticides (15 hours)

Biopesticides – history of development, production of biopesticides from bacteria, fungi and viruses and their applications against different types of pathogens (BT, *Trichoderma viridae*). Biofertilizer production technology-strain selection, sterilization, growth and fermentation, standards and quality control, biofertilizer application technology. Mass production of Biofertilizers (*Rhizobium*, *Azotobacter*); Biopolymers, Single cell protein (Bacteria, fungi etc).

UNIT IV: Scope and Applications Therapeutics (15 hours)

Scope and its applications in human therapeutics, Properties of antimicrobial agents, Types of chemotherapeutic agents – Synthetic, Semi synthetic, Natural - therapeutic agents. Types of antibiotics with their mode of action; antibacterial, antifungal, antiviral, antiprotozoal. Pharmaceutical Formulation (Tablets, Capsule, Ointments, Syrup, Gel), Stages of Pharmaceutical product Development.

UNIT V: Spoilage and Preservation of Pharmaceutical Products (15 hours)

Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage. Objectives of preservation, the ideal preservative, preservative system etc., Antimicrobial preservatives and their properties. Preservative stability and efficacy.

TEXT BOOKS:

1. Dubey, R. C. A. *Text Book of Biotechnology*. (4th Edition) S. Chand & Company Limited, New Delhi, 2007.
2. Gupta, P.K. *Elements of Biotechnology*. Rastogi Publications, Meerut, 2003.
3. Jogdand, S. N. *Gene Biotechnology*; (5th Edition) Himalaya Publishing House, 2000.
4. Reed, G. Prescott and Dunn. *Industrial Microbiology*. Macmillan Publication., 1982.

REFERENCE BOOKS:

1. Hugo W. B and Russell A.D. *Pharmaceutical Microbiology*. Sixth Edition, The Black well Science Ltd., UK, 1998.
2. Stanbury, P.F.A. Whitaker and Hall. *Principles of Fermentation Technology*, 2002.

Course Outcomes

CO. No.	Upon completion of the course, the students will be able to	PSO addressed	Cognitive level
CO1	Comprehend different fermentation techniques, bioreactor design, inoculum development for industrial fermentations.	1,2	Understanding
CO2	Schedule the industrial production and purification with help of different microbes.	3,4	Applying
CO3	Formulate the importance of biofertilizers and biopesticides	4,3	Analyzing
CO4	Test the industrial production and purification	1,5	Evaluating
CO5	Choose the substances either of natural or synthetic sources as antimicrobial agents.	2,1	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
IV	21PCMB42	INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY					75	4		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓	✓	✓
CO-2	✓			✓	✓	✓	✓			✓
CO-3	✓	✓	✓		✓	✓		✓	✓	✓
CO-4		✓		✓	✓	✓		✓		✓
CO-5	✓	✓	✓	✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 37 Relationship =High									

SEMESTER-IV

Course Title	RESEARCH PROJECT
Total Hrs	120
Hrs/Week	8
Sub.Code	21PPMB41
Course Type	DSC-XII
Creditss	8
Marks	150

The following are the guidelines to be adhered to by the Postgraduate students :

- Individual Projects should be taken.
- The Project should be written in English only.
- The Minimum number of pages should be 60.
- Project observations, suggestions and summation/conclusion shall form part of the Project Report.
- The Projects will be evaluated by the Internal Examiner and the External Examiner for 150 marks. The distribution of mark should be 90 marks for the Project Report and 60 marks for the Viva-Voce Examination. The Division of marks for the Project Report is as follows:

Particulars	Internal Examiner	External Examiner
Wording of Title	5	5
Objectives / Formulation including Hypothesis	10	10
Review of Literature	15	15
Relevance of the Project to Social Needs	10	10
Methodology / Technique / Procedure Adopted	30	30
Summary / Findings / Conclusion / Summation	10	10
Bibliography / Annexure / Foot notes / Works Cited / Works Consulted	10	10
Total	90	90

- ❖ The Internal Examiner and the External Examiner will award the marks for each candidate. The average mark obtained by the candidate is considered marks for the Project Report.

SEMESTER – IV

Course Title	ADVANCES IN BIOTECHNOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB41A
Course Type	DSE-IV-A
Creditss	4
Marks	100

General Objective:

The course creates knowledge on digestive enzymes, vectors, vaccines and recent techniques in Biotechnology.

Course Objectives:

CO No.	The learners will be able to
CO-1	Discuss the fundamental concepts of Biotechnology.
CO-2	Interpret the Modern trends in the vectors.
CO-3	Distinguish the genetic transformation in microorganisms.
CO-4	Construct the protein separation and profiling.
CO-5	Rank the vaccine production and application.

Unit I: Basics of Biotechnology (12 hours)

Biotechnology – history, scope and importance of Biotechnology. PCR methods and Applications: PCR methods- Real time PCR, Multiplex PCR, Nested PCR. Molecular markers-RFLP, SSR, RAPD and AFLP analysis.

Unit II: Genetic Recombination (12 hours)

Steps of Genetic Recombination processes -Restriction digestion, ligation, cloning. Cloning Vectors: Definition and Properties, Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 vectors, Cosmids, BACs, YACs, Expression vectors: E. coli lac and T7 promoter-based vectors, yeast- YE_p and YC_p vectors.

Unit III: Genomic Techniques: (12 hours)

Transformation of DNA: Chemical method, Electroporation. Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, Agrobacterium - mediated delivery. Hybridization -Southern for genome analysis.

Unit IV: Proteomics (12 hours)

Protein separation: Single dimensional and two dimensional gel electrophoresis. Detection of protein: Organic dye staining - silver staining - fluorescent staining - image analysis. Protein arrays: Definition - diagnostics expression profiling and applications. Exoproteome analysis.

Unit V: Applications of recombinant technology (12 hours)

Applications of recombinant technology: Recombinant therapeutic proteins-insulin and Follicle Stimulating Hormone (FSH). Recombinant vaccines: Hepatitis-B vaccine. Genetic engineering of plants: Insecticide - herbicide resistant crops. Gene targeting for gene therapy: CRISPR – Cas system. Synthetic biology: Artificial cells. Ethics in Biotechnology and intellectual property rights (IPR).

TEXT BOOKS:

1. DAS, H.K. *A Text Book of Biotechnology*, Revised Edition, Wiley publications Ltd., New Delhi, 2010.
2. Glick, B.R., and J.J. Pasternak, 2003. *Molecular Biotechnology*. ASM Press; Washington D.C.
3. Nicholl D. S. T. 2008. *An Introduction to Genetic Engineering*, Cambridge University Press

REFERENCE BOOKS:

1. Friedberg, C. Graham C. Walker and S. Wolfram Siede, Richard. *DNA Repair and Mutagenesis*. ASM Publications, 1995.
2. Larry, S. and Wendy. *Molecular Genetics of Bacteria*. ASM Publications, 1997.
3. Lewin. *Gene*. VII edition. Oxford University y Press, 2000.
4. Maloy. *Microbial Genetics*. Jones and Bartlett Publishers. Dale J. W. 1994.
5. Streips and Yasbin. *Modern Microbial Genetics*. John Wiley and Sons. Niley Ltd; 1991.
6. Watson J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, *Molecular Biology of the Gene*. Benjamin / Cummings Publications Co. Inc. California, 1987.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Identify the basics and concept of biotechnological terms.	1,3	Understanding
CO-2	Apply importance of PCR and vector.	4,2	Applying
CO-3	Analyse the protein arrays.	1,5	Analyzing
CO-4	Combine the proteomic technique.	4,2	Evaluating
CO-5	Appraise the application of biotechnology in medical and its allied fields, gene therapy, genetic counselling.	4,1	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
IV	21PEMB41A	ADVANCES IN BIOTECHNOLOGY				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓		✓	✓	✓			✓	✓	✓
CO-2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO-3	✓	✓		✓	✓	✓		✓	✓	✓
CO-4		✓	✓	✓	✓	✓	✓		✓	✓
CO-5	✓		✓	✓	✓		✓	✓		✓
	Number of matches (✓) = 40 Relationship = High									

SEMESTER – IV

Course Title	VERMICULTURE TECHNIQUES AND MUSHROOM TECHNOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB41B
Course Type	DSE-IV-B
Creditss	4
Marks	100

General Objective:

Acquired skills and an initial understanding of recent developments of Vermi Technology and Mushroom Cultivation.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the vermi composting and mushroom cultivation for Entrepreneurship
CO-2	Interpret the concept and skill in the techniques of vermi composting.
CO-3	Analyze the knowledge on different types of mushroom
CO-4	Evaluate the different types of mushroom and its uses.
CO-5	Create awareness about the medicinal and nutritive value of mushrooms.

UNIT-I: Classification of Earthworm (12 hours)

Earthworm Classification – Morphology and Anatomy. Biology of *Lampitomaruitii*. Vermicomposting - Definition, Introduction and Scope- The nature of earthworms-soil environment-basic environmental requirements.

UNIT-II: Vermicompost and its types (12 hours)

Vermicomposting materials and their Classification, Physical, chemical and biological changes brought by earthworm in Soil Structure - Carbon, Nitrogen and Phosphorous transformations. Vermicomposting methods - Optimal conditions for Vermiculture - temperature, moisture, pH, soil type, organic matter, Vermicomposting in Homes, Maintenance of vermicomposting beds. Harvesting the worms. Earthworm predators, parasites and pathogens. Vermiwash, Applications of vermicomposting.

UNIT-III: Mushroom Technology (12 hours)

Mushroom Technology - Introduction, History and Scope –Morphology of mushroom -Vegetative characters - Formation and development of

Basidiocarp, Structure of basidiocarp - *Agaricus*. Edible and Poisonous Mushrooms. Medicinal and nutritive value of edible mushrooms. Food preparation- soup, cutlet, vegetable curry, samosa, omlette and pickle. Mushroom research centers in India.

UNIT-IV: Cultivation of mushroom (12 hours)

Cultivation of button mushroom (*Agaricus bisporus*), milky mushroom (*Calocybe indica*), oyster mushroom (*Pleurotussajor caju*) and paddy straw mushroom (*Volvariella volvcea*).Preparation of Pure Culture and spawn cultivation methods.

UNIT-V: Cultivation technology (12 hours)

Cultivation technology - Substrates, Bed, Polythene- Bag preparation, spawning - casing - Cropping - Mushroom production - Harvest - Storage methods and marketing. Post harvest technology: Storage-Freezing, dry Freezing, drying, canning.

Text Books:

1. Lee, K.E., 1985. Earthworms - Their ecology and relationship with soil and land use, Academic Press, Sydney.
2. Ranganathan L.S. 2006. Vermibiotechnology from soil health to human health. Agrobios India.
3. Gupta P.K. 2008. Vermicomposting for sustainable agriculture. Agrobios. India.

Reference Books:

1. Edwards, C.A. and Bohlen, P.J. 1996, Ecology of earthworms-3rd Edition, Chapman and hall.
2. Jsmail, S.A., 1970, Vermicology. The biology of earthworms. Orient Longman, London.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyse the Morphology and Anatomy. Biology of Earthworms	1,3	Analyzing
CO-2	Infer the Vermicomposting materials and their Classification.	3,4	Understanding
CO-3	Evaluate the Morphology, vegetative characters,formation and development of basidiocarpof mushroom	1,2	Evaluating
CO-4	Classify the Cultivation of button mushroom and milky mushroom	4,5	Analyzing
CO-5	Develop the knowledge in Cultivation technology of mushroom	4,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
IV	21PEMB41B	VERMICULTURE TECHNIQUES AND MUSHROOM TECHNOLOGY					60	4		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-2		✓	✓	✓	✓		✓	✓		✓
CO-3	✓	✓		✓		✓	✓		✓	
CO-4	✓		✓		✓		✓	✓	✓	✓
CO-5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Number of matches (✓) = 39									
	Relationship = High									

SEMESTER – IV

Course Title	ENVIRONMENT AND WASTE MANAGEMENT
Total Hrs	60
Hrs/Week	4
Sub.Code	21PEMB41C
Course Type	DSE-IV-C
Creditss	4
Marks	100

General Objective

Acquired skills, understanding different environment, pollution and waste management.

Course Objectives:

CO No.	The learners will be able to
CO-1	Understand the Soil profile and soil microflora.
CO-2	Interpret the concept Solid waste management methods, land filling and recycling.
CO-3	Analyze the types and major sources of air pollutants
CO-4	Evaluate the International Programme on Chemical Safety.
CO-5	Create an awareness about degradation of common pesticides, organic hydrocarbons and oil spills

UNIT I: Terrestrial Environment (12 hours)

Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrastatic & osmotic pressures, salinity, & low nutrient levels.

UNIT II: Solid wastes (12 hours)

Sources, generation, classification & composition of solid wastes. Solid waste management methods - Sanitary land filling, Recycling, Composting, Vermi composting, Incineration, energy recovery from organic waste.

UNIT III: Environmental Pollution and its types (12 hours)

Types and major sources of air pollutants, effects of air pollutants on physico-chemical and biological properties surrounding atmosphere, air born diseases. Types and major sources of water pollutants, effects of water

pollutants on physico-chemical and biological properties of water bodies, water born diseases with special reference to water pollution. Types and major sources of soil pollutants, effects of soil pollutants on physico-chemical and biological properties of soil.

UNIT IV: Environmental health Management (12 hours)

Scope of International Programme on Chemical Safety (IPCS). Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Water borne diseases; Prevention and protection of community health from water borne diseases. Air borne bio-allergents; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control.

UNIT V: Degradation of pesticides (12 hours)

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants. Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

TEXT BOOKS

1. Shiva Aithal, C. (2010). Modern approaches in Soil, Agricultural and Environmental Microbiology. Himalaya Publishers, New Delhi.
2. Atlas, R.M., and Bartha, M. (2003). Microbial Ecology – Fundamentals and applications. Benjamin – Cummings, Mento Park, California.
3. Martin Alexander (1983). Introduction to Soil Microbiology, Wiley eastern Ltd., New Delhi.
4. Subba Rao, N.S. (1997). Biofertilizers in Agriculture and Forestry III Ed, Oxford and IBH Publishing Co, Pvt. Ltd, New Delhi.
5. Subba Rao, N.S. (1995). Soil Microorganisms and Plant growth. Ed, Oxford and IBH Publishing Co, Pvt. Ltd, New Delhi

REFERENCE BOOKS:

1. Wheeler, B.E. (1976). An introduction to Plant disease. ELBS and John Wiley and sons, Ltd.
2. Rangaswamy. G., and Bagyaraj, D.J. (1996). Agricultural Microbiology. Prentice- Hall of India Pvt Ltd., New Delhi.
3. Dirk, J. Elsas, V., Trevors, T., and Wellington, E.M.H. (1997). Modern Soil Microbiology. , Marcel Dekker INC, New York, Hong Kong.
4. Dubey R.C. (2001). A Text Book of Biotechnology. S Chand & Co. New Delhi.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Analyse the aeromicroflora and dispersal of microbes.	1	Analyzing
CO-2	Infer the sources, generation, classification& composition of solid wastes.	3	Understanding
CO-3	Evaluate the different Environmental Pollution and its impacts.	1	Evaluating
CO-4	Classify the Environmental health Management.	4	Analyzing
CO-5	Develop the knowledge in Treatment and safety of drinking (potable) water samples.	4	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
IV	21PEMB41C	ENVIRONMENT AND WASTE MANAGEMENT				60	4			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
	CO-1	✓	✓		✓		✓		✓	✓
	CO-2		✓	✓	✓	✓	✓	✓		✓
	CO-3	✓	✓				✓		✓	
	CO-4	✓			✓	✓		✓		✓
	CO-5	✓	✓	✓	✓	✓	✓	✓		✓
	Number of matches (✓) = 39 Relationship = High									

SEMESTER-IV

Course Title	TECHNIQUES IN FOOD AND DAIRY MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB4P1
Course Type	Practical-VII
Creditss	2
Marks	100/2

General Objective:

The course gives practice to isolate and to identify food borne pathogens and food beverages.

Course Objectives:

CO No.	The learners will be able to
CO-1	Report and confirmation of <i>Salmonella</i> sp and <i>Shigella</i> sp in beverages
CO-2	Practice and identify yeast from Idly batter
CO-3	Analyze the Bacteria from spoiled fruit.
CO-4	Collect the microbial load in spoiled meat.
CO-5	Compare the quality of milk

1. Detection and confirmation of *Salmonella* sp and *Shigella* sp in beverages.
2. Isolation and identification of yeast from Idly batter.
3. Isolation and identification of Bacteria from spoiled fruit.
4. Isolation and identification of Bacteria from spoiled Vegetable.
5. Isolation and identification of Bacteria from spoiled meat.
6. Isolation and identification of *Vibrio* species from fish product..
7. Wet mount Preparation spoiled bread, grapes.
8. Determination of quality of milk-Methylene Blue Reduction Test (MBRT).
9. Resazurin test of milk.
10. Phosphatase Test.

TEXT BOOKS:

1. Cappuccino, J.G. and N. Sherman. *Microbiology: A Laboratory Manual*. 10th Edition. Pearson education Limited. 2014.
2. Doyle, M.P. and L.R. Beuchat. *Food Microbiology: Fundamentals and Frontiers*, 3ed, 2002.
3. Kannan. *Laboratory Manual in General Microbiology*. Palani Paramount Publications, Palani, 1996.

REFERENCE BOOKS:

1. Adams, M.R. and M.O. Moss. *Food Microbiology*, 2ed (Royal Society of Chemistry); 2000.
2. Knorr, D., Food Biotechnology. Marcel Dekker, New York, 1982.
3. Rehm, H.J. and G, Reed. Biotechnology, VI-VIII, Verlag Chemie, Wainheim, 1983.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Summarize the procedure for Isolation and identification of microorganisms from various foods.	1,2	Understanding
CO-2	Examine the quality of milk by applying Methylene Blue Reduction Test.	3,4	Applying
CO-3	Analyze the methods on wet mount preparation of spoiled bread and grapes.	1,5	Analyzing
CO-4	Determine the quality milk by Phosphatase Test.	4,5	Evaluating
CO-5	Choose the bacteria from various spoiled food samples.	1,3	Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credits			
IV	21PCMB4P1	TECHNIQUES IN FOOD AND DAIRY MICROBIOLOGY				60	2			
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓		✓	✓		✓	✓	✓	✓
CO-2	✓	✓		✓	✓	✓	✓		✓	✓
CO-3	✓	✓	✓		✓	✓		✓	✓	✓
CO-4	✓	✓		✓	✓		✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓	✓	✓
	Number of matches (✓) = 39 Relationship = High									

SEMESTER-IV

Course Title	TECHNIQUES IN INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY
Total Hrs	60
Hrs/Week	4
Sub.Code	21PCMB4P2
Course Type	Practical-VIII
Creditss	2
Marks	100/2

General Objective:

The course creates practical skill on industrially important micro organisms and bioassay of various antibiotics.

Course Objectives:

CO No.	The learners will be able to
CO-1	Identify and confirm industrially important micro organisms.
CO-2	Apply immobilization technique for an enzyme or cell.
CO-3	Categorize the Solubility of drug at room temperature.
CO-4	Design the Sterility testing of Pharmaceutical products.
CO-5	Rate the Microbiological assay of antibiotics.

1. Isolation and identification of industrially important micro organisms- crowded plate technique-giant colony technique.
2. Ethanol Fermentation.
3. Immobilization of an enzyme or Cell.
4. Production of Streptomycin (DEMO).
5. Production of Beer (DEMO).
6. Production of Wine (DEMO).
7. Determination of Solubility of drug at room temperature.
8. Sterility testing of Pharmaceuticals.
9. Microbiological assay of antibiotics by cup plate method.
10. Bioassay of chloramphenicol by plate assay method and turbidimetric Assay method.

REFERENCE BOOKS:

1. Aneja, K.R., *Experiments in Microbiology, Plant Pathology and Tissue Culture*. Wishwa Prakashan; New Delhi, India. 1993.
2. Benson. *Microbiological Applications – Laboratory Manual in General Microbiology*. International Edition, McGraw Hill Higher Education, 2002.
3. Dubey, R.C. and D.K. Maheswari. *Practical Microbiology*, 1st Edition Chand & Company Ltd., India, 2002.
4. Gunasekaran, P. *Laboratory Manual in Microbiology*. New Age International Ltd., Publishers, New Delhi, 1996.
5. Jayaraman, J. *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi. 1985.
6. Plummer. D.T. *An Introduction to Practical Biochemistry*. Tata McGraw Hill, New Delhi, 1998.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Cognize and review the sterility test of pharmaceuticals.	1,2	Understanding
CO-2	Exhibit the microbiological assay of antibiotics using cup plate method.	1,3	Applying
CO-3	Correlate the knowledge on production of Streptomycin.	3,4	Analyzing
CO-4	Assess the technique for Beer production	3,5	Evaluating
CO-5	Design Bioassay of chloramphenicol by plate and turbidimetric Assay method	1,5	Creating

Relationship Matrix

Semester	Course Code	Title of the Course					Hours	Credits		
IV	21PCMB4P2	TECHNIQUES IN INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY					60	2		
Course Outcomes (COs)	Programme Learning Outcomes (PLOs)					Programme Specific Outcomes (PSOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO-2		✓	✓		✓	✓	✓		✓	✓
CO-3	✓	✓	✓		✓	✓		✓	✓	✓
CO-4	✓			✓	✓		✓		✓	✓
CO-5	✓	✓		✓	✓		✓	✓		✓
	Number of matches (✓) =37 Relationship = High									

INTERDISCIPLINARY COURSES (2021 – 2024)							
SEM	TITLE OF THE COURSE	COURSE CODE	H/W	C	MARKS		
					I	E	T
DEPT. OF ENGLISH							
II	SOFT SKILLS	21PIEN11	2	2	40	60	100/2
III	ENGLISH FOR BUSINESS COMMUNICATION	21PIEN31	2	2	40	60	100/2
DEPT. OF HISTORY							
II	INDIAN HISTORY FOR COMPETITIVE EXAMINATIONS UPTO 1707A.D	21PIHS11	2	2	40	60	100/2
III	INDIAN HISTORY FOR COMPETITIVE EXAMINATIONS FROM (1707-1947 A.D)	21PIHS31	2	2	40	60	100/2
DEPT. OF COMMERCE							
II	ENTREPRENEURIAL DEVELOPMENT	21PICO11	2	2	40	60	100/2
III	HUMAN RESOURCE MANAGEMENT	21PICO31	2	2	40	60	100/2
DEPT. OF MATHEMATICS							
II	DISCRETE STRUCTURE – I	21PIMA11	2	2	40	60	100/2
III	DISCRETE STRUCTURE – II	21PIMA31	2	2	40	60	100/2
DEPT. OF CHEMISTRY							
II	ANALYTICAL BIOCHEMISTRY	21PICH11	2	2	40	60	100/2
III	INDUSTRIAL CHEMISTRY	21PICH31	2	2	40	60	100/2
DEPT. OF COMPUTER SCIENCE							
II	DIGITAL LITERACY	21PICS11	2	2	40	60	100/2
III	DIGITAL TECHNOLOGY	21PICS31	2	2	40	60	100/2
DEPT. OF MICROBIOLOGY							
II	MICROBIOLOGY AND HUMAN HEALTH	21PIMB11	2	2	40	60	100/2
III	ENTREPRENEURSHIP IN MICROBIOLOGY	21PIMB31	2	2	40	60	100/2
DEPT. OF PHYSICS							
II	THE BASICS OF DIGITAL ELECTRONICS	21PIPH11	2	2	40	60	100/2
III	ENERGY PHYSICS	21PIPH31	2	2	40	60	100/2
DEPT. OF ZOOLOGY							
II	ORNAMENTAL FISH CULTURE	21PIZO11	2	2	40	60	100/2
III	APPLIED ZOOLOGY	21PIZO31	2	2	40	60	100/2
DEPT. OF NUTRITION AND DIETETICS							
II	DIET THERAPY-I	21PIND11	2	2	40	60	100/2
III	DIET THERAPY-II	21PIND31	2	2	40	60	100/2

THE SCHEME OF EXAMINATIONS UNDER CHOICE BASED CREDIT SYSTEM

- The medium of instruction in all the UG and PG Programmes is English and Students shall write the CIA Tests and the Semester Examinations in English. Three CIA Tests for one hour each will be conducted. For the calculation of CIA Tests marks the average of the best two tests will be taken. The portion for each test can be 1.5 units of the unitized syllabi.
- Two assignments for the Undergraduate Programmes and one assignment and one seminar for the Postgraduate Programmes are compulsory.
- Two Practical Examinations will be conducted for CIA at the end of the semester and the average will be taken

Distribution of Marks for the Students admitted into the UG and PG Programmes from the academic year 2021-2022

CIA Tests and Semester Examinations

Undergraduate, Certificate, Diploma and Advanced Diploma Programmes						
Course Type	TOTAL MARKS	CIA TESTS MAX.MARKS	SEMESTER EXAMINATION Max. Marks	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	25	75	Nil	30	40
Practical (2Hrs.)	50	20	30	Nil	12	20
Practical (4Hrs.)	100	40	60	Nil	24	40
Project	100	Nil	Report- 60 Marks Viva-Voce- 40 Marks	Nil	Nil	100

Postgraduate Programmes						
Course Type	TOTAL MARKS	CIA MARKS	SEMESTER EXAM	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	40	60	Nil	30	50
Practical	50	20	30	Nil	15	25
Practical (for PG Maths only)	100	40	60	Nil	30	50
Project Report	150	Nil	Project Report- 90 Marks Viva-Voce Examination - 60 Marks	Nil	Nil	150

FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2020-2021 for UG and 2019-2020 for PG Distribution of Marks for CIA Tests and Semester Examinations Undergraduate, Certificate, Diploma and Advanced Diploma Programmes						
Course Type	TOTAL MARKS	CIA TESTS MAX.MARKS	SEMESTER EXAMINATION Max. Marks	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	25	75	Nil	30	40
Practical(2Hrs.)	50	20	30	Nil	12	20
Practical(4Hrs.)	100	40	60	Nil	24	40
Project	100	Nil	Report- 60 Marks Viva-Voce- 40 Marks	Nil	40	40

Distribution of Marks for CIA Tests and Semester Examinations for Postgraduate Programmes						
Course Type	TOTAL MARKS	CIA MARKS	SEMESTER EXAM	PASSING MINIMUM		
				CIA	SEM. EXAM	OVERALL
Theory	100	40	60	Nil	30	50
Practical	50	20	30	Nil	15	25
Practical (for PG Maths only)	100	40	60	Nil	30	50
Project Report	150	Nil	Project Report- 90 Marks Viva-Voce Examination - 60 Marks	Nil	75	75

CIA TESTS

Distribution of Marks

Components	Tests (A)			Assignment (B)	Seminar (C)	Record Note (D)	Total (A+B+C+D)
	I	II	III				
UG-Theory	20	20	20	5	-	-	25
	The Average of the Best Two Tests:20						
PG-Theory	30	30	30	5	5	-	40

	The Average of the Best Two Tests:30					
UG- Practical (2 hrs)	15	15	-	-	5	20
	The Average of the Tests: 15					
UG- Practical (4 hrs)	30	30	-	-	10	40
	The Average of the Tests: 30					
PG- Practical	15	15	-	-	5	20
	The Average of the Tests: 15					
PG- Practical (Maths only)	30	30	-	-	10	40
	The Average of the Tests: 30					

Question Pattern for CIA Test (Theory)

Programme	Question Paper Pattern			Total (A+B+C)
	Part-A	Part-B	Part-C	
UG	MCQs- 8x0.5=4 marks	Internal Choice (Either or type). 2x4=8 marks Answer should not exceed 250 words	Internal Choice (Either or type) 1x8=8 marks Answer should not exceed 500 words	20
PG	MCQs- 20x0.5=10 marks	Internal Choice (Either or type) 3x4=12 marks Answer should not exceed 250 words	Internal Choice (Either or type) 1x8=8 marks Answer should not exceed 500 words	30

End Semester Examination (ESE)

The students who have put in the required number of days of attendance are eligible to appear for the End Semester Examinations irrespective of whether they have passed in the CIA Tests or not. They have to pay the examination fees for all the current courses and the arrear courses, if any, and submit the application form before the due date specified for the purpose. For any reason, the dates will not be extended. Hall tickets will be issued only for those who have paid the fees. The question papers for the End Semester Examinations for all the theory courses of the UG and the PG Programmes will be set for 75 marks.

Question Pattern for End Semester Examinations (Theory)

Programme	Question Paper Pattern			Total (A+B+C)
	Part-A	Part-B	Part-C	75

UG	MCQs- 30x0.5=15 marks	Internal Choice (Either or type) 5x4=20 marks Answer should not exceed 250 words	Internal Choice (Either or type) 5x8=40 marks Answer should not exceed 500 words	
PG	MCQs- 30x0.5=15 marks	Internal Choice (Either or type) 5x4=20 marks Answer should not exceed 250 words	Internal Choice (Either or type) 5x8=40 marks Answer should not exceed 500 words	($\frac{x}{75}$ x 60) 60

The Question Paper Pattern for the End Semester Examinations (Practical)

The Question Paper Pattern is designed by the respective departments.