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1.1.2: The programmes offered by the institution focus on employability / entrepreneurship / skill development and their course syllabi are adequately revised to incorporate contemporary requirements

SYLLABUS OF THE COURSES FOCUSING EMPLOYABILITY / ENTREPRENEURSHIP / SKILL DEVELOPMENT

Colour Coding

EMPLOYABILITY

ENTREPRENEURSHIP

SKILL DEVELOPMENT

M.Sc. APPLIED MICROBIOLOGY

YEAR - I	IMMUNOLOGY ((For those students admitted in the year 2021–22 andonwards)	21PMB12
SEMESTER - I		HRS/WK - 4
CORE - 2		CREDITS - 4

Objective: To make the students understand Immune system and its functions.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Acquires knowledge about the Immune system and its functions.
CO2: Gains knowledge about Serological and Hematological techniques.
CO3: Understands the mechanisms and functions of MHC.
CO4: Learns the Immunological process of transplantation and cancer.
CO5: Learns the importance of polyclonal and monoclonal antibody production.

SEMESTER: I	COURSE CODE: 21PMB12				COURSE TITLE: IMMUNOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	3	4	5	4	4	4	5	4.6	
CO2	3	3	3.5	3.5	3	3	4	4.5	3.4	
CO3	2	3	3	4	4	3	4.5	5	3.5	
CO4	4	2	3	3.5	4	3.5	3.5	4	3.4	
CO5	3	2.5	3.5	4	4	3.5	4	4.5	3.6	
Mean Overall Score									3.7	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1: **(12 Hrs)**
History of Immunology; Overview of the immune system - Cells and organs of the immune system; Antigens – immunogenecity and antigenecity, haptens, adjuvants, vaccines; Immunoglobulins - structure and classes.

Unit-2: **(12 Hrs)**
Immunohematology- Blood groups, blood transfusion, Rh incompatibilities; Antigen-Antibody reactions - Complement fixation, Immunofluorescence - ELISA, RIA, Flow cytometry.

Unit-3 **(12 Hrs.)**
Host-Parasitic relationships - Microbial infections, Virulence and host resistance; Innate and acquired immunity – MHC molecules – Endogenous, Exogenous pathway; T-cell receptors, T-cell maturation, activation and differentiation; B-cell generation, activation and

differentiation; Cell mediated Immunity – Lymphokines and Cytokinins.

Unit-4: **(12 Hrs)**

Complement pathways – Classical, Alternate and Lectin pathway; Hypersensitivity – Types and Mechanisms; Basic concepts of Autoimmunity – Brief account of autoimmune diseases; Immunodeficiency; Transplantation immunology – immunological basis of graft rejection, immunosuppressive therapy; Cancer and the immune system.

Unit-5: **(12 Hrs)**

Antibody production -Production of polyclonal antibodies; antibody titre assay; Separation and Identification of protein or antigen; Hybridoma technology - Monoclonal antibodies, Antibody engineering; IgY antibodies and their applications.

Text Book

- KubyImmunology. 4th Edition, 2000. Goldsby, R.A., T. J. Kindt and B. A.Osborne. W. H. Freeman and Company, New York.

Reference Books

- Text book of Microbiology and Immunology. 2nd Edition, 2012. Subash Chandra Parija. Reed Elsevier India Pvt. Ltd.,India.
- TextbookofMicrobiology.12thEdition,2017.AnanthanarayananRandPanicker C.K. Universities Press (India) Private Ltd, Hyderabad, India.
- Essential Immunology. 8thEdition, 2011. Roitt I. M. Wiley Blackwell,UK.
- Medical Immunology. 6thEdition, 2007. Gabriel Virella. Informa Healthcare,USA.
- Immunology. 4lhEdition, 1995. Tizard, I. R. Saunders College Publishing,USA.

YEAR - I	MICROBIAL GENETICS (For those students admitted in the year 2021 – 22 and onwards)	21PMB13
SEMESTER - I		HRS/WK - 4
CORE - 3		CREDITS - 4

Objective: To make the students understand the basics of Microbial genetics and Mechanisms of geneexpression.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Understands the components of Nucleic acids and its types
CO2: Understands gene expression and regulation
CO3: Gains knowledge of different kinds of mutations and role of viruses in oncogenesis
CO4: Knows different gene transfer mechanisms in bacteria
CO5: Acquires knowledge about phage life cycles and its genetics

SEMESTER: I	COURSE CODE: 21PMB13				COURSE TITLE: MICROBIAL GENETICS				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES(PO)				PROGRAMME SPECIFIC OUTCOMES(PSO)				MEAN SCORE OF Cos	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3.5	4	3.5	4	4	4	4	3.87	
CO2	3.5	3.5	4	4	4	3.5	3.5	4	3.75	
CO3	3	3	4	3.5	4	4	3.5	3.5	3.56	
CO4	3	3.5	3.5	4	4	3	3	3.5	3.43	
CO5	3.5	3.5	3.5	4	4	3.5	3	4	3.62	
Mean Overall Score									3.64	

Result: The score of this course is 3.64 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit– 1 **(12 Hrs)**

Nucleic acids – Components, Nucleic acids as a genetic material, Griffith and Hershey and Chase experiments; DNA structure and forms; RNA – types and functions; Denaturation and Renaturation; Plasmids and their types; Organization of Prokaryotic and Eukaryotic genetic material; Replication of DNA - methods, enzymes involved; DNA damage and Repair.

Unit– 2 **(12 Hrs)**

Gene concept - Gene expression – Transcription – Mechanism, Post transcriptional modifications in Prokaryotes and Eucaryotes; Translation – the genetic code – overlapping genes – polypeptide synthesis, Post translational modifications - Gene regulation- 'Lac' and 'Trp' operons.

Unit– 3 **(12 Hrs)**

Mutation - Types, Mutagens, Mutagenesis; Biochemical basis of Mutations – Spontaneous and Induced; Gene as a unit of mutation; Oncogenes and Cancer - Transforming viruses carrying oncogenes - Retroviral oncogenes - Immortalization & transformation; Reversion, suppression, genetic analysis of mutants; Transposons.

Unit– 4 **(12 Hrs)**

Gene transfer mechanisms - Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection); Conjugation - effective contact and pili in conjugation, F-factor, the conjugal transfer process; high frequency recombination (Hfr) strains; the order of chromosome transfer; formation of F prime (F').

Unit– 5 **(12 Hrs)**

Genetics of Bacteriophages – General properties, phage life cycles, phage counting, Host restriction and modification - Phage genetics I: phage T4 – Phage mutants, Genetic mapping of phage T4, features of the T4 life cycle. Phage genetics II: phage λ – λ DNA and its gene organization, outline of the life cycle of λ, λ DNA replication and phage production, recombination in the λ life cycle. Phage genetics III: Lysogeny – Immunity and repression, lysogenization and prophage insertion, prophage excision, Polylysogeny. Phage genetics IV: Transduction – DNA transfer by means of transduction, cotransduction and linkage, properties of specialized transducing prarticles.

Text book

- Molecular Biology. Freifelder, D. 2008. Narosa Publishing House, NewDelhi.

Reference Books

- Molecular Biology. 3rd Edition, David P. Clark, Nanette J. Pazdernik and Michelle R. McGehee. Academic Cell,USA
- Molecular Cell Biology. 2021. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K.C., Yaffe, M. and Amon, A. WH Freeman&Co.
- Genes VIII. Lewin B. 2004. Oxford UniversityPress.
- Molecular Biology. 4thEdition, 2008. Robert F. Weaver. McGraw – HillPublishers.
- Modern Microbial Genetics. 2ndEdition, 2002. Streips, U. N. and R. E. Yasbin. Wiley-Liss, Inc., NewYork.

YEAR - I	MICROBIAL ECOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB14
SEMESTER - I		HRS/WK - 4
CORE - 4		CREDITS - 4

Objective: To make the students understand the importance of microorganisms in ecology and theirapplications.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Gains knowledge about the basics of microbial ecology
CO2: Acquires knowledge about microbial interactions in various ecosystems
CO3: Understands the role of microorganisms in cycling of nutrients and biodegradation of pollutants
CO4: Gains knowledge about role of microorganisms in wastewater treatment
CO5: Acquires knowledge about quantitative studies and microbial applications in environment

SEMESTER: I	COURSE CODE: 21PMB14				COURSE TITLE: MICROBIAL ECOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3	4	4	4	4	3	3	3.62	
CO2	4	4	4	3	4	4	3	4	3.75	
CO3	4	3	4	3	4	4	4	3	3.62	
CO4	4	4	4	3	3	4	4	4	3.75	
CO5	4	4	4	3	4	4	3	4	3.75	
Mean Overall Score									3.70	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit– 1 **(12 Hrs)**

Microbial communities – terminology, ecological hierarchy, ecological niche; Microbial colonization - energy flow in ecosystem - Environmental factors affecting microbial populations; Adaptation of microorganisms in various ecosystem – Atmosphere - Microbiology of air, droplet nuclei, aerosols, enumeration of microorganisms in air, air sanitation, Laboratory hazards, airborne diseases.

Unit– 2 **(12 Hrs)**

Interaction of microorganisms with their physical and chemical environments; marine ecosystem - mangroves, estuaries, deep seas and hydrothermal vents; fresh water ecosystem - lakes, rivers, ponds; terrestrial ecosystem - rock and soil, prairie, forest, tundra; extreme environments – hot springs, glaciers and acid-mine drainage; interaction of microorganisms with plants, animals and microorganisms.

Unit– 3 **(12 Hrs)**

Biogeochemical cycles - carbon, nitrogen, sulfur, iron, and phosphorus cycles; adaptation of microorganisms to toxic pollutants; biodegradation of xenobiotics (pesticides, heavy metals, hydrocarbons) – mechanisms.

Unit– 4 **(12 Hrs)**

Waste water treatment - primary, secondary (anaerobic and aerobic - trickling, activated sludge, oxidation pond), Sludge digestion, Disposal; Drinking water treatment – chlorination; Microbiological standards of water; Water pollution - indicators of water pollution - BOD – COD - techniques for the study of water pollution; Waterborne diseases.

Unit– 5 **(12 Hrs)**

Quantitative microbial ecology - Culture based methods and molecular based methods; Composting – landfills; Bioleaching of metals - Biodeterioration of paint, textile and leather; biofouling; Biofilms; Microbial enhanced oil recovery.

Text Book

- Microbial Ecology - Fundamental and Applications. 4th Edition, 1998. Atlas & Bartha, Benjamin/ Curmmings Publishing Company, Inc.,California

Reference Books

- Environmental Microbiology. 1981. Grant W. D. and Long P.E. Blackie and Son Ltd,, Glasgow.
- Aquatic Microbiology. 2nd Edition, 1980. Rheinheimer, G. Jhon Wiley & Sons. New York.
- Environmental Aspects of Microbiology. 1996. Joseph C. Daniel. Brightsun Publications, Chennai.
- Environmental Microbiology. 2ndEdition, 2016. Mitchell, R and J.I. DongGu. John Wiley, NewYork.

YEAR - I	BIOINFORMATICS (For those students admitted in the year 2021 – 22 and onwards)	21EPM15A
SEMESTER - I		HRS/WK - 3
ELECTIVE – I A		CREDITS - 2

Objective: To make the students familiar with recent techniques in sequence analysis using data bases.

Course Outcomes:
Upon successful completion of the course, the student:
CO1:will be able to describe various sequence databases and sequence analysis methods
CO2:will understand the structural aspects of proteins *in silico*
CO3:will be able to appreciate the significance of Comparative Genomics
CO4:will be able to relate the basics of Functional Genomics and Proteomics with their application
CO5:will be able to apply the concept of Pharmacogenomics in Pharma industry

SEMESTER: I	COURSE CODE: 21EPM15A				COURSE TITLE: BIOINFORMATICS				HOURS: 3	CREDITS: 2
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3.5	4	3.5	4	4	4	4	3.9	
CO2	3.5	3.5	4	3.5	4	4	3.5	4	3.8	
CO3	3	3	4	3.5	4	4	3.5	3.5	3.6	
CO4	3	3.5	3.5	4	3.5	3.5	3	3.5	3.4	
CO5	3.5	3.5	3.5	4	4	3.5	3	4	3.6	
Mean Overall Score									3.7	

Result: The score of this course is 3.4 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit1 **(9 Hrs)**

Introductory basics - Historical introduction and overview of Bioinformatics; Databases – Introduction, Nucleotide sequence databases, Protein sequence databases, Sequence motif databases, Protein structure databases, Enzyme and pathway databases, Family and domain databases; Sequence Formats; Sequence analysis – Alignment of pairs of sequences, Multiple sequence alignments; Phylogenetic tree; Database searching for similar sequences – Scoring matrices, BLAST.

Unit2 **(9 Hrs)**

Structural Bioinformatics- Protein structure basics - Amino acids, Peptide formation, Secondary structures, Tertiary structures, Determination of protein three-dimensional structure; Protein structural visualization, Protein structure comparison, Protein structure classification; Protein secondary structure prediction - for globular proteins, for transmembrane proteins, Coiled coil prediction; Protein tertiary structure prediction, Methods, Homology modeling, Threading and fold recognition, Ab initio protein structural prediction, CASP.

Unit3: **(9 Hrs)**

Comparative Genomics:Purpose and Methods of comparison, Applications of Comparative Genomics - Reconstruction of metabolic pathway, predicting regulatory elements, Identifying targets, examination of domain function, analysis of conserved strings, gene mapping and study of human diseases; Genome projects and Model Organism research – Human Genome Project, *E. coli*, Yeast, *Drosophila*, *C. elegans* and Mouse.

Unit4 **(9 Hrs)**

Functional Genomics and Proteomics: Functional Genomics- Sequence-Based Approaches - SAGE; EST - clustering and assembly, EST databases (DBEST, UNIGENE), Microarray-based approaches; Proteomics**:** Technology of protein expression analysis, Post- translational modification, Protein sorting, Protein–Protein interactions.

Unit5 **(9 Hrs)**

Pharmacogenomics - Introduction, Benefits, Ethical issues, Pharmacogenomics in the treatment of cancer and cardiovascular diseases as examples. Process of drug development - clinical trials phase I, II and III. High throughput screening; Phage antibody as tool.

Text Book

- Bioinformatics – Methods and Applications. 3rd Edition, 2008. S. C. Rastogi, N. Mendiratta and P. Rastogi PHI Learning Private Limited, New Delhi.

Reference Books

- Bioinformatics. 2001. David W. Mount. CBS Publishers & Distributors, New Delhi.
- Fundamental Concepts of Bioinformatics. 2003. Dan E. Krane and Michael L. Razmer. Pearson Education Inc.UK
- Microarrays for an Integrative Genomics. 2004. Ed. I.S. Kohane, A.T. Kho and A.J. Buttle. Ane Books, New Delhi.

YEAR – I	LAB COURSE – I (For those students admitted in the year 2021 – 22 and onwards)	21PMBP11
SEMESTER - I		HRS / WK - 8
PRACTICAL		CREDITS - 4

EXPERIMENTS IN BASIC MICROBIOLOGY

1. Gram staining
2. Negative staining
3. Capsule staining
4. Spore staining
5. Hanging drop technique
6. Catalase test
7. Oxidase test
8. Indole test
9. Methyl red test
10. Voges proskauer test
11. Citrate utilization test
12. Urease test
13. Triple sugar iron agar test
14. Lysine iron agar test
15. Nitrate reduction test
16. Slide culture for fungi

EXPERIMENTS IN IMMUNOLOGY

1. Separation of serum
2. Separation of plasma
3. ABO blood grouping by reverse grouping
4. ASO semi quantitative test
5. Single radial immunodiffusion
6. Double immunodiffusion
7. Rocket immunoelectrophoresis
8. Serum electrophoresis
9. Isolation of lymphocytes
10. Dot ELISA

EXPERIMENTS IN ENVIRONMENTAL MICROBIOLOGY

1. Enumeration of total coliform by MPN method
2. Enumeration of faecal coliform by MPN method
3. Membrane filter technique
4. Biochemical oxygen demand
5. Nitrogen cycle:
   a. Ammonification
   b. Nitrification
   c. Denitrification

EXPERIMENTS IN BIOSTATISTICS

1. Testing the difference between means of two samples (independent)
2. Testing the difference between means of two samples (dependent)
3. Chi square test for independence of attributes
4. F – test (or) the variance ratio test
5. One way analysis of variance (anova)
6. Randomized block design(rbo)
7. Latin square design(lsd)

EXPERIMENTS IN BIOINFORMATICS

1. Pair wise alignment
2. Blast

YEAR - I	MICROBIAL PHYSIOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB21
SEMESTER - II		HRS/WK - 4
CORE - 5		CREDITS - 4

Objective: To enable students to understand the physiology of microorganisms.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Acquires knowledge about microbial nutrition and pure culture methods.
CO2: Attains knowledge about microbial growth.
CO3: Learns about bioenergetics, enzymes and redox.
CO4: Gains knowledge about catabolism.
CO5: Gains knowledge about anabolism.

SEMESTER: II	COURSE CODE: 21PMB21				COURSE TITLE: MICROBIAL PHYSIOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	3.5	4	3.5	4	3.5	4	3.5	3.68	
CO2	3	3.5	4	3.5	3.5	4	3.5	4	3.62	
CO3	3.5	4	4	3.5	4	3.5	4	3.5	3.75	
CO4	3.5	3.5	3.5	3.5	4	4	3.5	4	3.68	
CO5	4	4	3	3	4	3	3.5	4	3.56	
Mean Overall Score									3.66	

Result: The score of this course is 3.66 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(12 Hrs)**

Microbial Nutrition: Nutritional requirements; Nutritional types of microorganisms; Growth factors; Uptake of nutrients – passive diffusion, facilitated diffusion, active transport, group translocation and iron uptake; Bacteriological media – types of media - Isolation of pure culture - streak plate, pour plate and spread plate; Methods of maintenance and preservation of microorganisms; Culturecollections.

Unit-2 **(12 Hrs)**

Microbial Growth: Growth curve of bacteria– phases of growth, synchronous growth, mathematics of growth; Measurement of microbial growth; Continuous culture of microorganisms – chemostat and turbidostat; Influence of environmental factors on growth – solutes and water activity, pH, temperature, oxygen concentration, pressure and radiation; Microbial growth in natural environments – biofilms, cell-cell communication within microbial populations.

Unit-3 **(12 Hrs)**

Introduction to Metabolism:Energy and work, Laws of thermodynamics, Free energy and reactions, ATP, oxidation-reduction reactions, Electron transport chains, Enzymes, Ribozymes, Regulation of metabolism, Post translational regulation of enzyme activity.

Unit-4 **(12 Hrs)**

Catabolism:Aerobic respiration; Glycolysis - Embden-Meyerhof pathway, Pentose phosphate pathway and Entner-Doudoroff pathway; Tricarboxylic acid cycle; Electron transport and oxidative phosphorylation; Anaerobic respiration; Fermentation; Catabolism of carbohydrates and intracellular reserve polymers; Lipid catabolism; Protein and amino acid catabolism, chemolithotrophy; Phototrophy.

Unit-5 **(12 Hrs)**

Anabolism: Carbon di oxide fixation; Synthesis of sugars and polysaccharides; Synthesis of amino acids; Synthesis of purines, pyrimidines and nucleotides; Lipid synthesis.

Text Book

- Microbial Physiology. 2002 (4th Edition). Moat AG, Foster JW, Spector MP. Wiley-Liss, Inc., NewYork.

Reference Books

- Microbial Physiology and Metabolism. 1995. Caldwell D.R. McGraw Hill Education, USA.
- Bacterial Physiology and Metabolism. 1st Edition, 2008. Kim B.H. and Gadd G.M, Cambridge University Press, Cambridge.
- Microbial Physiology. 1992 (2ndEdition). Dawes I.W. and Sutherland I.W. Blackwell Scientific Publications,London.
- Advances in Microbial Physiology. 2016 (1stEdition). Robert Poole K. Academic Press,London.
- The Physiology and Biochemistry of Prokaryotes. 2011 (4thEdition). White D., Drummond J. and Fuqua C. Oxford University Press,London.

YEAR - I	FERMENTATION TECHNOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB22
SEMESTER - II		HRS/WK - 4
CORE - 6		CREDITS - 4

Objective: To make the students familiar with Microbiological techniques and applications in fermentationindustry.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Imparts knowledge on bioprocess techniques and fermenter design
CO2: Learns the basic operations of fermenter
CO3: Acquires knowledge about Strain development, preservation and media formulation
CO4: Gets familiar with product recovery
CO5: Gains knowledge about stoichiometry of cell growth and product formation.

SEMESTER: II	COURSE CODE: 21PMB22				COURSE TITLE: FERMENTATION TECHNOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	4	4	3.5	4	3.5	4	3.5	3.8	
CO2	4	4	4	3.5	4	3.5	2.5	3	3.6	
CO3	4	3.5	3.5	3.5	4	4	3	4	3.7	
CO4	3.5	4	3	3.5	4	3.5	3	3	3.4	
CO5	4	3.5	4	4	4	4	3	3.5	3.8	
Mean Overall Score									3.7	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit– 1 **(12Hrs)**

Historical development of bioprocess technology, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets - General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries - aerator, agitator, valves. steam traps, stirrer and seals; Main parameters to be monitored and controlled in fermentation processes - asepsis and containment requirements - body construction and temperature, pH control - aeration and agitationsystems.

Unit– 2 **(12 Hrs)**

Sterilization of fermentor; Design of sterilization equipment - aseptic inoculation methods, sampling methods - valve systems - monitoring and control devices and types of fermentors – An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry; solid-substrate fermentation and its applications.

Unit– 3 **(12 Hrs)**

Screening and strain development strategies – preservation of industrially important microorganisms - Fermentation media - Desired qualities - Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, media formulation strategies - formulation of optimal growth and product formation, examples of simple and complex media; role of buffers, precursors, inhibitors, inducers and antifoams - design and usage of various commercial media for industrial fermentations - Sterilization methods – Batch and Continuous sterilization of medium and air - thermal death kinetics of microorganisms - filter sterilization of liquid media, air.

Unit– 4 **(12 Hrs)**

Downstream process - Objectives and criteria - foam separation - precipitation methods - filtration devices and filter aids - industrial scale centrifugation and cell disruption methods - liquid-liquid extraction - solvent recovery – chromatography - two-phase aqueous extraction - ultrafiltration, drying devices, crystallization and whole broth processing-Product formulation – Fermentation economics.

Unit– 5 **(12 Hrs)**

Stoichiometry of Cell growth and product formation, degrees of reduction of substrate and biomass, yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth - Phases of cell growth in batch cultures, product formation kinetics, substrate and product inhibition on cell growth and product formation.

Text Book

- Biotechnology. 2nd Edition, 2000. Crueger W. and A Crueger. Panima Publishing Corporation, New Delhi.

Reference Books

- Industrial Microbiology; An Introduction. 2001. Waits, M.J., N.L. Morgan and G. Higton. Blackwell Science,Oxford.
- Prescott & Dunn's Industrial Microbiology. 4lh Edition, 1982. Reed, G. CBS Publishers Distributors,Delhi.
- Microbial Technology-Fermentation Technology. 2nd Edition, 2004. Peppler. H. J. and D. Perlman. Academic Press,Madison.
- Principles of Fermentation Technology. 3rdEdition, 2016. Stanbury. P. A. Whitaker and S. Hall. Butterworth-Heinemann.Oxford.

YEAR – I	MEDICAL MICROBIOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB23
SEMESTER - II		HRS/WK - 4
CORE – 7		CREDITS - 4

Objective: To make the students familiar with various disease-causing microorganisms.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Becomes familiar with Host-parasite relationship
CO2: Acquires knowledge about the diseases caused by bacteria and their characteristics
CO3: Attains knowledge about fungal infections
CO4: Learns about parasitic and worm infections
CO5: Gains knowledge about pathogenesis and laboratory diagnosis of viruses

SEMESTER: II	COURSE CODE: 21PMB23				COURSE TITLE: MEDICAL MICROBIOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	3.5	4	4	4	3.5	4	4	3.81	
CO2	3	3.5	4	3.5	3.5	4	3.5	4	3.62	
CO3	3.5	4	4	3.5	4	3.5	4	3.5	3.75	
CO4	3.5	3.5	3.5	3.5	4	4	3.5	4	3.68	
CO5	4	4	3	3	4	3	3.5	4	3.56	
Mean Overall Score									3.68	

Result: The score of this course is 3.68 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1: **(12 Hrs)**

Host -parasite relationship - General attributes and virulence factors of bacteria causing infections – Pathogenicity and laboratory diagnosis of infections caused by selected bacteria - Staphylococci, Streptococci, *Neisseria*, Corynebacteria, *Escherichia coli*, *Salmonella*, *Shigella*, *Vibrio*.

Unit-2: **(12 Hrs)**

Pathogenicity and laboratory diagnosis of infections caused by selected bacteria (contd.) - *Bacillus, Clostridium*, *Mycobacterium, Yersinia*, *Haemophilus*, *Helicobacter, Bordetella, Legionella*, *Listeria,* Rickettsiae, *Chlamydia*, Spirochaetes, *Mycoplasma*.

Unit-3: **(12 Hrs)**

Characteristics of fungi; Pathogenesis and Lab diagnosis of selected fungal infections - Superficial mycoses – Surface mycoses - *Malassezia* infections, Tinea nigra, Piedra; Cutaneous mycoses – Dermatophytoses; Subcutaneous mycoses - Mycotic mycetoma; Systemic mycoses – Histoplasmasis, Blastomycosis, Coccidioidomycosis; Opportunistic Mycoses; Yeasts of medical importance - *Candida*, *Cryptococcus*.

Unit-4: **(12 Hrs)**

Brief account of selected parasites - *Entamoeba histolytica, Giardia intestinalis, Trichomonas vaginalis, Plasmodium, Cryptosporidium, Pneumocystis carinii, Taenia saginata, Taenia solium, Schistoma haematobium, Ancylostoma duodenale, Ascaris lumbricoides, Wuchereria bancrofti.*

Unit-5: **(12 Hrs)**

General properties of viruses - Outline of animal tissue culture - Virus-Host interactions – Brief account of the following viruses - Pox viruses, Herpes viruses, Adeno viruses, Picorna viruses, Orthomyxo viruses, Paramyxo viruses, Arboviruses, Rhabdo viruses, Hepatitis viruses, Rubella virus, Rota virus, Corona Viruses, Retroviruses.

Text Book

- Text Book of Microbiology. 9^{lh} Edition, 2013. Ananthanarayanan, R and C.K.J. Panicker. Orient Longman Private Ltd.,Chennai.

Reference Books

- Jawetz, Melnick &Adelberg's Medical Microbiology. 24thEdition, 2007. Geo F Brooks, Karen C Carroll, Janet S Butel, Stephen A Morse.McGraw-Hill.
- Medical Microbiology. 7th Edition, 2012. Ken S. Rosenthal, Michael A. Pfaller, and Patrick R Murray. Elsevier HealthSciences.
- Medical Microbiology - A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Investigation and Control. 19th Edition, 2018. Editors: Michael Barer W L Irving.Elsevier.

YEAR - I	MICROBIAL GENOMICS (For those students admitted in the year 2021 – 22 and onwards)	21PMB24
SEMESTER - II		HRS/WK - 4
CORE - 8		CREDITS - 4

Objective: To make the students understand the genome of microorganisms.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: will be able to interpret the basics of Genomics
CO2: will be able to correlate Genomics with Microbial evolution
CO3: will be able to understand the role of DNA microarray technology in Genomics
CO4: will be able to describe the functional genomics of model organisms
CO5: will be able to comprehend the Genomic analysis of selected bacteria

SEMESTER: II	COURSE CODE: 21PMB24				COURSE TITLE: MICROBIAL GENOMICS				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	4	4.5	4	4	4	3.5	4	4.0	
CO2	4	4	4	3.5	4	3.5	2.5	3	3.6	
CO3	4	3.5	3.5	3.5	4	4	3	4	3.7	
CO4	3.5	4	3	3.5	4	3.5	3	3	3.4	
CO5	4	3.5	4	4	4	4	3	3.5	3.8	
Mean Overall Score									3.7	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(12 Hrs)**

Genomics:Introduction, Definitions, Historical Perspectives, Scope and General Approaches;Microbial Diversity and Genomics - Genome analysis, Next-generation sequencing,Properties of genomes, Genome size, Gene families, Skew, GC content, and codon usage; Prokaryotic genomes, Microbial eukaryoticgenomes.

Unit-2 **(12 Hrs)**

Microbial evolution and Genomics: Identification of Orthologous Genes; Genome Perspectives on Molecular Clock; Genome Perspectives on Horizontal Gene Transfer - Identification of HGT, Mechanisms underlying HGT, Types of genes subjected to HGT, Evolutionary impact of HGT; Genomic Perspectives on Gene Duplication, Gene Loss, and Other Evolutionary Processes; Universal Tree of Life - Genome-based phylogenetic analysis; Minimal Genomes

Unit-3 **(12 Hrs)**

DNA microarray technology: Types of Microarrays and Advantages; Microarray Fabrication; Microarray Hybridization and Detection; Microarray Image Processing; Using Microarrays to Monitor Gene Expression; Microarray Gene Expression Data Analysis

Unit-4 **(12 Hrs)**

Thefunctionalgenomicsofmodelorganisms:*Escherichiacoli*:AModelEubacterium-
E. coli genome, transcriptomics, proteomics, Modeling *E. coli* metabolism; *Bacillus subtilis*:- *B. subtilis* genome, transcriptomics, proteomics; *Saccharomyces cerevisiae*: A Model for higher eukaryotes - Yeast genome, transcriptomics, proteomics, interactome, Comparison with Genomics of Model Eukaryotic Organisms.

Unit-5 **(12 Hrs)**

Genomic analysis of bacterial pathogens and Environmentally significant microorganisms: Understanding bacterial pathogenesis through genome sequence and function annotation, Predicting virulence genes from sequence homology, Evolution of bacterial pathogens: gene acquisition and loss, Comparative Genomics: Clues to Bacterial Pathogenicity, The genomics of *Mycobacterium tuberculosis*: virulence gene identification and genome plasticity, Microarray-based comparative genomics of *Helicobacter pylori*, Sequence comparison of pathogenic and nonpathogenic species of *Listeria*; *E. coli* K1: identification of invasion genes; Genome Sequence and Functional Analysis of Environmentally Important Microorganisms - Dissimilatory metal ion-reducing bacterium *Shewanella oneidensis;* Extreme radiation-resistant bacterium *Deinococcus radiodurans*; Hyperthermophilic archaeon *Pyrococcus furiosus*.

Text book

- Microbial Functional Genomics. Jizhong Zhou, Dorothea K. Thompson, Ying Xu, James M. Tiedje. 2004. John Wiley & Sons, Inc., Hoboken, NewJersey.

Reference Books

- An Introduction to Ecological Genomics. Second Edition. 2012. Nico M. van Straalen and Dick Roelofs. Oxford University Press Inc., NewYork.
- Microbial Genomes. 2004. Claire M. Fraser, Timothy Read and Karen E. Nelson. (Eds.). HumanaPress.
- Functional Microbial Genomics**.** 2002**.** Editors: Brendan Wren **and** Nick Dorrell**.** AcademicPress**.**

YEAR – I	RESEARCH METHODOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21EPM25A
SEMESTER – II		HRS / WK - 3
Elective – III A		CREDIT - 2

Objective: To make the students understand the concept behind designing the research, data collection and data analysis using statistical methods.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Acquires knowledge about Research and Experimental designs
CO2: Becomes familiar with Citation and Impact factor
CO3: Learns about preparing Research Report
CO4: Understands the role of committees in biological research
CO5: Gains knowledge about General Laboratory Procedures

SEMESTER: II	COURSE CODE: 21EPM25A				COURSE TITLE: RESEARCH METHODOLOGY				HOURS: 3	CREDITS: 2
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3.5	4	3.5	4	4	4	4	3.87	
CO2	3.5	3.5	4	4	4	3.5	3.5	4	3.75	
CO3	4	3.5	4	4	3.5	4	4	4	3.56	
CO4	3	3.5	3.5	4	4	3	3	3.5	3.87	
CO5	3.5	3.5	3.5	3.5	4	3.5	3	3.5	3.50	
Mean Overall Score									3.71	

Result: The score of this course is 3.71 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit1 **(9 Hrs)**
Research – Definition – Experimental designs - Identification, Selection and formulation of research problem – Research questions – Research Hypothesis.

Unit2 **(9 Hrs)**
Literature Collection – Literature Citation - Major search engines - Major Websites, book and scientific information – Journals – Impact factor.

Unit3 **(9 Hrs)**
Research Report – Components of a Research Report – Authors and Addresses – Abstract – Synopsis – Key words – Introduction – Materials and Methods – Results – Discussion – Acknowledgements – Summary and Conclusions – Appendixes – References - Title – Tables – Figures – Formatting andTyping.

Unit4 **(9 Hrs)**

Biological research - Institutional Ethical committee – Animal ethical committee – Use of laboratory animals in research - Laboratory animal management.

Unit5 **(9 Hrs)**

General Laboratory Procedures – pH, Buffers, Electrodes and Biosensors – Estimation of Carbohydrates (Bradford Method) – Protein (Lowry Method) – Lipid (Soxlet Method) – Nucleic Acid (Spectrophotometry) – Techniques for Sample Preparation.

Text Books

- Research Methodology: For Biological Sciences. Dr. N. Gurumani. 2006, MJP Publishers.
- Biophysical Chemistry Principles and Techniques. Upadhyay, Upadhyay and Nath. 1997. Himalaya Publications.

Reference Books

- Y. K. Singh and R. B. Bajpai, Research Methodology Data Presentation, 2008. APH Publishing Corporation, NewDelhi**.**
- Modern Experimental Biochemistry. 3rdEdition, 2000. Rodney Boyer. Addison Wesley Longman,Inc.
- A Biologists guide to Principles and Techniques of Practical Biochemistry. 5thEdition, 2000. Wilson and Walker. Cambridge University Press.
- Physical Biochemistry. 2ndEdition, 1982. David Freifelder. W. H. Freeman and Company, NewYork.

YEAR – I	METHODS IN BIOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21EPM26A
SEMESTER - II		HRS / WK - 3
ELECTIVE – IV A		CREDIT - 2

Objective:
To make the students familiar with techniques routinely used in bio sciences

Course Outcomes:
Upon successful completion of the course, the student:
CO1: acquires the knowledge about the study of advanced techniques in biology
CO2: gains the knowledge about the biophysical techniques used to detect functional structure of biological samples
CO3: gets insight knowledge about radioisotopes and its application
CO4: gets depth insights about the electrophysiological methods.
CO5: acquires the knowledge about the animal population and migration through remote sensor technique.

SEMESTER: II	COURSE CODE: 21EPM26A				COURSE TITLE: METHODS IN BIOLOGY				HOURS: 3	CREDITS: 2
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3.5	4	3.5	4	4	4	4	3.87	
CO2	3.5	3.5	4	4	4	3.5	3.5	4	3.75	
CO3	4	3.5	4	4	3.5	4	4	4	3.56	
CO4	3	3.5	3.5	4	4	3	3	3.5	3.87	
CO5	3.5	3.5	3.5	3.5	4	3.5	3	3.5	3.50	
Mean Overall Score									3.71	

Result: The score of this course is 3.71 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit1 **(9 Hrs)**
Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, atomic force microscope, circular dichroism, NMR and ESR spectroscopy

Unit2 **(9 Hrs)**
Biophysical methods: structure determination using X-ray diffraction, X-ray photoelectron spectroscopy; analysis using light scattering, different types of mass spectrometry, Optical Tweezers

Unit3 **(9 Hrs)**
Radiolabeling techniques:Properties of radioisotopes, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines for removal of radioactivewastes.

Unit4 **(9 Hrs)**

Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

Unit5 **(9 Hrs)**

Methods in field biology**:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.

Text Book

- Biophysical Chemistry Principles and Techniques, (4th Edition) Upadhyay, Upadhyay and Nath, 2009, Himalaya Publications,India

Reference Book

- A Biologists guide to Principles and Techniques of Practical Biochemistry, (8th Edition), Wilson and Walker, 2018, Cambridge UniversityPress.
- Physical Biochemistry, (2nd Edition) David Freifelder, 1982, W. H. Freeman and Company, NewYork.
- Modern Experimental Biochemistry (3rdEdition) Boyer, R. 2000, Addison Wesley Longman.
- Fundamentals and Techniques of Biophysics and Molecular Biology, (1stedition), Pranavkumar, 2016, Pathfinder Publication, New Delhi.
- Biophysics Tools and Techniques, (1stedition), Mark C. Leake, 2016, CRC press.UK

YEAR – I	LAB COURSE – II (For those students admitted in the year 2021 – 22 and onwards)	21PMBP22
SEMESTER - II		HRS / WK - 8
PRACTICAL		CREDITS - 4

EXPERIMENTS IN MICROBIAL PHYSIOLOGY

1. Micrometry
2. Direct microscopiccount
3. Starch hydrolysistest
4. Casein hydrolysistest
5. Lipid hydrolysistest

EXPERIMENTS IN MEDICAL MICROBIOLOGY

1. Throat swab
2. Blood culture
3. Faecal culture
4. Cholera stool sample
5. Dermatophytes –LPCB
6. Assimilation Test foryeast
7. Floatation and Sedimentation ofParasites
8. MIC Phenol Co-efficienttest
9. Antibiotic Sensitivitytest
10. β – Lactamaseactivity

EXPERIMENTS IN FERMENTATION TECHNOLOGY

1. Amylase production and Estimation
2. Wine Production
3. Screening for antibiotic producing bacteria
4. Microbial Limit Test

EXPERIMENTS IN RESEARCH METHODOLOGY

1. Agarose gel electrophoresis
2. Preparation of acetatebuffer
3. Lowry's method for proteinestimation

YEAR - II	SOIL AND AGRICULTURAL MICROBIOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB31
SEMESTER - III		HRS/WK - 4
CORE - 9		CREDITS - 4

Objective: To make the students understand the importance of microbiology in the field of soil and agriculture

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Understands the soil properties and the role of soilborne microbes
CO2: Understands the cyclical movements of important plant nutrients in the soil
CO3: Gains knowledge about different biofertilizers and their production
CO4: Understands different biopesticides and theirapplications
CO5: Knows important plant diseases of India and theircontrol

SEMESTER: III	COURSE CODE: 21PMB31				COURSE TITLE: SOIL AND AGRICULTURAL MICROBIOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3.5	4	3.5	4	4	4	4	3.87	
CO2	3.5	3.5	4	4	4	3.5	3.5	4	3.75	
CO3	3.5	3	4	3.5	3.5	4	3.5	3.5	3.56	
CO4	3	3.5	3.5	3.5	4	3.5	3	3.5	3.43	
CO5	3.5	3.5	3.5	4	4	3.5	3	4	3.62	
Mean Overall Score									3.64	

Result: The score of this course is 3.64 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit–1 **(12Hrs)**

Soil- Chemical and physical properties of soil -Types-Soil as a habitat for microbes - Microflora of various soil types-Influence of soil and environmental factors on soil microflora - Role of microorganisms in soil fertility- Interaction among soil microorganisms- Interaction between plants and microorganisms - Rhizosphere, Phyllosphere, Spermosphere; Effect of soil borne microbes on plant (Harmful and Beneficial) - Plant Growth Promoting Rhizobacteria (PGPR), Mechanisms of plant growth promotion byPGPR.

Unit–2 **(12Hrs)**

Microorganisms in soil process - Carbon cycle, Nitrogen cycle, Iron cycle, Phosphorus cycle - Nitrogen fixation – Types - symbiotic, free living and associative symbiotic - Mechanism of nitrogen fixation- Genetics of nitrogen fixation- Solubilizationof nutrients (P, K and Zn) - Mobilization of nutrients(Mycorrhizae).

Unit-3 **(12Hrs)**

Biofertilizers - Definition, types and importance - Standards and quality control- Carrier materials- Isolation and mass multiplication of bacterial biofertilizers (*Rhizobium*, *Azospirillum*, *Azotobacter*, *Pseudomonas*) - Isolation and mass multiplication of fungal biofertilizer (VAM) - Isolation and mass multiplication of algal biofertilizers (BGA, *Azolla*)- Applications - National and regional biofertilizers production and development centers- Advantages and disadvantages of biofertilizers.

Unit–4 **(12Hrs)**

Problems associated with chemical pesticides; Biocontrol agents - Definition, Types and importance, Examples and mechanisms of controlling – *Bacillus thuringiensis*, *Pseudomonas fluorescence*, *Trichoderma viridae*, NPV, Entamopathogenic protozoa and Entamopathogenic nematodes - Production and applications; Advantages and disadvantages; Microbial genes in creation of pest resistant plants.

Unit–5 **(12Hrs)**

Microbial Diseases of plants - disease symptoms, - mode of entry of pathogens – factors affecting disease incidence – control measures - Examples -Bacterial Diseases: Bacterial Blight of Paddy, Citrus Canker - *Mycoplasma* Diseases: Rice Yellow Dwarf, Grassy shoot of sugarcane, Fungal Diseases: Late Blight of Potato, Downy Mildew of Maize, Rust of Wheat, Wilt of Cotton, Leaf Spot of Turmeric, Blast disease of Rice, Mango Anthracnose - Viral Diseases: Leaf Curl of Tomato, Yellow Vein Mosaic of Bhendi – Nematode Diseases: Ear Cockle of Wheat, root knot of vegetables.

Text Books

- Soil Microbiology - Soil microorganisms and Plant growth. 4th Edition, 2017. Subba Rao, N.S. Oxford & IBH publishing Co. Pvt.Ltd.
- Agricultural microbiology. 2nd Edition, 2004. Rangaswami, G., and Bhagyaraj, D.J. Prentice Hall of India, New Delhi.

Reference Books

- Plant diseases. 10th Edition. Singh, R.S. 2017. Medtech, NewDelhi
- Diseases of crop plants in India. 1998. 4th Edition. G. Rangaswami, A. Mahadevan. Prentice - Hall of India Private Ltd., NewDelhi.
- A Text book of Microbiology. 2013. Dubey, R.C., and Maheshwari, D.K. S Chand Publishing, NewDelhi.
- Biofertilizers: Commercial production Technology and quality control. Hyma, P. 2017. Random publishers. New Delhi.
- Biofertilizer Technology. 2019. Ramanathan, N. Kalyani Publishers, NewDelhi.

YEAR - II	r-DNA TECHNOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB32
SEMESTER - III		HRS/WK - 4
CORE - 10		CREDITS - 4

Objective: To make the students familiar with techniques in recombination technology**.**

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Learns the available genetic engineering tools & molecular techniques
CO2: Learns the importance of Cloning vectors
CO3: Acquires knowledge about Cloning strategies
CO4: Understands the expression of cloned DNA molecules
CO5: Learns the importance of Genome Editing using r-DNA technology.

SEMESTER: III	COURSE CODE: 21PMB32				COURSE TITLE: r-DNA TECHNOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	3.5	4	3.5	4	3	4	3	3.56	
CO2	4	4	3.5	4	3	3.5	3.5	4	3.69	
CO3	3.5	3.5	4	3	4	3.5	4	3.5	3.63	
CO4	4	4	3.5	3	3.5	4	3	3	3.50	
CO5	4	3.5	4	3	4	3.5	4	3	3.63	
Mean Overall Score									3.60	

Result: The score of this course is 3.60 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit1 **(12 Hrs)**

Molecular Techniques: Agarose gel electrophoresis, Nucleic acid blotting, Southern blotting, Northern blotting, Western blotting, Transformation of *E. coli* - Cutting and Joining DNA **molecules** - Host-controlled restriction and modification, Restriction Endonucleases, Nomenclature, Mechanical shearing of DNA, Joining DNA molecules (DNA ligase, Double linkers, Adaptors, Homopolymer tailing)

Unit2 **(12 Hrs)**

Cloning vehicles for use in *E. coli*: Construction and characterization of a new cloning vehicle: pBR322, Improved vectors derived from pBR322, Direct selection vectors, Low-copy-number plasmid vectors, Runway plasmid vectors - Bacteriophage and cosmid vectorsfor*E.coli*-Bacteriophageλ,VectorDNA,Improvedphageλvectors,Packaging phage λ DNA in vitro, Cosmid vectors, Phagmid vectors.

Unit3 **(12 Hrs)**

Cloning Strategies, Gene Libraries and cDNA Cloning:Cloning strategies, Chromosome walking, cDNA cloning, Full-length cDNA cloning, Genomic and cDNA libraries; Recombinant Selection and Screening - South-Western screening for DNA-binding proteins, Nucleic acid hybridization methods.

Unit4 **(12 Hrs)**

Expression of Cloned DNA molecules in *E. coli*: Expression of fusion proteins, Manipulation of cloned genes to achieve expression of native proteins, Secretion of proteins, Detecting expression of cloned genes, Maximizing the expression of cloned genes, Constructing the optimal promoter, The effect of plasmid copy number.

Unit5 **(12 Hrs)**

Genome Editing Technology**:** DNA finger printing and Foot printing, Restriction fragment Length Polymorphism (RFLP) analysis, RAPD, Genome Editing: ZFN, TALENS, CRISPR Applications of recombinant DNA technology - Production of Recombinant and Synthetic Vaccines; Genetically modified microorganisms; Recombinant proteins as therapeutic agents; Ethical and legal issues in rDNA technology.

Text Book

- Principles of Gene manipulation. 5th Edition, 1994. Old, R.W. and S.B. Primrose. Blackwell Science,Oxford.

Reference Books

- Molecular Biology of the Gene. 5th Edition, 2004. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Pearson Education.Inc.
- Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition, 2001. Helen Kruez. ASMpublications.
- From Genes to Clones. 2003. Ernst-L. Winnacker. Panima Publishing Corporation, New Delhi.
- Genetics - A Molecular Approach. 2004. Brown, T.A. Chapman Hall.London.
- Molecular Biotechnology - Principles and Applications of Recombinant DNA technology. 2006. Glick, B.R. and J.J. Pasternak. ASM press,Washington.

YEAR - II	FOOD MICROBIOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB33
SEMESTER - III		HRS/WK - 4
CORE - 11		CREDITS - 4

Objective: To make the students understand the importance of microbiology in the field of food industry.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Recognizes the principles of food preservation and the factors that influence growth and survival of microorganisms in food.
CO2: Understands the importance of fermented dairy and nondairy foods and probiotics.
CO3: Acquires knowledge on food spoilage and foodborne diseases.
CO4: Comprehends and applies the standard methods for microbiological analysis of foods.
CO5: Gains knowledge on food regulatory agencies and policies related to food safety and quality.

SEMESTER: III	COURSE CODE: 21PMB33				COURSE TITLE: FOOD MICROBIOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	4	4.5	4	4	4	3.5	4	4.0	
CO2	4	4	4	3.5	4	3.5	2.5	3	3.6	
CO3	4	3.5	3.5	3.5	4	4	3	4	3.7	
CO4	3.5	4	3	3.5	4	3.5	3	3	3.4	
CO5	4	3.5	4	4	4	4	3	3.5	3.8	
Mean Overall Score									3.7	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(12 Hrs)**

Importance of studying food and dairy microbiology; Microorganisms important in food microbiology; Food as a substrate for microorganisms, Extrinsic and Intrinsic factors; Food preservation methods with principles - physical irradiation, drying, heat processing - high temperature, low temperature; modification of atmosphere; Food additives – sodium chloride, sugar, vinegar, class I and class II preservatives.

Unit-2 **(12 Hrs)**

Food fermentations – Meat Products, Fish Products, Idly, Breads, Sauerkraut, Pickles; therapeutic and nutritional value of fermented foods; Milk and Milk products; fermented dairy products - butter, cheese, yogurt, acidophilus milk; Spoilage and defects of fermented dairy products; Milk preservation methods – pasteurization, sterilization; Probiotics, Prebiotics and Symbiotics - Definition and Health benefits.

Unit-3 **(12 Hrs)**

Contamination and spoilage: vegetables, fruits, cereals, meat products, fish and sea foods, Poultry and egg; Food poisoning and food borne infections by bacteria such as *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio*, fungi and viruses; bacterial and fungal exo- and endo- toxins; Food borne disease outbreaks.

Unit– 4 **(12 Hrs)**

Detection of food borne microorganisms: Culture, Microscopic and sampling methods – Chemical methods (Thermostable nuclease, Limulus lysate for endotoxin, Adenosine triphosphate measurement), Immunological Methods (Serotyping, Fluorescent Antibody, Enrichment serology, Radioimmunoassay and ELISA), Molecular Genetic methods (Nucleic acid probe, PCR), Fingerprinting methods (AFLP, Ribotyping, Microarrays) and Physical methods (Biosensor, Flow Cytometry).

Unit– 5 **(12 Hrs)**

Food safety and Quality control: Principles of quality control and microbiology criteria, Indicators of product quality, Indicators of food safety, Predictive Microbiology, Hazard analysis Critical Control Point (HACCP), Good Manufacturing process (GMP) - Food control agencies and its regulations (Codex Alimentarius, NABL, FDA, EPA and ISI).

Text Book

- Modern food microbiology. 7th Edition, 2005. James M. Jay, Martin J. Loessner, David A. Golden. Springer Science &Business.

Reference Books

- Food Microbiology. 5th Edition, 2013. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha. McGraw-Hill Education(India).
- Food Microbiology, 1st Edition, 2016. Foster, W. M. CBS Publishers and Distributors Pvt. Ltd., NewDelhi.
- Food Microbiology, 4th Edition, 2015. Adams, M.R., Moss, M.O and McClure, P. J. RSC Publication, CPI Group (UK) Ltd., Croydon, UK.
- FoodMicrobiology-FundamentalsandFrontiers.2ndEdition,2001.Doyle,M.P.,L. R. Beuchat and T. J. Montville. ASM Press. Washington, D.C.
- The Microbiological Safety and Quality of Food. 2000. Barbara M. Lund, Baird-Parker, Gould G.W. An Aspen publication, Maryland, U.S.A.

YEAR - II	HUMAN INFECTIONS AND DIAGNOSIS (For those students admitted in the year 2021 – 22 and onwards)	21PMB34
SEMESTER - III		HRS/WK - 4
CORE - 12		CREDITS - 4

Objective: To make the students familiar with clinical manifestations and diagnosis of various microbial infections.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: will be able to describe various methods of diagnosis
CO2: will be able to describe the infections in Respiratory and Genitor-urinary tract
CO3: will be able to describe the infections in Gastrointestinal and Central nervous system
CO4: will be able to distinguish infections caused by vectors and animals
CO5: will learn the methods of Antimicrobial susceptibility testing

SEMESTER: III	COURSE CODE: 21PMB34				COURSE TITLE: HUMAN INFECTIONS AND DIAGNOSIS				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	4	4	4	4	4	4	4	4.0	
CO2	3.5	3.5	3	4	4	3	2	4	3.4	
CO3	3.5	3.5	3	4	4	3	2	4	3.4	
CO4	4	4	4	4	4	3.5	2.5	3.5	3.7	
CO5	4	4	4	4	4	4	4	4	4.0	
Mean Overall Score									3.7	

Result: The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(12 Hrs)**

Background to the infectious diseases; Transmission; Specimen Processing; Non-cultural Techniques; Cultivation of Microorganisms; Identification of Microorganisms; Antibody detection methods; Assessment of host defense systems.

Unit-2 **(12 Hrs)**

Clinical manifestations and diagnosis of infections by body system –Upper respiratory tract infections; Lower respiratory tract infections; Urinary tract infections; Sexually transmitted diseases.

Unit-3 **(12 Hrs)**

Gastrointestinal tract infections; Obsteric and perinatal infections; Central nervous system infections; Infections of the eye; Infections of the skin, muscle, joints, bone and hemopoietic system.

Unit-4 **(12 Hrs)**

Vector borne infections; (Rickettsial diseases, Malaria, Dengue as examples); Multisystem Zoonoses; Pyrexia of unknown origin – Infections in the compromised host - Hospital acquired infection.

Unit-5 **(12 Hrs)**

Anaerobic culture; Serological tests; Nucleic acid techniques in Diagnostic Microbiology; Antimicrobial susceptibility testing - General principles, Clinical definition of terms "resistant" and "susceptible" - the three-category system, The modified Kirby–Bauer method, Determination of MIC, Quality control.

Text Book

- Mims' Pathogenesis of Infectious Diseases. 4th Edition, 1995. Mims, C.A. Academic Press,London.

Reference Books

- Medical Microbiology. 21st Edition, 1998. Brooks, G.F., Janet S. Butel, Stephen A, Jawetz, Melnick &Adlerberg. Prentice Hall InternationalInc.
- Text Book of Microbiology. 6lh Edition, 2000. Ananthanarayanan, R and C.K.J. Panicker. Orient Longman Private Ltd.,Chennai.
- Medical Microbiology. 2ndEdition, 1993. Murray. P.R., G.S, Kobyashi, M.A. Pfaller and K. S. Rosenthal. Mosby St.Louis.
- Bailey & Scott's Diagnostic Microbiology. 12thEdition, 2007. Betty A. Forbes,Daniel F. Sahm and Alice S. Weissfeld. Elsevier/ Mosby.

YEAR – II	BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS (For those students admitted in the year 2021 – 22 and onwards)	21EPM35A
SEMESTER - III		HRS / WK - 3
Elective – VII A		CREDIT - 2

Objective: To make the students completely equipped with strategies of patent rights

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Acquires knowledge about concept of bioethics
CO2: Learns about Ethics committees
CO3: Attains knowledge about intellectual property
CO4: Understands the Patents, Copy rights and related rights
CO5: Gains knowledge about Indian IPR legislations

SEMESTER: III	COURSE CODE: 21EPM35A				COURSE TITLE: BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS				HOURS: 3	CREDITS: 2
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3	4	4	3	3	3	3	4	3.3	
CO2	3	3	3	4	3	3	3	5	3.2	
CO3	3	3	3	4	3	3	4	5	3.5	
CO4	3	3	3	3	3	3	4	5	3.3	
CO5	3	4	3	3	5	3	3	5	3.6	
Mean Overall Score									3.4	

Result: The score of this course is 3.4 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(9 Hrs)**

Bioethics – definition - The birth of the concept of 'bioethics' - History of Bioethics as a Discipline - Bioethics as bridge between facts and values - Bioethics versus medical ethics - Health and disease as values - Principles of bioethics - Health care decisions include facts and values, Universal Declaration on Bioethics and Human Rights.

Unit-2 **(9 Hrs)**

Ethics committees – Need, Types, Composition, Function - Human dignity and human rights - Benefit and harm – Definitions, comparing harms and benefits; Autonomy and individual responsibility, health care provider-patient relationship; 'informed consent' – Animal Ethics Committee.

Unit-3 **(9 Hrs)**

Introduction – Invention and Creativity, intellectual property (IP) – Importance; Protection of IPR – Basic types of property (i) Movable property (ii) Immovable property and (iii) Intellectual property; International convention relating to intellectual property - Establishment of WIPO, Mission and Activities: General Agreement on Trade and Tariff (GATT).

Unit-4 **(9 Hrs)**

Patents, Copy rights and related rights, Trade Marks and rights arising from trade mark registration, Industrial designs, Protection of Geographical Indications at national and international levels - application procedures.

Unit– 5 **(9 Hrs)**

Indian IPR legislations; Patent Ordinance and the Bill; National Intellectual property policy; Case studies on patents - Basmati rice, Turmeric, Neem.

Text book

- Bioethics for Scientists. 2002. John A. Bryant, Linda Baggott la Velle, John F. Searle. Wiley.
- Biotechnology and Intellectual Property Rights. 2014. Kshitij Kumar Singh. Springer India.

Reference Books

- An Introduction to Bioethics. 4thEdition, 2009.Thomas A. Shannon and Nicholas J. Kockler. PaulistPress.
- Contemporary issues in Bioethics. 2013. Tom L Beauchamp. Jerffry Khan, LeRoy Walters, Anna CMastroanni.
- Intellectual Property in Asia. 2009. Paul Goldstein and Joseph Straus Springer Science & Business Media.
- Law Relating to Intellectual Property Rights. 2ndEdition, 2007. Ahuja. V.K. LexisNexis.
- Hand book of Indian Patent Law and Practice. 1998. Subbarab, N. R. Viswanathan Printers and Publishers Pvt.Ltd.

YEAR – II	LAB COURSE – III (For those students admitted in the year 2021 – 22 and onwards)	21PMP33
SEMESTER - III		HRS / WK - 8
PRACTICAL		CREDITS - 4

EXPERIMENTS IN AGRICULTURAL MICROBIOLOGY

1. Enumeration of bacteria fromsoil
2. Enumeration of fungi fromsoil
3. *Rhizobium*Isolation
4. Rhizosphere effect
5. Isolation and Enumeration of Phosphate utilizingbacteria

EXPERIMENTS IN MICROBIAL BIOTECHNOLOGY

1. Isolation of Actinomycetes
2. Isolation and enumeration of *Azospirillum* from soil
3. Isolation and enumeration of *Azotobacter* from soil
4. Carrier based inoculum preparation for biofertilizer
5. Immobilization of Amylase enzyme
6. Sterility test

EXPERIMENTS IN FOOD MICROBIOLOGY

1. MBRT
2. Resazurin Test
3. Isolation of *Vibrio* from marine food

EXPERIMENTS IN MOLECULAR BIOLOGY

1. Agarose gel electrophoresis
2. Isolation of Bacterial Genomic DNA
3. Isolation of Plasmid DNA
4. Preparation of acetate buffer
5. Lowry's method for protein estimation

YEAR - II	MICROBIAL BIOTECHNOLOGY (For those students admitted in the year 2021 – 22 and onwards)	21PMB41
SEMESTER - IV		HRS/WK - 4
CORE - 13		CREDITS - 4

Objective: To make the students familiar with applications of microbiology

Course Outcomes:
Upon successful completion of the course, the student:
CO1: learns about Microbial enzyme technology and Biotransformation
CO2: becomes familiar with the microbial products of industrial fermentations
CO3: acquires knowledge about the use of microorganisms in the production of biopolymers
CO4: gains knowledge about biotechnological applications available for environmental issues
CO5: understands the possibilities of entrepreneurship in microbiology

SEMESTER: IV	COURSE CODE: 21PMB41				COURSE TITLE: MICROBIAL BIOTECHNOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3.5	3.5	4	3.5	4	3	4	3	3.56	
CO2	4	4	3.5	4	3	3.5	3.5	4	3.69	
CO3	3.5	3.5	4	3	4	3.5	4	3.5	3.63	
CO4	4	4	3.5	3	3.5	4	3	3	3.50	
CO5	4	3.5	4	3	4	3.5	4	3	3.63	
Mean Overall Score									3.60	

Result: The score of this course is 3.60 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(12 Hrs)**

Introduction and Basics**:** History and Scope of Microbial Biotechnology – Enzyme technology - production of microbial enzymes (amylase, pectinases, cellulase) - Enzyme immobilization, Products, Applications; Biotransformation.

Unit-2 **(12 Hrs)**

Important industrial fermentations- Amino acid production (glutamic acid and lysine) - Production of antibiotics (penicillin, tetracycline) - Production of Vitamins (riboflavin, cyanocobalamin) - Production of alcohol (Ethanol) and beverages (beer and wine) - Organic acids - lactic acid, citric acid.

Unit-3 **(12 Hrs)**

Biopolymers and Biomass**:** Microbial production of carbohydrates, Xanthan gum and polyester (PHAs, higher alkanes and methanol); Single cell proteins; Microbial whole-cell bioreporters; Biosensors - Types and Applications; Role of microorganisms in Nanotechnology.

Unit-4 **(12 Hrs)**

Environmental Biotechnology**:** Biotechnological methods for environmental monitoring – Recalcitrant xenobiotics - Biodegradation (hydrocarbons, pesticides, herbicides); Bioremediation – contaminated soils and water; marine oil pollutants; Microbes in mining, Ore leaching.

Unit-5 **(12 Hrs)**

Entrepreneural Aspects**:**Qualities of an entrepreneur, Factors influencing entrepreneurship; Biogas production; Biofuels; Mushroom cultivation; *Spirulina* cultivation; *Azolla* cultivation; Microbial pigments; bacterial and algal carotenoids.

Text Book

- Elements of Biotechnology. 1996. Gupta, P.K. Rastogi and Company,Meerut.

Reference Books

- Concepts in Biotechnology. 1996. Balasubramanian, D., C.F.A. Brycee., K. Dharmalingam, J. Green and K. Jayaraman. Universities Press (India) Limited, Hyderabad.
- Molecular Biotechnology. Indian Edition, 2002. Glick, B.R. and J.J. Pasternack. Panima Publishing Corporation, NewDelhi.
- Microbial Biotechnology. 1995. Alexander N. Glazer and Hiroshi Nikaido. W. H Freeman andCompany.
- Biotechnology Expanding Horizons. 2021. Singh B.D. Kalyani Publishers,Ludhiana.
- Biotechnology. 2005. Satyanarayana U. Books and Allied (P) Ltd.,Kolkata.

YEAR – II	BIOTECHNIQUES (For those students admitted in the year 2021 – 22 and onwards)	21EPM42A
SEMESTER - IV		HRS / WK - 3
ELECTIVE –VIII A		CREDIT - 2

Objective: To make the students familiar with basics and advanced techniques routinely used in biosciences.

Course Outcomes:
Upon successful completion of the course, the student:
CO1: Understands the basic Microscopy.
CO2: Learns the importance of Electron Microscopy and its application.
CO3: Acquires knowledge about basic Chromatographic techniques.
CO4: Gains knowledge on Advanced Chromatographic techniques and its application.
CO5: Learns the importance of Modern Cytogenetic techniques and Immunotechniques.

SEMESTER: IV	COURSE CODE: 21EPM42A				COURSE TITLE: BIOTECHNIQUES				HOURS: 3	CREDITS: 2
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	3	4	3	4	3	3	3	4	3.3	
CO2	3	3	3	4	3	4	3	4	3.2	
CO3	3	3	3	4	3	3	4	5	3.5	
CO4	3	3	3	3	3	3	4	5	3.3	
CO5	3	4	4	3	4	3	3	5	3.6	
Mean Overall Score									3.4	

Result: The score of this course is 3.4 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme SpecificOutcomes.

Unit-1 **(9 Hrs)**

Microscopic techniques:Visualization of cells and sub cellular components by light microscopy, Dark field Microscopy, resolving powers of different microscopes, microscopy of living cells.

Unit-2 **(9 Hrs)**

Electron Microscopy:Scanning and transmission microscopes,different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Unit-3 **(9 Hrs)**

Chromatography: Principles – Planar Chromatography (Paper and Thin – Layer) – Column Chromatography – Ion-Exchange Chromatography - Affinity Chromatography

Unit-4 **(9 Hrs)**

Advanced Chromatography**:** Gel Exclusion Chromatography – High Performance Liquid Chromatography (HPLC) – Gas Chromatography - LC Mass Spectrophotometry. Nano LC.

Unit-5 **(9 Hrs)**

Modern Cytogenetic techniques and Immunotechniques**:** Flowcytometry, Nano pro Immunoassay, Immunoadsorption and Immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

Text Book

- Biophysical Chemistry Principles and Techniques. 1997. Upadhyay, Upadhyay and Nath. HimalayaPublications.

Reference Books

- Modern Experimental Biochemistry. 3rd Edition, 2000. Rodney Boyer. Addison Wesley Longman,Inc.
- Molecular Biomethods - Hand book. 2nd Edition, 2008. John M. Walker and Ralph Rapley. Human Press, NewJersey.
- Microbiology. 6thEdition, 2005. L.M. Prescott, J.P. Harley and D.A. Klein. McGraw Hill,Boston.