

M.Sc.MICROBIOLOGY

Course Structure and Syllabus

(For the candidates admitted from the academic year 2023-2024 onwards)

CHOICE BASED CREDIT SYSTEM- LEARNING OUTCOMES BASED CURRICULUM FRAME WORK (CBCS-LOCF)



THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)



(Nationally Re-Accredited by NAAC with B⁺⁺)

(Affiliated to Bharathidasan University, Tiruchirappalli)

ELAMBALUR, PERAMBALUR – 621 220



THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)

ELAMBALUR, PERAMBALUR-621 220

M.Sc. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM –LEARNING OUTCOMES BASED

CURRICULUM FRAMEWORK (CBCS-LOCF)

(Applicable to the candidates admitted from the academic year 2023-2024 onwards)

Semester	Course Code	Title of the Course	Ins. Hours/ Week	Credits	Exam Hrs	Max. Marks		
						CIA	ESE	Total
I	23PMB1CC1	General Microbiology and Microbial Diversity	6	5	3	25	75	100
	23PMB1CC2	Immunology, Immunomics and Microbial Genetics	6	5	3	25	75	100
	23PMB1CC3P	Practical-I	6	4	3	40	60	100
	23PMB1EC11 23PMB1EC12	Bioinstrumentation/ /Essentials of Laboratory Management and Biosafety	6	3	3	25	75	100
	23PMB1EC2 1 23PMB1EC2 2	Forensic Science/ Health Hygiene	6	3	3	25	75	100
	23PMBVA1	Value Added Course-1*	-	2*	2	50	50	100*
		Total		30	20	-	-	-
II	23PMB2CC4	Medical Bacteriology and Mycology	6	5	3	25	75	100
	23PMB2CC5	Medical Virology and Parasitology	6	5	3	25	75	100
	23PMB2CC6P	Practical-II	6	4	3	40	60	100
	23PMB2EC31 23PMB2EC32	Bioinformatics/ Nanobiotechnology	5	3	3	25	75	100
	23PMB2EC4 1 23PMB2EC4 2	Clinical And Diagnostic Microbiology Herbal Technology	5	3	3	25	75	100
	23PMB2NME1	NME -1	2	2	3	25	75	100
	23PMB2OC	SWAYAM/NPTEL Online Course		2* *				
	Total		30	22	-	-	-	600
III	23PMB3CC7	Soil and Environmental Microbiology	6	5	3	25	75	100
	23PMB3CC8	Recombinant DNA Technology and Biotechnology	6	5	3	25	75	100
	23PMB3CC9P	Practical III	6	4	3	40	60	100

	23PMB3EC51 23PMB3EC52	Biosafety, Bioethics and IPR/ Water Conservation and Water Treatment	5	4	3	25	75	100
	23PMB3CI	Fermentation Technology and Pharmaceutical Microbiology	5	4	3	25	75	100
	23PMB3NME2	NME 2	2	2	3	25	75	100
		Internship / Industrial Activity***	-	2	-	-	-	100
	23PMBVA2	Value Added Course-2*	-	2*	2	50	50	100*
		Total	30	26	-	-	-	700
IV	23PMB4CC10	Food & Dairy Microbiology	6	4	3	25	75	100
	23PMB4CC11	Research Methodology & Biostatistics	6	4	3	25	75	100
	23PMB4CC12P	Practical IV	6	4	3	40	60	100
	23PMB4EC61 23PMB4EC6 2	Marine Microbiology/ Life Science for Competitive Examinations	4	3	3	25	75	100
	23PMB4PW	Project with Viva Voce	4	3	3	25	75	100
	23PMB4SE1	Microbial Quality Control and Testing	2	2	3	25	75	100
	23PMB4SE2	Soft Skill	2	2	3	25	75	100
		Extension Activity	-	1	-	-	-	-
		Total	30	23				700
		Grand Total	120	91				2500

*** Internship/Industrial Activity-Internship after 2nd semester during summer vacation -30 Hours and 2 credits will be included in the 3rd semester.

* The value added course credit will not be included in the total CGPA. These courses are extra- credit courses. Instruction hours for these courses is 30 hours

** SWAYAM/NPTEL Online Course -Extra Credit Course. Not considered for grand total & CGPA

SEMESTER-I

Course Code: 23PMB1CC1
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

CORE COURSE I: GENERAL MICROBIOLOGY AND MICROBIAL DIVERSITY

Course Objectives:

- Acquire knowledge on the principles of different types of microscopes and their applications.
- Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
- Exemplify, isolate and cultivate microalgae from diverse environmental sources.
- Explain various pure culture techniques and discuss sterilization methods.
- Discuss the importance and conservation of microbial diversity.

Course Outcome:

CO1: Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.

CO2: Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.

CO3: Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.

CO4: Create aseptic conditions by following good laboratory practices.

CO 5: Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.

UNIT 1:

History and Scope of Microbiology. Microscopy – Principles and applications. Types of Microscopes - Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry – Stage, Ocular and its applications.

UNIT II

Bacterial Structure, properties and biosynthesis of cellular components – Cell wall. Actinomycetes and Fungi- Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition - Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.

UNIT III

Algae - Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Life cycle - *Chlamydomonas*, *Volvox Spirogyra* (Green algae), *Nostoc* (Cyanobacteria) *Ectocarpus*, *Sargassum* (Brown algae), *Polysiphonia*, *Batrachospermum* (Red algae).

UNIT IV

Microbial techniques - Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining.

Automated Microbial identification systems - Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres - National and International.

UNIT V

Biodiversity - Introduction to microbial biodiversity – Thermophiles - Classification, Thermophilic Archaeobacteria and its applications. Methanogens - Classification, Habitats, applications. Alkaliphiles and Acidophiles - Classification, discovery basin, its cell wall and membrane. Barophiles - Classification and its applications. Halophiles - Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes, Osmoadaptation / halotolerance - Applications of halophiles. Conservation of Biodiversity

Text Books

1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd.
2.	Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5 th Edition). Mc.Graw Hill. Inc, New York.
3.	Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6 th Edition). McGraw - Hill company, New York.
4.	White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
5.	Dubey R.C. and Maheshwari D. K. (2009). Textbook of Microbiology. S. Chand, Limited.

References:

Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12 th Edition). Pearson, London, United Kingdom
Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3 rd Edition). Cambridge University Press, Cambridge.
Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elsevier Academic Press, California.
Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2 nd Edition). Books / Cole Thomson Learning, UK.
Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15 th Edition). Pearson.
Web Resources:
http://sciencenetlinks.com/tools/microbeworld
https://www.microbes.info/
https://www.asmscience.org/VisualLibrary
https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMB1CC1	General Microbiology and Microbial Diversity					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number of Matches (✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-I

Course Code: 22PMB1CC2
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

CORE COURSE 2 – IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS

Course Objectives

- Discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
- Describe immunoglobulin and its types. Categorize MHC and understand its significance
- Elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
- Acquire knowledge the structure DNA in prokaryotes and eukaryotes
- Explain out gene transfer studies in microbes.

Course Outcomes

CO1: Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity

CO2: Justify the significance of MHC molecules in immune response and antibody production.

CO3: Design antibodies and evaluate immunological assays in patient samples.

CO4: Analyze genomic DNA of prokaryotes and eukaryotes.

CO5: Summarize gene transfer mechanisms for experimental study.

UNIT I:

Introduction to biology of the immune system – Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Antigen processing and presentation to T- lymphocytes.

UNIT II:

Immunoglobulins. Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, Diversity of TCR, T cell surface alloantigens, lymphocyte activation, clonal proliferation and differentiation.

UNIT III

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry. Role of cytokines, lymphokines and chemokines.

UNIT IV

Structural of prokaryotic and eukaryotic genome. Introduction to prokaryotic genomic structure, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications- methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, organelle genome.

UNIT V

Gene Transfer Mechanisms- Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast.

Text Books

1.	Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5 th Edition). Wiley-Blackwell, New York.
2.	Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7 th Edition). W. H. Freeman and Company, New York.
3.	Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10 th Edition). Elsevier.
4.	Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4 th Edition). Narosa Publishing House, New Delhi.
5.	Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8 th Edition). Wiley India Pvt. Ltd.

References Books

1.	Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3 rd Edition). Current Biology Ltd. New York.
2.	Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11 th Edition). Wiley-Blackwell.
3.	Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4 th Edition). Wiley-Blackwell.
4.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.
5.	Russell P.J. (2010). Genetics - A Molecular Approach. (3 rd Edition). Pearson New International Edition.

Web Resources

1.	https://www.ncbi.nlm.nih.gov/books/NBK279395/
2.	https://med.stanford.edu/immunol/phd-program/ebook.html
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMB1CC2	Immunology, Immunomics And Microbial Genetics					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number of Matches (✓) = 42 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-I

Course Code: 22PMB1CC3P
Instruction Hours: 6
Credits: 4

Exam Hours: 6
Internal Marks: 40
External Marks: 60

CORE COURSE PRACTICAL 1 –CORE COURSE III- PRACTICAL I

Course Objectives:

- Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.
- Prepare media for bacterial growth. Discuss plating and growth measurement techniques.
- Acquire adequate skills to perform blood grouping and serological reactions.
- Provide fundamental skills in preparation, separation and purification of immunoglobulin.
- Apply the knowledge of molecular biology skills in clinical diagnosis.

Course Outcomes:

CO1:Apply microscopic techniques and staining methods in the identification and differentiation of microbes.

CO2:Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.

CO3:Perform and evaluate immunological reactions to aid diagnosis.

CO4:Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques

CO5:Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis

UNIT I:

Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop.

Dark field microscopy – Motility of Spirochetes.

Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration.

Quality control check for each method.

Staining techniques - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.

UNIT II:

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media.

Preparation of Biochemical test media, media to demonstrate enzymatic activities.

Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer.

Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate.

Bacterial growth curve. Effect of physical and chemical factors on growth.

Anaerobic culture methods.

UNIT III

Hematological reactions - Blood Grouping – forward and reverse, Rh Typing

Identification of various immune cells by morphology – Leishman staining, Giemsa staining. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.

Detection of HBs Ag by ELISA. Precipitation reactions in gels– Ouchterlony double

immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID)
 Immuno-electrophoresis and staining of precipitin lines- Rocket immuno electrophoresis and counter current immuno electrophoresis

UNIT IV

Preparation of lymphocytes from peripheral blood by density gradient centrifugation.
 Purification of immunoglobulin– Ammonium Sulphate Precipitation. Separation of IgG by chromatography using DEAE cellulose or Sephadex

UNIT V:

Western Blotting – Demonstration.
 Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis
 Estimation of DNA using colorimeter (Diphenylamine reagent)
 Separation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE)
 UV induced mutation and isolation of mutants by replica plating technique.
 Plasmid DNA isolation from *E.coli*.
 RNA isolation from yeast.
 RNA estimation by Orcinol method.

Text Books

1.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
2.	Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.
3.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2 nd Edition). - Taylor & Francis.
4.	Rich R. R., Fleisher T. A., Shearer W. T., Schroeder H, Frew A. J. and Weyand C. M. (2018). Clinical Immunology: Principles and Practice. (5 th Edition). Elsevier.
5.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.

References Books

1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi.
2.	Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
3.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7 th Edition). John Wiley and Jones, Ltd.
4.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd. 2012.
5.	Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2 nd Edition). Narosa Publishing Home Pvt Ltd.

Web Resources

1.	http://textbookofbacteriology.net/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4.	[PDF] Lehninger Principles of Biochemistry (8 th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMB1CC3P	PRACTICAL -I					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number of Matches (✓) = 45 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-I

Course Code: 22PMB1EC11
Instruction Hours: 6
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

ELECTIVE I-BIOINSTRUMENTATION

Course Objectives:

Explain the principles and working mechanisms of laboratory instruments.
Discuss chromatography techniques and molecular biology techniques
Illustrate molecular techniques in biological applications.
Acquire knowledge on spectroscopic techniques
Demonstrate the use of radio isotopes in various techniques.

Course Outcomes:

CO1:Make use of the laboratory instruments- laminar air flow, pH meter, centrifugation methods, biosafety cabinets following SOP.
CO2:Apply chromatography techniques in the separation of biomolecules.
CO3:Perform molecular techniques like mutagenesis and their detection.
CO4:Estimate molecules in biological samples by adopting UV spectroscopic techniques.
CO5:Cultivate organisms anaerobically

UNIT I

Basic laboratory Instruments. Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation coefficient; Principles, methodology and applications of differential, rate zonal and density gradient centrifugation - Applications in determination of molecular weight

UNIT II

General principles of chromatography - Chromatographic Performance parameters; Types- Thin layer chromatography, Paper Chromatography, Liquid chromatography (LPLC & HPLC), Adsorption, ion exchange, Gel filtration, affinity, Gas liquid (GLC). Flash Chromatography and Ultra Performance convergence chromatography. Two dimensional chromatography. Stimulated moving bed chromatography (SEC).

UNIT III

Electrophoresis: General principles - moving boundary electrophoresis - electrophoretic mobility – supportive materials – electro endosmosis – types (horizontal, vertical and two dimensional electrophoresis) - Principle and applications - paper electrophoresis, Serum electrophoresis, starch gel electrophoresis, Disc gel, Agarose gel, SDS – PAGE, Immuno electrophoresis. Blotting techniques -Southern, northern and western blotting.

UNIT IV

Spectroscopic techniques: Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer, NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH. Biophysical methods: Analysis of biomolecules by Spectroscopy UV/visible.

UNIT V

Radioisotopic techniques: Principle and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, auto radiography and its applications. Commonly used isotopes in biology, labeling procedures and safety aspects.

Text Books:

1.	Sharma B. K. (2014). Instrumental Method of Chemical Analysis. Krishna Prakashan Media (P) Ltd.
2.	Chatwal G. R and Anand S. K. (2014.) Instrumental Methods of Chemical Analysis. Himalaya Publishing House.
3.	Mitchell G. H. (2017). Gel Electrophoresis: Types, Applications and Research. Nova Science Publishers Inc.
4.	Holme D. Peck H. (1998). Analytical Biochemistry. (3 rd Edition). Prentice Hall.
5.	Jayaraman J. (2011). Laboratory Manual in Biochemistry. (2 nd Edition). Wiley Eastn Ltd., New Delhi.

References:

1.	Pavia D. L. (2012) Spectroscopy (4 th Edition). Cengage.
2.	Skoog A. and West M. (2014). Principles of Instrumental Analysis. (14 th Edition). W.B.Saunders Co., Philadelphia.
3.	Miller J. M. (2007). Chromatography: Concepts and Contrasts (2 nd Edition) Wiley-Blackwell.
4.	Gurumani N. (2006). Research Methodology for Biological Sciences. (1 st Edition) MJP Publishers.
5.	Ponmurugan P. and Gangathara P. B. (2012). Biotechniques. (1 st Edition). MJP Publishers.

Web Resources:

1.	https://norcaloa.com/BMIA
2.	http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge-introduction- types-uses-and-other-details-with-diagram/12489
3.	https://www.watelectrical.com/biosensors-types-its-working-and-applications .
4.	http://www.wikiscales.com/articles/electronic-analytical-balance/
5.	https://study.com/academy/lesson/what-is-chromatography-definition-types-uses .

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMB1EC11	Bioinstrumentation					6	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓		✓	✓	
CO3	✓	✓	✓	✓		✓	✓	✓	✓		
CO4	✓		✓	✓	✓	✓	✓	✓		✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-I

Course Code: 22PMB1EC12
Instruction Hours: 6
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

ELECTIVE II- ESSENTIALS OF LABORATORY MANAGEMENT AND BIOSAFETY

Course Objectives;

- To utilize containment principles to ensure biosafety.
- To enrich the student role and responsibilities of laboratory hazards and their control.
- To know the importance of first aid technique for various common lab accidents.
- To acquire knowledge of biosafety level, risk assessment and maintain proper hygiene in the laboratory.
- To discuss the biosafety regulations and guidelines and implementation of safety programs.

Course Outcomes:

CO1: Employ skills on laboratory safety and avoid laboratory accidents.

CO2: Prevent laboratory hazards by practicing safety strategies.

CO3: Practice various first aid procedures during common laboratory accidents.

CO4: Ensure biosafety strategies in laboratory

CO5: Recognize the importance of biosafety guidelines.

UNIT I

Introduction to the laboratory and laboratory hazards - General laboratory facilities – Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan

UNIT II

Common hazards in laboratory: Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling - Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Stages of Fire. Fire Extinguishers. Fire Response.

UNIT III

Prevention and First aid for laboratory accidents. Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.

UNIT IV

Biosafety - Historical background. Blood borne pathogens (BBP) and laboratory - acquired infections. Introduction to biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms. Recommended biosafety. Levels for infectious agents and infected animals. Risk groups with examples - Risk assessment. Safety levels. Case studies - Safe working, hand hygiene. Laboratory instruments, packing, sending, transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization.

UNIT V

Biosafety regulations and guidelines. Centers for disease control and prevention and the National institutes of health. Occupational safety and health administration. Recombinant DNA advisory committee(RDAC), Institutional biosafety committee(IBSC), Review committee on genetic manipulation(RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines.

Text Books:

1.	Sateesh M. K. (2013). Bioethics and Biosafety, IK International Pvt Ltd. ISBN : 8190675702.
2.	Muthuraj M. and Usharani B. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN 10: 1645878856
3.	Biosafety in Microbiological and Biomedical Laboratories - U.S. Health Department and Human Services. (2016). (5 th Edition). Lulu.com.
4.	Kanai. L. Mukherjee. (Medical Laboratory Technology(4 th Edition). CBS Publishers.
5.	Ramakrishnan (2012). Manual of Medical Laboratory Techniques. JP brothers.

References:

1.	World Health Organization, Biosafety programme management. (2010). (4 th Edition). WHO Publications.
2.	Rashid N. (2013). Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1 st Edition).
3.	Dayuan X. (2015). Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, ISBN-10 : 1842657917
4.	Ochei J. Kolhatkar(2000). A. (Medical Laboratory Science – Theory and Practice. ISBN; 13:978-0074632239.
5.	Lynne S. Garcia. Clinical Laboratory Management (2 nd Edition). ASM Press

Web Resources:

1.	https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf
2.	https://ucanapplym.s3.ap-south-1.amazonaws.com/RGU/notifications/E_learning/Online_study/PG-SEM-IV-Biosafety%20regulation.pdf
3.	https://consteril.com/biosafety-levels-difference/
4.	https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf
5.	https://www.who.int/publications/i/item/9789240011311

Semester	Code	TitleoftheCourse					Hours	Credits			
I	23PMB1EC12	Essentials of Laboratory Management and Biosafety					6	3			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number ofMatches(□) =43 Relationship:High											

Relationship MatrixforCOs,POsand PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER-I

Course Code: 22PMB1EC21
Instruction Hours: 6
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

FORENSIC SCIENCE

Course Objectives:

- Understand the Scope, need and learn the tools and techniques in forensic science.
- Comprehend organizational setup of a forensic science laboratory.
- Identify and Examine body fluids for identification
- Extract DNA from blood samples for investigation
- Recognize medico legal post mortem procedures and their importance
-

Course Outcomes:

CO1: Identify the scope and need of forensic science in the present scenario.

CO2: Plan for the organizational setup and functioning of forensic science laboratories.

CO3: Analyze the biological samples found at the crime scene.

CO4: Perform extraction and identification of DNA obtained from body fluids.

CO5: Discuss the concept of forensic toxicology

UNIT I:

Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.

UNIT II:

Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.

UNIT III:

Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.

UNIT IV:

DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.

UNIT V:

Forensic toxicology - Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action.

Text Books:

1.	Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN- 10:8190113526 / ISBN-13:9788190113526.
2.	James S. H. and Nordby, J. J. (2015) Forensic Science: An Introduction to Scientific and Investigative Techniques. (5 th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3.	Li R. (2015) Forensic Biology. (2 nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4.	Sharma B.R (2020) Forensic science in criminal investigation and trials. (6 th Edition)Universal Press.
5.	Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12 th Edition).Pearson Press.

References:

1.	Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, New York. ISBN:0-8493-8122-3.
2.	Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3 rd Edition). CRC Press, New York. ISBN-10:1498720196.
3.	Lincoln, P.J. and Thomson, J. (1998). (2 nd Edition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4.	Val McDermid (2014). Forensics. (2 nd Edition). ISBN 9780802125156.
5.	Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2 nd Edition). CRC Press.

Web resources

1.	http://clsjournal.ascls.org/content/25/2/114
2.	https://www.ncbi.nlm.nih.gov/books/NBK234877/
3.	https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8
4.	https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics
5.	https://cisac.fsi.stanford.edu/events/microbial forensics

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMBEC21	Forensic Science					6	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number of Matches (✓) = 41 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-I

Course Code: 22PMB1EC22
Instruction Hours: 6
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

HEALTH AND HYGIENE

Course Objectives:

- Acquire knowledge on hygiene and live healthy.
- Provide insights on health laws for food safety and hygiene.
- Explain health, physical exercises and their importance.
- Illustrate mental hygiene and involved in mental hygiene.
- Describe the various health and health education programmes by the government.

Course Outcomes:

- CO1: Identify factors affecting health and health habits.
- CO2: Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.
- CO3: Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.
- CO4: Explore Mental hygiene and maintain emotional stability
- CO5: Participate in health education programmes

UNIT I:

Introduction to hygiene and healthful live. Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.

UNIT II:

Nutrition and Health – Balanced diet, Food surveillance, food Fortification, adulteration and preventive measures. Health laws for food safety. Environmental and housing hygiene. Ventilation and lighting.

UNIT III:

Physical health, physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief. International control of health, WHO. Personal hygiene, Sun bathing, Colon Hygiene. Health destroying habits and addictions - Pan, supari, ganja, drinking, smoking, tea and coffee.

UNIT IV:

Mental hygiene - factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adulthood and old age. Mental health occupational hazards.

UNIT V:

Health programme and health education – Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive and Child health programmes (RCH).

Text Book:

1.	Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4 th Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2.	Swaminathan (1995) Food & Nutrition (Vol I) (2 nd Edition). The Bangalore Printing & Publishing Co Ltd., Bangalore.
3.	Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd
4.	Lindsay Dingwall.(2010). Personal Hygiene Care Print ISBN:9781405163071 Online ISBN:9781444318708 DOI:10.1002/9781444318708
5.	Walter C. C. Pakes(1900). The Science of Hygiene: a Text-book of Laboratory Practice. (London: Methuen and Co.,).

References:

1.	Khader V. (2000) Food, Nutrition and Health, Kalyan Publishers, New Delhi.
2.	Srilakshmi, B. (2010) Food Science, (5 th Edition) New Age International Ltd., New Delhi.
3.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4.	Park K. 2007, Park's text book of Preventive and Social Medicine, Banarsidas Bhanot publishers, India.
5.	Srilakshmi, 2002, Dietetics, New Age Publications, India

Web Resources:

1.	Health and Hygiene - Personal Hygiene, Community Hygiene and Diseases (vedantu.com)
2.	Chapter-32.pdf (nios.ac.in)
3.	Menstrual Health and Hygiene Guide Student Health and Counseling Services (ucdavis.edu)
4.	https://nap.nationalacademies.org/read/11756/chapter/13
5.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
I	23PMB1EC22	Health and Hygiene					6	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓			✓	✓	✓		✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓		✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓		
Number of Matches (✓) = 40 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 23PMB2CC4
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

MEDICAL BACTERIOLOGY AND MYCOLOGY

Course Objectives:

- Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens
- Explain morphology, characteristics and pathogenesis of bacteria.
- Discuss various factors leading to pathogenesis of bacteria.
- Acquire knowledge on antifungal agents and their importance.
- Describe various diagnostic methods available for fungal disease diagnosis.

Course Outcomes:

CO1: Collect, transport and process of various kinds of clinical specimens.

CO2: Analyze various bacteria based on morphology and pathogenesis.

CO3: Discuss various treatment methods for bacterial disease.

CO4: Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents..

CO5: Apply various immunodiagnostic method to detect fungal infections.

UNIT I

Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice

UNIT II

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci*, *Streptococci*, *Pneumococci*, *Neisseriae*., *Bacillus*, *Corynebacteria*, *Mycobacteria* and *Clostridium*.

UNIT III

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, *Yersinia*, *Pseudomonas*, *Vibrio*, *Mycoplasma*, *Helicobacter*, *Rickettsiae*, *Chlamydiae*, *Bordetella*, *Francisella*., *Spirochaetes*-*Leptospira*, *Treponema* and *Borrelia*. Nosocomial, zoonotic and opportunistic infections - prevention and control.

UNIT IV

Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. *Trichophyton*, *Epidermophyton* & *Microsporum*. Yeasts of medical importance – *Candida*, *Cryptococcus*. Mycotoxins. Antifungal agents, testing methods and quality control.

UNIT V

Dimorphic fungi causing Systemic mycoses, *Histoplasma*, *Coccidioides*, *Sporothrix*, *Blastomyces*. Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents.

Text Books:

1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (2017).Orient Longman, Hyderabad.
2.	Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18 th Edition). Churchill Livingstone, London.
3.	Finegold, S. M. (2000) Diagnostic Microbiology, (10 th Edition). C.V. Mosby Company, St. Louis.
4.	Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology, (4 th Edition). Wiley Publishers.
5.	Chander J. (2018). Textbook of Medical Mycology. (4 th Edition). Jaypee brothers Medical Publishers.

References:

1.	Salle A. J. (2007). Fundamental Principles of Bacteriology. (4 th Edition). Tata McGraw-Hill Publications.
2.	Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). <u>Mackie & McCartney Practical Medical Microbiology</u> . 14 th edn, Churchill Livingston.
3.	Cheesbrough M. (2006). <u>District Laboratory Practice in Tropical countries.- Part 22ndedn</u> .Cambridge University Press.
4.	Topley and Wilson's. (1998). <u>Principles of Bacteriology</u> .9 th edn. Edward Arnold, London.
5.	Murray P.R., Rosenthal K.S. and Michael A. (2013). <u>Medical Microbiology</u> . Pfaller. 7 th edn. Elsevier, Mosby Saunders.

Web Resources:

1.	http://textbookofbacteriology.net/nd
2.	https://microbiologysociety.org/members-outreach-resources/links.html
3.	https://www.pathselective.com/micro-resources
4.	http://mycology.cornell.edu/fteach.html
5.	https://www.adelaide.edu.au/mycology/

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2CC4	Medical Bacteriology and Mycology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Number of Matches (✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 23PMB2CC5
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

MEDICAL VIROLOGY AND PARASITOLOGY

Course Objectives:

- Describe the replication strategy and cultivation methods of viruses.
- Acquire knowledge about oncogenic virus and human viral infections.
- Develop diagnostic skills, in the identification of virus infections.
- Impart knowledge about parasitic infections.
- Develop diagnostic skills, in the identification of parasitic infections.

Course Outcomes:

CO1: Cultivate viruses by different methods and aid in diagnosis. Perform purification and viral assay.

CO2: Investigate the symptoms of viral infections and presumptively identify the viral disease.

CO3: Diagnose various viral diseases by different methods.(serological, conventional and molecular

CO4: Educate public about the spread, control and prevention of parasitic diseases.

CO5: Identify the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.

UNIT I

General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).

UNIT II

Virus Entry, Host Defenses Against Viral Infections, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, treatment for the following viruses: DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and reemerging viral infections

UNIT III

Bacterial viruses - Φ X 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics. Diagnosis of viral infections –conventional serological and molecular methods. Antiviral agents and viral vaccines.

UNIT IV

Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba*, Aerobic and Anaerobic amoebae, *Giardia*, *Trichomonas*, *Balantidium*. *Toxoplasma*, *Cryptosporidium*, *Leishmania*, and *Trypanasoma*.

UNIT V

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia Solium*, *T. Saginata*, *T. Echinococcus*. Trematodes – *Fasciola Hepatica*, *Fasciolopsis Buski*, *Paragonimus*, *Schistosomes*. Nematodes - *Ascaris*, *Ankylostoma*, *Trichuris*, *Trichinella*, *Enterobius*, *Strongyloides* and *Wuchereria*. Other

parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti-protozoan drugs.

Text Books:

1.	Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10 th Edition). Universities Press (India) Pvt. Ltd.
2.	Dubey, R.C. and Maheshwari D.K. (2010). A Text Book of Microbiology. S. Chand & Co.
3.	Rajan S. (2007). Medical Microbiology. MJP publisher.
4.	Paniker J. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi.
5.	Arora, D. R. and Arora B. B. (2020). Medical Parasitology. (5 th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

References:

1.	Carter J. (2001). Virology: Principles and Applications (1 st Edition). Wiley Publications.
2..	Willey J., Sandman K. and Wood D. Prescott's Microbiology. (11 th Edition). McGraw Hill Book.
3.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19 th Edition). Lange Medical Publications, U.S.A.
4.	Finegold S.M. (2000). Diagnostic Microbiology. (10 th Edition). C.V. Mosby Company, St. Louis.
5.	Levanthal R. and Cheadle R. S. (2012). Medical Parasitology. (6 th Edition). S.A. Davies Co. Philadelphia.

Web Resources:

1.	https://en.wikipedia.org/wiki/Virology
2.	https://academic.oup.com/femsre/article/30/3/321/546048
3.	https://www.sciencedirect.com/science/article/pii/S0042682215000859
4.	https://nptel.ac.in/courses/102/103/102103039/
5.	https://www.healthline.com/health/viral-diseases#contagiousness

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2CC5	Medical Virology and Parasitology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 22PMB2CC6P
Instruction Hours: 6
Credits: 4

Exam Hours: 3
Internal Marks: 40
External Marks: 60

Core Course VI- Practical II

Course Objectives:

- Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
- Impart knowledge on fungal infections and its diagnosis.
- Diagnose parasitic
- To gain knowledge about industrially important microbes.
- Screen and utilize microorganisms for effective industrial production of metabolites.

Course Outcomes:

CO1:Collection of different clinical samples, transport, culture and examination.

CO2:Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.

CO3:Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.

CO4:Perform antibiotic sensitivity tests and compare with the standard tests.

CO5:Screening of industrially important microbes for metabolite production.

UNIT I

Staining of clinical specimens - Wet mount, Differential and Special staining methods.

Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests.

Enumeration of bacteria in urine to detect significant bacteriuria.

Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method.

Minimum inhibitory concentration (MIC) test.

Minimum bactericidal concentration (MBC) test.

UNIT II

Identification and Classification of common fungi.

Mounting and staining of VAM spores.

Examination of different fungi by Lactophenol cotton blue staining.

Examination of different fungi by KOH staining.

Cultivation of fungi and their identification - *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*.

Microscopic observation of different asexual fungal spores.

Microscopic observation of fungal fruiting bodies.

Identification of Dermatophytes.

Isolation and characterization of bacteriophage from natural sources by phage titration.

Cultivation of viruses –Egg Inoculation methods.

Diagnosis of Viral Infections –ELISA –HIA.

Spotters of viral inclusions and CPE-stained smears.

UNIT III

Examination of parasites in clinical specimens - Ova/cysts in faeces.

Concentration: methods – Flootation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods- Formal ether method.

Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain.

Identification of common arthropods of medical importance - spotters of *Anopheles*, *Glossina*, *Phlebotomus*, *Aedes*, Ticks and mites.

UNIT IV

Good Laboratory Practices in Industrial Microbiology laboratory.

Study of Bioreactor and its essential parts.

Culturing and Characterization of microorganisms used in Dairy and Pharmaceutical industry.

Screening for Enzyme producers (amylase /protease).

Optimization of parameters for Amylase production.

Screening for Organic acid producers (acetic acid/lactic acid).

Screening for Antibiotic producers

UNIT V

Immobilization of microbial cells and enzyme and its assessment.

Microbiological assays of fermentation products – MIC- MBC.

Microbiological assay of antibiotics by cup plate method and other methods.

Sterility testing of pharmaceuticals.

Text Books

1.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2 nd Edition. Publisher-Taylor and Francis.
2.	Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.
3.	Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.
4.	Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.
5.	Morag C. and Timbury M.C. (1994). Medical Virology. 4 th edn. Blackwell Scientific Publishers.

References:

1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi.
2.	Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.
3.	Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
4.	.Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22 nd Edition. Cambridge University Press.
5.	Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7 th Edition. Elsevier, Mosby Saunders

Web Resources

1.	http://textbookofbacteriology.net/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
5.	https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics-and-biotechnological-applications/vaccines-and-antiviral-agents

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2CC6P	Practical II					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 22PMB2EC31
Instruction Hours: 5
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

BIOINFORMATICS

Course Objectives

- Discuss about various biological data mining concepts, tools.
- Elucidate the principles and applications of sequence alignment methods and tools.
- Demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.
- Acquaint with various approaches in predicting 3D and 2D structure of proteins.
- Describe various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics.

Course Outcomes

CO1: Access to databases that provides information on nucleic acids and proteins

CO2: Invent algorithms for sequence alignment.

CO3: Construct phylogenetic tree

CO4: Predict the structure of proteins.

CO5: Design drugs by predicting drug ligand interactions and molecular docking.

UNIT I

Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNIT II

Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.

UNIT III

Computational Protein Structure prediction – Secondary structure – Homology modelling- Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats-Molecular visualization tools.

UNIT IV

Prediction of Properties of Ligand Compounds – 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds

UNIT V

Molecular Docking- Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery –

Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development

Text Books:

1.	Lesk A. M. (2002). Introduction to Bioinformatics. (4 th Edition). Oxford University Press.
2.	Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley- VCH.
3.	Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4 th Edition). Prentice-Hall of India Pvt.Ltd.
4.	Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addison Wesley Longman Limited, England.
5.	Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2 nd edn.CBS Publishers, New Delhi.

Reference Books:

1.	Baxevanis A. D. and Ouellette F. (2004). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (2nd Edition). John Wiley and Sons.
2.	Bosu O. and Kaur S. (2007). Bioinformatics - Database, Tools, and Algorithms. Oxford University Press.
3.	David W. M. (2001). Bioinformatics Sequence and Genome Analysis (2 nd Edition). CBS Publishers and Distributors(Pvt.)Ltd.
4.	Xiong J, (2011). <u>Essential bioinformatics</u> , First south Indian Edition, Cambridge University Press.
5.	Harshawardhan P.Bal, (2006). <u>Bioinformatics Principles and Applications</u> , Tata McGraw-Hill Publishing Company Limited.

Web Resources:

1.	https://www.hsls.pitt.edu/obrc/
2.	https://www.hsls.pitt.edu/obrc/index.php?page=dna
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4.	https://www.ebi.ac.uk/
5.	https://www.kegg.jp/kegg/kegg2.html

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2EC31	Bio Informatics					5	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓					
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 22PMB2EC32
Instruction Hours: 5
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

NANOBIOTECHNOLOGY

Course Objectives

- Analyze nanomaterials based on the understanding of nanobiotechnology
- Discuss the methods of fabrication of nanomaterials
- Gain Knowledge on characterization of nanomaterials.
- Discover nanomaterials for targeted drug delivery.
- Explain nanomaterials in nanomedicine and environmental pollution.

Course Outcomes

CO1:Employ knowledge in the field of nanobiotechnology for development.

CO2:Identify various applications of nanomaterials in the field of medicine and environment

CO3:Examine the prospects and significance of nanobiotechnology.

CO4:Identify recent advances in this area and create a career or pursue research in the field.

CO5:Design non-toxic nanoparticles for targeted drug delivery.

UNIT I

Introduction to nanobiotechnology, Nano size-changing phenomena at nano scale, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials) and based on realization of their applications (The First, second, third and fourth generation materials), Class of nanomaterials and their applications. Need for nanomaterials and the risks associated with the materials.

UNIT II

Fabrication of Nanomaterials-Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.

UNIT III

Characterization of nanoparticles – Based on particle size/morphology- Dynamic light scattering (DLS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Based on surface charge-zeta potential, Based on structure – X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX), Based on optical properties- UV – Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer (VSM).

UNIT IV

Nanomaterial based Drug delivery and therapeutics-surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxide nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.

UNIT V

Nanomaterials in diagnosis-Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.

Text Books:

1.	Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
2.	Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
3.	Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.
4.	Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.
5.	Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.

Reference Books:

1.	Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
2.	Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
3.	Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
4.	Rehm, B. (2006). Microbial Bionanotechnology: Biological Self-Assembly Systems and Biopolymer-Based Nanostructures. Horizon Scientific Press.
5..	Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press

Web Resources

1.	https://www.gale.com/nanotechnology
2.	https://www.understandingnano.com/resources.html
3.	http://dbtnanobiotech.com/index2.php
4.	http://www.istl.org/11-winter/internet1.html
5.	https://www.cdc.gov/niosh/topics/nanotech/default.html

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2EC32	Nanobiotechnology					5	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 23PMB2EC41
Instruction Hours: 5
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks:75

CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Course Objectives

- Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
- Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
- Elucidate various diagnostic procedures in microbiology
- Acquire knowledge on different methods employed to check antibiotic sensitivity.
- Gain knowledge on hospital acquired infections and their control measures.

Course Outcomes

CO1: Apply Laboratory safety procedures and hospital waste disposal strategies.

CO2: Collect various clinical specimens, handle, preserve and process safely.

CO3: Identify the causative agents of diseases by conventional and molecular methods following standard protocols.

CO4: Assess the antimicrobial susceptibility pattern of pathogens.

CO5: Trace the sources of nosocomial infection and recommend control measures.

UNIT I

Microbiology Laboratory Safety Practices -General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.

UNIT II

Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.

UNIT III

Diagnosis of microbial diseases - Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.

UNIT IV

Antibiotic sensitivity tests - Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution - Agar dilution & broth dilution - MBC/MIC - Quality control for antibiotics and standard strains.

UNIT V

Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.

Text Books:

1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14 th Edition). Elsevier, New Delhi. ISBN-10:0443047219 / ISBN-13-978-0443047213.
2.	Tille P. M. (2021). Bailey and Scott's Diagnostic Microbiology. (15 th Edition). Elsevier. ISBN:9780323681056.
3.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19 th Edition). Lange Medical Publications, U.S.A.
4.	Mukherjee K.L. (2000). Medical Laboratory Technology. Vol. 1-3. (2 nd Edition). Tata McGraw-Hill Education. ISBN-10:0074632604.
5.	Sood R. (2009). Medical Laboratory Technology – Methods and Interpretations. (6 th Edition). Jaypee Brothers Medical Publishers (P) Ltd. New Delhi. ISBN:9788184484496.

Reference Books:

1.	Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Tenover F.C. (2003). Manual of Clinical Microbiology. (8 th Edition). American Society for Microbiology, Washington, DC. ISBN:1-555810255-4.
2.	Bennett J. E., Dolin R. and Blaser M. J. (2019). Principles and Practice of Infectious Diseases. (9 th Edition). Elsevier. EBook ISBN:9780323550277. Hardcover ISBN:9780323482554.
3.	Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7 th Edition. Hodder Arnold Publication. ISBN-10:0340554231 / ISBN-13:9780340554234.
4.	Koneman E.W., Allen S. D., Schreckenberg P. C. and Winn W. C. (2020). Koneman's Color Atlas and Textbook of Diagnostic Microbiology. (7 th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378.
5.	Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2 nd Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1 / ISBN-10:0-521-67631-2.

Web Resources

1.	https://www.ncbi.nlm.nih.gov/books/NBK20370/
2.	https://www.msmanuals.com/en-in/home/infections/diagnosis-of-infectious3disease/diagnosis-of-infectious-disease
3.	https://journals.asm.org/doi/10.1128/JCM.02592-20
4.	https://www.sciencedirect.com/science/article/pii/S2221169116309509
5.	http://www.textbookofbacteriology.net/normalflora_3.html

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2EC41	Clinical and Diagnostic Microbiology					5	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 23PMB2EC42
Instruction Hours: 5
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

HERBAL TECHNOLOGY

UNIT - I

Pharmacognosy - Definition and history, Indian systems of medicine - Siddha, ayurvedha, and Unani systems. Taxonomy of locally available medicinal plants, their chemical constituents and medicinal uses - Classification of Crude drugs - Chemistry of Drugs - Future of pharmacognosy.

UNIT - II

Classification of medicinal plants - Vernacular name and family - Geographical source, cultivation, collection, and processing for market and commerce in crude drugs. Morphological and histological studies, chemical constituents - Therapeutic and other pharmaceutical uses. Underground stem - ginger, Alpinia - Roots - Rauolfia - Belladonna - Aerial parts - Bark - Cinchona.

UNIT - III

Leaves - Adathoda, Eucalyptus - Flower - Clove fruits seeds - Nux vomica Nutmegs, Gooseberry - unorganized drugs - Gum - Acacia - Resin - Turpentine, fixed oil - castor oil.

UNIT - IV

Herbal medicines for Human ailments - Drugs acting on cardiac diseases, cerebral diseases, Nasal, diseases - Blood pressure Drugs acting on Nervous system - Depressants. - Stimulants - Respiration and Drugs - Urogenital system and drugs - Psychoactive plants.

UNIT - V

Propagation of medicinal plants - Micro and macro propagation conservation of rare medicinal plants Role of biotechnology in medicinal plants banks - cultivation of medicinal and aromatic plants - Drug adulteration - methods of Drug evaluation, Herbal food - Food processing - packaging - Herbal sale and Export of medicinal plants - marketing - Intellectual property rights - Export laws.

References

1. George Edward Trease and W.C. Evans - Pharmacognosy 12th edition, English Language Books Society, Baelliere Tindall.
2. Handa, S.S. and Kapoor, V.K. Pharamcognosy by 2nd Edition, Vallabh Prakashan Publishers, New Delhi.
3. Jain, S.K (1980) Indian Medicinal plants.
4. Kokate, C.K., Durohit, A.P. and Gokhale, S.R., Pharmacognosy by 12th edition - Nirali Prakasham Publishers, Pune.
5. Kumar N.C. (1993) An Introduction to Medical Botany and Pharmacognosy.
6. Nadkarni (1981) Indian Materia Medica.
7. Shah, S.C. and Qudary (1990) A text book of Pharmacognosy.
8. Wallis, T.E, Text book of pharmacognosy by 5th edition. CBS publishers and distributors, New Delhi.

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB2EC42	Herbal Technology					5	3			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO2	✓	✓		✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓		✓			✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 41 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-II

Course Code: 23PMB2NME1
Instruction Hours: 2
Credits: 2

Exam Hours: 3
Internal Marks: 25
External Marks: 75

VERMITECHNOLOGY

Course Objectives:

- Introduce the concepts of vermicomposting.
- Explain the physiology, anatomy and biology of earthworms.
- Acquire the knowledge of the vermicomposting process.
- Explain the trouble shooting, harvesting and packaging of vermin composts
- Gain knowledge on applications of vermin composts and their value added products.

Course Outcomes:

CO1: Compare and contrast the uses of vermicompost to the soil.

CO2: Recommend different species of earthworms after acquiring knowledge on its biology.

CO3: Design the vermicomposting process.

CO4: Assess the Best Practices of Vermicomposting

CO5: Recommend the applications of vermicompost to different soils and for different crops.

UNIT I

Introduction to Vermiculture - Definition, classification, history, economic importance- In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure. Its role in the bio transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.

UNIT II

Earthworm Biology and Rearing - Key to identify the species of earthworms. Biology of *Eisenia fetida*. a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

UNIT III

Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.

UNIT IV

Vermicomposting - Trouble Shooting-Temperature-Aeration- Acidity- Pests and Diseases- Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method- migration method. Packing & Nutritional analysis of vermicompost.

UNIT V

Applications of Vermiculture - Vermiculture Bio-technology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Verm wash- vermicompost tea-vermi meal-enriched vermicompost-pelleted vermicompost.

Text Books:

1	ail S. A. (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2	Rathoure A. K., Bharati P. K. and Ray J. (2020). Vermitechnology, Farm and Fertilizer. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3	isty M. V. 2008. Vermitechnology, (1 st Edition), MJP Publishers.
4	complete technology book on Vermiculture and Vermicompost with manufacturing Process, machinery equipment details and Plant Layout. AB Press.
5	shav Singh (2014). A Textbook of vermicompost: Vermiwash and Biopesticide.

Reference Books:

1	Roy D. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
2	mar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
3	shmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.
4	<u>Edwards CA, Arancon NQ ShermanRL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1st edn.CRC Press.</u>
5	<u>Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1st edn. Orient longman.</u>

Web Resources:

1.	https://en.wikipedia.org/wiki/Vermicompost
2.	http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
3.	https://www.kngac.ac.in/elearning-portal/ec/admin/contents/4_18K4ZEL02_2021012803204629.pdf
4.	https://composting.ces.ncsu.edu/vermicomposting-2/
5.	https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/

Semester	Code	TitleoftheCourse					Hours	Credits			
II	23PMB2SE2	Vermicomposting					2	2			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO3	✓		✓	✓			✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓		✓		✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number ofMatches(□) =41 Relationship: High											

Relationship MatrixforCOs,POsand PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER-III

Course Code: 23PMB3CC7
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

SOIL AND ENVIRONMENTAL MICROBIOLOGY

Course Objectives:

- Explain the role of microorganisms in soil fertility.
- Discuss the benefits of interactions among soil microbes and acquire awareness about microbes as biofertilizers and biocontrol agents.
- Create awareness about components of environment, environmental pollution, and detection methods.
- Acquire in depth knowledge about solid and liquid waste treatments.
- Develop knowledge about organic matter degradation, bioremediation, and the environment risk assessment.

Course Outcomes:

CO1: Depict diversity and significance of soil microbes and predict the role of microbes in biological nitrogen fixation.

CO2: Utilize the knowledge of microbial interactions, with beneficial application of biofertilizers for sustainable agriculture and benefits of biopesticides.

CO3: Explain the different types of microorganisms in water. Identify the causes of water pollution and the methods for quality assessment of water and control of water borne diseases.

CO4: Apply knowledge about waste treatments and microbial decomposition and bio-remediation process in environmental cleanup.

CO5: Plan a clear approach on environmental issues. Control pollution and explain protection laws to public.

UNIT I

Soil Microbiology– Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major group of microorganisms in soil. Quantification of soil microflora, role of microorganism in soil fertility. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation- Chemistry and Genetics of BNF. Phytopathology and Disease cycle of Plant pathogens - Tikka and Citrus canker, Types of disease symptoms, Structural and Inducible biochemical defenses - Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Plantibodies, Phenolics, Phytoalexins

UNIT II

Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria– symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non-Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. Biofertilizers and Biocontrol agents – Types, benefits and application. Advantages, social and environmental aspects - Bt crops, golden rice.

UNIT III

Components of Environment: Hydrosphere, lithosphere, atmosphere, and biosphere – definitions with examples; Energy flow in the ecosystem- Carbon, Nitrogen, Sulfur and Phosphorous cycles. Physical factors affecting distribution of microorganisms in various environments. Predisposing factors for Environmental diseases – infectious (water and air

borne) and pollution related, spread and control of these diseases. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Space microbiology - Microbiological research in space environment.

UNITIV

Waste management – Solid waste - Types - management - Factors affecting solid waste generation rates. Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process. Quality assessment of decontaminated matters and other biological effluents. Biological reference standards. Utilization of Solid Waste as Food, Feed and Fuel- Composting, Vermicomposting, Bio manure and Biogas production. E waste management.

UNIT V

Degradation of organic matter - lignin, cellulose, hemicellulose, pectin, common pesticides-herbicides (2,4-D) and pesticides (DDT), heavy metals. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers. Biodegradation of Hydrocarbons. Biodeterioration of Textiles and Leather. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, EIA guidelines, US Environment protection Agency norms.

Text Books;

1.	Subba Rao. N. S. (2017). Soil Microbiology. (5 th Edition). MedTech Publishers.
2.	Daniel. C. J. (2006). Environmental Aspects of Microbiology. (2 nd Edition). Bright Sun Publications.
3.	Rangaswami. G. and Mahadevan. A. (2006). Diseases of Crop Plants in India. (4 th Edition). Prentice–Hall of India Pvt. Ltd.
4.	Sharma P. D. (2010). Microbiology and Plant pathology. (2 nd Edition). Rastogi Publications.
5.	Subba Rao. N.S. (2005). Soil microorganisms and Plant Growth. (4 th Edition). Oxford and IBH Publishing Pvt. Ltd.

Reference Books:

1.	Pepper I. L., Gerba C. P. and Gentry T. J. (2014). Environmental Microbiology (1 st Edition). Academic Press, Elsevier.
2.	Bitton, G. (2011). Wastewater Microbiology. (4 th Edition). Wiley-Blackwell.
3.	Bridgewater L. (2012). Standard Methods for the Examination of Water and Wastewater. American Public Health Association.
4.	Shrivastava A.K. (2003). Environment Auditing. A. P. H. Publishing Corporation.
5.	Tinsley, S. and Pillai, I. (2012). Environmental Management Systems – Understanding Organizational Drivers and Barriers. Earthscan.

Web Resources

1.	https://academic.oup.com/femsec/article/93/5/fix044/3098413
2.	http://www.fao.org/3/t0551e/t0551e05.htm
3.	www.environmentshumail.blogspot.in/
4.	https://www.frontiersin.org/articles/10.3389/fpls.2017.01617/full
5.	https://serc.carleton.edu/microbelife/index.html

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
II	23PMB3CC7	Soil and Environmental Microbiology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO2	✓		✓	✓	✓	✓		✓	✓		
CO3	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO5	✓	✓		✓	✓	✓	✓	✓	✓		
Number of Matches (✓) = 42 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-III

Course Code: 22PMB3CC8
Instruction Hours: 6
Credits: 5

Exam Hours: 3
Internal Marks: 25
External Marks: 75

RECOMBINANT DNA TECHNOLOGY AND BIOTECHNOLOGY

Course Objectives:

- Provide knowledge on the structure, replication and repair mechanisms of DNA. Illustrate the structure, functions and significance of RNA.
- Discuss the gene regulatory mechanisms in prokaryotes and eukaryotes and importance of mutations.
- Provide in depth knowledge about artificial gene transfer mechanisms and selection of Recombinants.
- Impart knowledge on various molecular techniques and their importance in biotechnology
- Explain the applications of genetic engineering in various fields.

Course Outcomes:

CO1: Analyze, demonstrate and appreciate DNA replication and protein synthesis.

CO2: Investigate the types of mutation and its impact on microbes. Illustrate various strategies on gene cloning.

CO3: Analyze, modify and characterize DNA modifying enzymes.

CO4: Illustratively assess the molecular techniques for DNA and protein analysis.

CO5: Adopt the applications of Genetic Engineering in the field of agriculture and medicine towards scientific research.

UNIT I

DNA replication – modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, r-RNA and t-RNA. Ribosomes. Genetic Code and Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications

UNIT II

Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems - repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations - base substitutions, frame shift, deletion insertion, duplication, inversion. Silent, conditional and lethal mutation. Chemical mutagenesis. Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test).

UNIT III

Genomic DNA and cDNA library - Construction and Screening. Substrative hybridization for tissue specific DNA libraries. Techniques in genetic engineering Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking,

UNIT IV

Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array. Protein engineering and techniques Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes, Basic concepts in enzyme engineering, engineering for kinetic properties of enzymes. protein folding, protein sequencing, protein crystallization. Applications of protein engineering.

UNIT V

Plant biotechnology - constituents and concepts of sterilization - preparation, isolation and selection of explant. Suspension cell culture, callus culture, protoplast isolation, culture & fusion. Anther and pollen culture for production. Animal biotechnology – equipment and media used for animal cell culture technology. Primary and established cell line culture and culture media. Applications of animal cell cultures. Serum protein media viability and cytotoxicity. Applications of Genetic Engineering - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Human Gene Therapy - Germline and Somatic Cell Therapy - Ex-vivo Gene Therapy. In-vivo Gene Therapy.

Text Books:

1.	Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4 th Edition). Narosa Publishing House, New Delhi.
2.	Snusted D.P. and Simmons M. J. (2019). Principles of Genetics. (7 th Edition). John Wiley and Sons, Inc.
3.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.
4.	Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7 th Edition). Blackwell Publishing.
5.	Maloy S. R. Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2 nd Edition). Narosa Publishing House Pvt. Ltd.

Reference Books:

1.	Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7 th Edition). John Wiley and Sons, Ltd.
2.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5 th Edition). ASM Press.
3.	Russell P.J. (2010). Genetics - A Molecular Approach. (3 rd Edition). Pearson New International Edition.
4.	Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria. (4 th Edition). ASM Press Washington-D.C. ASM Press.
5.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.

Web Resources

1.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
2.	https://geneticeducation.co.in/what-is-transcriptomics
3.	https://www.molbiotools.com/usefullinks.html
4.	https://geneticeducation.co.in/what-is-transcriptomics
5.	https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	23PMB3CC8	Recombinant DNA Technology and Biotechnology					6	5			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓			
Number of Matches (✓) = 42 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-III

Course Code: 22PMB3CC9P
Instruction Hours: 6
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

PRACTICAL III

Course Objectives:

- Illustrate the significance of artificial transformation and mutations.
- Discuss blotting techniques and PCR.
- Analyze and estimate water quality and potability
- Prepare Biofertilizers, vermicompost and test their efficiency
- Familiarize with common plant infections

Course Outcomes:

CO1: Utilize various molecular techniques for gene manipulation and detection of mutants.
CO2: Undertake novel research with techniques like PCR and blotting analysis.
CO3: Assess the microbial quality of water and air and relate the results to standards
CO4: Synthesize biofertilizers and vermicompost. Cultivate mushrooms using solid waste.
CO5: Identify various plant pathogens

UNIT I

Artificial Transformation
Detection of Antibiotic resistant mutants
Identification of mutants by replica plating method

UNIT II

Amplification of DNA by PCR
Western blotting - Demonstration
Southern blotting – Demonstration

UNIT III

Detection of Water hardness
Microbiological analysis of water
Total Heterotrophic Count
Test for indicative organisms
1) MPN
2) Membrane Filtration
Physical, chemical, assessment of water
Physical - Color, pH,
Chemical - alkalinity, acidity, DO, BOD, COD
Enumeration of bacteria and fungi from air – Air sampler
Isolation of free-living nitrogen fixers from soil and *Rhizobium* from root nodules of leguminous plants.
Isolation and enumeration of phosphate-solubilizing bacteria from soil

UNIT IV

Preparation of Biofertilizers and testing the efficiency of prepared biofertilizers
R:S ratio of soil microbes
Estimation of soil enzymes- urease and phosphatase
Study of phylloplane microflora by leaf impression method
Isolation of cellulose degrading bacteria
Preparation of a vermicompost
Isolation of VAM fungi from soil
Isolation of plant pathogen - *Alternaria* & *Curvulariaspp.*,
Cultivation of edible mushroom from solid waste

Cultivation of *Azolla*

UNIT V

Visual examination, observation, and identification of some common plant infections.

To test Koch postulates using plant pathogens

Collection of 5 herbarium specimens of infected leaves.

Text Books:

1.	Russell P. J. (2019). Genetics – A Molecular Approach (3 rd Edition). Pearson Education, Inc.
2.	Glick B. R. and Patten C. L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA (5 th Edition). ASM Press.
3.	Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
4.	James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5 th Edition). The Benjamin publishing company. New York.
5.	Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3 rd Edition). American Society for Microbiology.

References Books

1.	Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7 th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
2.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7 th Edition). John Wiley and Jones, Ltd.
3.	Dale J. W., Schantz M. V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3 rd Edition). John Wileys and Sons Ltd.
4.	Pepper I., Gerba C. and Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual. (2 nd Edition). Academic Press, Elsevier.
5.	Yates M.V., Nakatsu C.H., Miller R.V. and Pillai, S.D. (2016). Manual of Environmental Microbiology. (4 th Edition). Wiley.

Web Resources

1.	https://www.molbiotools.com/usefullinks.html
2.	https://geneticgenie.org3 .
3.	https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4.	https://vlab.amrita.edu/index.php?sub=3&brch=272
5.	https://nptel.ac.in/courses/102105087

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	23PMB3CC9P	Practical- III					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO2	✓		✓	✓	✓	✓	✓	✓			
CO3	✓	✓	✓	✓	✓		✓	✓	✓	✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓		✓		✓	✓	✓	
Number of Matches (✓) = 41 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER-III

Course Code: 22PMB3EC51
Instruction Hours: 5
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

BIOSAFETY, BIOETHICS AND IPR

Course Objectives:

- Create a research environment. Encourage investigation, analysis and study the bioethical principles, values, concepts, and social and juridical implications in the areas of science, biotechnology and medicine.
- Discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotechnological products.
- Familiarize fundamental aspects of Intellectual property Rights in the development and management of innovative projects in industries.
- Acquire knowledge about bioethics, biodiversity and Genetically modified foods and food crops
- Provide students with an understanding of bioethics in research associated with medicine

Course Outcomes:

CO1:Execute the role of IPR, Patent, Trademarks and its importance.

CO2:Develop patent procedure, patent filling and its mapping.

CO3:Become Patent attorneys and Patent officers.

CO4:Applybioethics in GMO, food crops and its biodiversity.

CO5:Analyze the importance of bioethics in research associated with HGP, clinical research, stem cell therapy.

UNIT I

Intellectual Property Rights: Different forms of Intellectual Property Rights – their relevance, importance to industry, Academia. Role of IPR's in Biotechnology, Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. International organizations and IPR - Overview of WTO, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.

UNIT II

Process involved in patenting. Patent Search - Procedural steps in patenting, process of filing, PCT application, pre-grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping.

UNIT III

Patentability of biotechnology inventions - Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Biotechnological inventions as patentable subject matter, territorial nature of patents - from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, tentative harmonisation efforts, implications of setting up a uniform world patent system.

UNIT IV

Introduction to bioethics - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods

and food crops, organisms and their possible health implications and mixing up with the gene-pool.

UNIT V

Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: stem cell research, human genome project, use of animals in research, human volunteers for clinical research, studies on ethnic races. he Nuremberg code.

Text Books	
1.	Usharani B., Anbazhagi S. and Vidya C. K. (2019). Biosafety in Microbiological Laboratories. (1 st Edition). Notion Press. ISBN-101645878856
2.	Satheesh M. K. (2009). Bioethics and Biosafety. (1 st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703
3.	Goel D. and Parashar S. (2013). IPR, Biosafety and Bioethics. (1 st Edition). Pearson education: Chennai. ISBN-13: 978-8131774700
4.	Raj Mohan joshi. Biosafety and Bioethics. Wiley Publications.
5.	Sibi. GIntellectual, Property Rights, Bioethics, Biosafety and Entrepreneurship in biotechnology. (2021). Wiley Publications.
References Books	
1.	Nithyananda K. V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
2.	Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited,
3.	Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis.
4.	Tony Hope (2004). Medical Ethics: A very Short introduction,. Oxford Publication.
5.	Goel Parashar. IPR, Biosafety and Bioethics (2013). Pearson Publications.
Web Resources	
1.	http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf .
2.	https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf .
3.	https://www.cdc.gov/training/quicklearns/biosafety/
4.	https://bioethics.msu.edu/what-is-bioethics
5.	https://www.wto.org/english/tratop_e/trips_e/intel1_e.html

Semester	Code	TitleoftheCourse					Hours	Credits			
III	23PMB3EC51	BIOSAFETY, BIOETHICS AND IPR					5	4			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO2	✓		✓	✓	✓	✓	✓	✓	✓		
CO3	✓	✓	✓		✓	✓			✓	✓	
CO4	✓	✓		✓	✓	✓		✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Number ofMatches(□) =41 Relationship: High											

Relationship MatrixforCOs,POsand PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER III

Course Code: 23PMB3EC52
Instruction Hours: 5
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

WATER CONSERVATION AND WATER TREATMENT TECHNOLOGIES

Course Objectives:

- Explain how societal and climatic changes will distress water supply and water demand in future
- Ascertain promising elucidations to the global water crisis and assess the pros and cons
- Acquire knowledge to identify the quality of water by standard method
- Illustrate the methods of water treatment technologies and assessing the impact of HWTS
- Describe the application and uses of various emerging water treatment technologies

Course Outcomes:

CO1: Appraise issues of water scarcity, stress, and conflict on global population.

CO2: Apprehend the multiple approaches against water scarcity and to understand various government schemes for water conservation.

CO3: Relate the connection between water quality and public health.

CO4: Design and execute standard strategy for successful HWTS implementation.

CO5: Cogitate the purpose, principles, operation, and limitation of various modern water treatment technologies.

UNIT I

Water Scarcity; Major Causes of Water Scarcity, Types of Water Scarcity, Water Footprint- Effects of Water Scarcity Across the Globe-, Water Scarcity in India; Effects of Water Scarcity in India - Social and Political Effects and Economic Risks of Water Scarcity in India.

UNIT II

Multi-pronged approach to Prevent Water Scarcity; Aquifer Recharging, Water reuse and Zero-Liquid Discharge Technology, Coastal Reservoir, Desalination Plants-Measures for Preventing Water Scarcity in India - Jal Shakti Abhiyan Campaign, Atal Bhujal Yojana, Adoption of Composite Water Management Index (CWMI), Water conservation resource management, Rain Water Harvesting.

UNIT III

Water Quality and Pollution; Impurities in the water, Characteristics of different water sources Vulnerability of the water sources to contamination, Water quality criteria - Quality of surface waters, flowing waters, impounded waters, Groundwater, Water quality standards, Microbiological quality of drinking Water, Chemical quality of drinking water.

UNIT IV

Water Treatment Technologies; Sedimentation, Filtration, Coagulation and flocculation, Water softening and adsorption processes, Membrane filtration, Microfiltration, Ultrafiltration and Nanofiltration, Water disinfection, Activated carbon filtration, Household Water Treatment and Safe Storage (HWTS). Methods for household water treatment Safe water storage, Household water treatment and safe storage decision tree, Assessing the impact of HWTS, Government policies for HWTS.

UNIT V

New and Emerging Drinking Water Treatment Technologies; Nanotechnology, Acoustic nanotube technology, Photocatalytic water purification technology, Aquaporin Inside™ technology, Automatic Variable Filtration (AVF) technology, Sun Spring System, Desalination.

Text Books:

1.	Vasileios A., Tzanakakis N. Paranychianakis V. and Angelakis A. N. (2020). Water Supply and Water Scarcity. MDPI, ISBN 978-3-03943-306-3 (Hbk). ISBN 978-3-03943-3070.
2.	Pannirselvam M., Shu Li.,Griffin G., Philip L., Natarajan A. and Hussain S. (2019). Water Scarcity and Ways to Reduce the Impact. ISBN: 978-3-319-75199-3.
3.	Tiwari A., Kumar A., Singh A., Singh T.N., Suozzi E., Matta G. and Russo S. (2022). Water Scarcity, Contamination and Management. Elsevier. ISBN: 9780323853781.
4.	Daniel, C.J. (1996). Environmental Aspects of Microbiology, 1 st edn. Bright Sun Publications.
5.	Maier RM, Pepper IL, Gerba CP (2008). Environmental Microbiology, 2 nd edn. Academic Press

Reference Books:

1.	Fujita K. and Mizushima T. (2021). Sustainable Development in India -Groundwater Irrigation, Energy Use, and Food Production. ISBN 9780367460976.
2.	Gupta R. (2008). Water Crisis in India. Atlantic Publishers. ISBN: 9788126909582, 9788126909582.
3.	Ahuja S. (2013). Monitoring Water Quality-Pollution Assessment, Analysis, and Remediation. Elsevier. Book ISBN: 9780444594044. Hardcover ISBN: 9780444593955.
4.	Saeid Eslamian ., Faezeh Eslamian ., (2021) Water harvesting and conservation – Basic Concepts and fundamentals, Wiley Publications.
5.	Buckley RG. (2016) Environmental Microbiology 1 st edn. CBS Publishing.

Web Resources:

1.	https://link.springer.com/book/10.1007/978-1-59745-278-6
2.	https://apps.who.int/iris/handle/10665/206916?show=full
3.	https://www.acs.org/content/acs/en/policy/publicpolicies/sustainability/water-statement.html
4.	https://www.toftigers.org/best-practice/water-conservation-and-treatment/
5.	https://doh.wa.gov/community-and-environment/wastewater-management/site-sewage-systems-oss

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	23PMB3EC52	Water Conservation and Water Treatment Technologies					5	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓		✓	✓	
CO3	✓	✓	✓	✓		✓	✓	✓		✓	
CO4	✓	✓		✓	✓	✓	✓	✓	✓		
CO5	✓	✓		✓	✓	✓	✓		✓	✓	
Number of Matches (✓) = 41 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER III

Course Code: 22PMB3CI

Instruction Hours: 5

Credits: 4

Exam Hours: 3

Internal Marks: 25

External Marks: 75

FERMENTATION TECHNOLOGY AND PHARMACEUTICAL MICROBIOLOGY

Course Objectives:

- Discuss about fermentation and its types, sensitize on methods of strain development for improved yield.
- Impart knowledge on the fermenter design and types.
- Acquire knowledge on the effective recovery and purification of the Explain the importance of pharmaceutical microbiology. products.
- Illustrate methods for production products using microorganisms and their quality control.

Course Outcomes:

CO1:Develop microbial strains, carry out fermentation and recover the products of the process.

CO2:Design fermenters according to needs for various products

CO3:Recover the end products of the fermentation process economically.

CO4:Utilize the knowledge on pharmaceutical microbiology for industrial production of products.

CO5:Produce therapeutic products from microbes employing technology and analyze the quality the products.

UNIT I

Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculums for fermentation process. Media for industrial fermentation - Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter pre-culture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

UNIT II

Fermenter – Design, types and construction, Instrumentation and control. Productivity. Yield coefficients. Heat production. Aeration and agitation. Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.

UNIT III

Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

UNIT IV

Overview of pharmaceutical microbiology - Ecology of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, ophthalmologic preparation, implants.

UNIT V

Production of pharmaceutical products and quality assurance – Vaccines, immunodiagnosics, immuno-sera, immunoglobulin. Antibiotics - Penicillin, Griseofulvin,

Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.

Text Books:

1.	Patel A. H. (2016). Industrial Microbiology. (2 nd Edition). Laxmi Publications, New Delhi.
2.	Casida L. E. J. R. (2019). Industrial Microbiology. New Age International Publishers.
3.	Sathyanarayana U. (2005). Biotechnology. (1 st Edition). Books and Allied (P) Ltd.
4.	Reed G. (2004). Prescott and Dunn's Industrial Microbiology. (4 th Edition). CBS Publishers & Distributors.
5.	Waite M. J., Morgan N. L., Rockey J. S. and Highton G. (2013). Industrial Microbiology: An Introduction. Wiley Blackwell Publishers.

References Books:

1.	Stanbury P. T. and Whitaker. (2016). Principles of Fermentation Technology. (3 rd Edition). Pergamon Press. NY.
2.	Handa S. S. and Kapoor V. K. (2022). Pharmacognosy, (4 th Edition). Vallabh Prakashan Publishers, New Delhi.
3.	Kokate C. K., Durohit A. P. and Gokhale S. R. Pharmacognosy. (2002). (12 th Edition). Nirali Prakasham Publishers, Pune.
4.	Hugo W. B. and Russell A. D. (2004). Pharmaceutical Microbiology. (7 th Edition). Blackwell Scientific Publication, Oxford.
5.	Wallis, T.E. (2005). Text book of Pharmacognosy. (5 th Edition). CBS publishers and distributors, New Delhi.

Web Resources:

1.	https://ib.bioninja.com.au/options/untitled/b1-microbiology-organisms/fermenters.html
2.	https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html
3.	https://www.sciencedirect.com/topics/biochemistry-genetics-andmolecular-biology/ethanol-fermentation
4.	https://www.usp.org/sites/default/files/usp/document/harmonization/genmethod/q05b_pf_ira_34_6_2008.pdf
5.	http://www.simbhq.org/

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	23PMB3CI	Fermentation technology					5	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓	
CO3	✓			✓	✓	✓		✓	✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓	✓		
CO5	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Number of Matches (✓) = 4 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER III

Course Code: 23PMB3NME2
Instruction Hours: 2
Credits: 2

Exam Hours: 3
Internal Marks: 25
External Marks: 75

ORGANIC FARMING AND BIOFERTILIZER TECHNOLOGY

Course Objectives:

- Impart knowledge on the importance, types and advantages of organic farming thereby creating awareness on conserving environment and natural resources, encouraging sustainable agriculture.
- Familiarize with the basic concepts of farm development and relate the development of organic farming in their countries to meet global trends.
- Explain the various types of biofertilizer and the scope in its production.
- Discuss about biofertilizer production and its field application, promoting economy.
- Develop the skill to analyze the quality of packaging, storage, assess the shelf life and bioefficacy of biofertilizers

Course Outcomes:

CO1: Produce biofertilizers and distinguish between organic and conventional farming.

CO2: Plan a Complete Farm Business including marketing, operation and financial outline.

CO3: Practice the application of microbial bio-fertilizers in large scales, thereby increasing soil fertility.

CO4: Develop integrated farming for sustainable agriculture.

CO5: Promote the quality of packaging, storage, increase shelf life, accelerate the bio efficacy of bio fertilizers as per BIS standards

UNIT I

Organic farming – Definition, relevance. Biological nutrient management - Organic manures, vermicompost, green manure, organic residue, biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, bio pesticides etc. Organic and Conventional farming. Organic and Chemical farming – Comparison

UNIT II

Certification and Schemes - Certification and Schemes. Organic certification in brief. Integrated farming system- definition, goal, components. Factors affecting ecological balance. Land degradation. Soil health management. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes - NPOF, NPOF, NHM, HMNEH, NPMSH&F and RKVY.

UNIT III

Biofertilizers - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*.

UNIT IV

Cyanobacterial biofertilizers- *Anabaena*, *Nostoc*, *Hapalosiphon* and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza. Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, potassium solubilization

UNIT V

Production technology - Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid bio-fertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Text Books:

1.	Sharma A. K. (2001). Hand book of Organic Farming. Agrobios.
2.	Gaur A. C. (2006). Hand book of Organic Farming and Biofertilizers. Ambika Book Agency.
3.	Subba Rao N.S. (2017). Bio-fertilizers in Agriculture and Forestry. (4 th Edition). Med Tech publisher.
4.	Subba Rao N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4 th Edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5.	Sathe T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.

Reference Books:

1.	Rakshit A. and Singh H. B. (2015). ABC of Organic Farming. (1 st Edition). Jain Brothers.
2.	Dubey R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
3.	Bansal M. (2019). Basics of Organic Farming. CBS Publisher.
4.	Bhoopander G., Ram Prasad., (2019) Biofertilizer for sustainable agriculture and Environment, Springer
5.	Niir Board., (2012) (1 st Edition) Biofertiliser and organic farming

Web Resources:

1.	https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2.	https://www.fao.org/organicag/oa-faq/oa-faq6/en/
3.	https://www.india.gov.in/topics/agriculture/organic-farming
4.	https://agriculture.nagaland.gov.in/bio-fertilizer/
5.	https://www.ccd.ngo/sustainable-agriculture.html?gclid=EAIaIQobChMI5a-KndCo-wIV2ZZLBR1ozQj9EAAYAiAAEgJW2_D_BwE

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
III	23PMB3NME 2	Organic Farming and Biofertilizer Technology					2	2			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓	
CO2	✓	✓	✓		✓	✓	✓		✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓		✓	
Number of Matches (✓) = 43 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER IV

Course Code: 23PMB3CC10
Instruction Hours: 6
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

FOOD AND DAIRY MICROBIOLOGY

Course Objectives:

- Discuss microorganisms involved in food spoilage.
- Illustrate bacterial and nonbacterial food borne infections important in public health
- Familiarize various national and international aspects of food safety and quality assurance.
- Elaborate on microbiology of milk, preservation techniques and production of dairy products.
- Explain Dairy plant hygiene, quality control and waste disposal.

Course Outcomes:

CO1: Explain Dairy plant hygiene, quality control and waste disposal.

CO2: Use the knowledge on food borne disease to protect public health.

CO3: Familiarize various national and international aspects of food safety and quality assurance.

CO4: Prepare dairy products and perform quality checks.

CO5: Apply microbiological standards to milk and milk products.

UNIT I

Microorganisms of food- Scope of food Microbiology. Contamination and spoilage of food – vegetables, fruits, poultry, fish, eggs, meat, meat products and canned foods. Food Preservation - Temperature (low and high), drying, radiation and chemicals.

UNIT II

Food microbiology and public health. Food hazards. Food infections - *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella*, *Shigella*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*. Nonbacterial food borne illness - Helminthes, nematodes, protozoa, toxigenic fungi and food borne virus.

UNIT III

Food microbiology and public health. Food hazards. Food infections - *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella*, *Shigella*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*. Nonbacterial food borne illness - Helminthes, nematodes, protozoa, toxigenic fungi and food borne virus.

UNIT IV

Introduction to Dairy microbiology – Milk production and hygiene. Microorganisms associated with milk. Microbial metabolites and their role in spoilages- souring, curdling, gassiness, ropiness, proteolysis, lipolysis, abnormal flavour and colour. Antimicrobial systems in raw milk. Microbiological grading of raw milk. Milk borne diseases and their control. Bacteriological aspects of milk processing – Thermization, pasteurization, boiling, sterilization, UHT, bactofugation, and membrane filtration.

UNIT V

Composition and chemistry of cream, butter, ghee, ice-cream, cheese, kefir, koumiss, rennin, condensed and dried milks, infant food. Spoilage of ghee and use of antioxidants. Chemistry of milk fermentation. Chemistry of rennin coagulation of milk and changes occurring during ripening of cheese, physico-chemical changes in the manufacture and storage of milk powder, lactose, crystallization and its significance. Dairy plant hygiene and sanitation. Disposal of dairy waste. Microbiological standards for Milk and Milk products- PFA BIS, Codex/ ISO standards.

Text Books:

1.	Adams M. R. and Moss M. O. (1996). Food Microbiology, New Age International (P) Limited Publishers, New Delhi.
2.	Frazier W.C., Westhoff. D. C. and Vanitha K.N. (2013). Food Microbiology. (6 th Edition). McGraw Hill Education.
3.	Jay J. M., Loessner M. J. and Golden D.A. (2006). Modern Food Microbiology. (7 th Edition). Springer.
4.	Doyle M. P., Buchanan R. L. (2012). Food Microbiology: Fundamentals and Frontiers. (4 th Edition). American Society for Microbiology Press.
5.	Ray B. and Bhunia A. (2013). Fundamentals of Food Microbiology. (5 th Edition). CRC Press.

References Books:

1.	Robinson R. K. (2000). Dairy Microbiology 3 rd edn, Elsevier Applied Science, London.
2.	2. Adams M.R, and Moss M.D, (2005). Food Microbiology 4 th edn, New Age International Pvt. Ltd., Publishers. First edition.
3.	3. Banwarst. G.J. (2003). Basic Food Microbiology 2 nd edn, CBS Publishers and distributors.
4.	4. Hobbs, B.C. and Roberts, D, (1968), Food Poisoning and Food Hygiene 7 th edn. Edward Arnold: London.
5.	5. Vijaya R K, (2004). Food Microbiology 1 st edn. MJP Publishers, Chennai.

Web Resources:

1.	https://www.fssai.gov.in
2.	https://www.who.int/news-room/fact-sheets/detail/food-safety
3.	https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines

Semester	Code	TitleoftheCourse				Hours	Credits			
IV	23PMB4CC10	Food and Dairy Microbiology				6	4			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓		✓	✓	✓	✓	✓		✓	✓
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓		✓	✓	✓		✓	✓	✓
Number ofMatches(□) = 42 Relationship: High										

Relationship MatrixforCOs,POsand PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER IV

Course Code: 23PMB3CC11
Instruction Hours: 6
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

RESEARCH METHODOLOGY AND BIOSTATISTICS

Course Objectives:

- Discuss the methods and techniques of data collection.
- Explain sampling methods, write research reports and articles.
- Discuss the basic concepts of Biostatistics.
- Describe statistical software for analysis.
- Explain the tests of significance.

Course Outcomes:

CO1: Collect and present data suitable to the research design.

CO2: Write research manuscripts and articles for journals.

CO3: Recommend the utilization of biostatistics tools for analysis of biological data.

CO4: Prove and justify hypothesis for a particular research.

CO5: Apply software tools for interpretation of biological data.

UNIT I

Introduction to Research Methodology - Meaning and importance. Statement, Constraints. Review of literature - Review and synopsis presentation. Types of research, Research tools. Methods and techniques of data collection - types of data, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/pilot study, methods), methods of secondary data collection.

UNIT II

Sampling and sampling distributions. Sampling frame, importance of probability sampling, sampling - simple random, systematic, stratified random and cluster. Variables - nominal, ordinal, discontinuous, continuous, derived. Research process, designs and Report writing - types of research reports, guidelines for writing an article and report, report format, appendices, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

UNIT III

Introduction to Biostatistics - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation. Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range, mean deviation and coefficient of variation. Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, t test, correlation coefficient.

UNIT IV

Correlation and regression - Positive, negative, calculation of Karl-Pearsons co-efficient of correlation. Linear regression and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. Tests of significance - Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error.

UNIT V

Probability and distributions - Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. RSM: methods for process optimization set up CCD, Box Behnken, optimal RSM design, regression models FDS curves, surface contours, multi linear constraints and categoric factors to optimal design.

Text Books:

1.	rma K. R. (2002) Research methodology. National Publishing House, New Delhi.
2.	Daniel W.W. (2005). Biostatistics; A foundation for analysis in the health sciences. (7 th Edition). Jhon Wiley & sons Inc, New York.
3.	Rao P. S. S. and Richard J. (2006). Introduction to Biostatistics & Research methods. Prentice-Hall, New Delhi.
4.	Veerakumari L. (2015) Bioinstrumentation 1 st edn. MJP Publishers.
5.	Ahuja V.K. (2017) Laws Relating to Intellectual Property Rights. Lexis Nexis.

Reference Books:

1.	J. H. (2006). Biostatistical Analysis. (4 th Edition). Pearson Education Inc. New Jersey.
2.	Ans B. C. and McCarthy M.A. (2011). Research Methods and Statistics. Pearson Education Inc. New Jersey.
3.	Ans K. A. and Lawrence E. M. K. (2014). Research Methods, Statistics, and Applications. SAGE Publications, Inc., New Delhi.
4.	Anderson J.B. and Poole M. (2011). Assignment and Thesis Writing. 4 th edn. Wiley India Private Limited.
5.	Kothari C.R. and Garg G (2004) Research Methodology: Methods and Techniques. 2 nd Edition. New Age International Publishers

Web Resources:

1.	https://www.studocu.com/en-ca/document/mount-royal-university/quantitative-research-methods-and-data-analysis/lecture-notes-all-lectures/344093
2.	https://www.khanacademy.org/math/statistics-probability/sampling-distributions-library
3.	https://testbook.com/learn/maths-mean-median-mode/
4.	https://rcub.ac.in/econtent/ug/bcom/sem4/Business%20Statistics%20Unit%204%20Correlation%20and%20Regression.pdf
5.	https://www.cse.iitk.ac.in/users/piyush/courses/pml_fall17/material/probabilty_tutorial.pdf

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	23PMB4CC1I	Research Methodology and Biostatistics					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓		✓	✓	✓	✓		✓	
CO2	✓		✓	✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓		✓	
CO4	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓		✓	✓	✓	✓		
Number of Matches (✓) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER IV

Course Code: 22PMB4CC12P
Instruction Hours: 6
Credits: 4

Exam Hours: 3
Internal Marks: 25
External Marks: 75

PRACTICAL IV

Course Objectives

- Enumerate bacteria in milk for quality analysis.
- Discuss tests for checking the quality of milk and milk products.
- Gain knowledge on microbes present in fermented foods and spoiled food.
- Explain isolation, identification and characterization of food borne pathogens.
- Analyze enzyme producing bacteria and detect toxins in spoiled food.

Course Outcomes:

CO1: Check the quality of milk

CO2: Analyse quality checking of milk

CO3: Knowledge of staining to differentiate the microbes

CO4: Data and types of microbes from fermented foods and spoiled food.

CO5: Knowing the enzyme production by bacteria and fungi, toxicity of food

UNIT I

Milk microbiology –Breed count, Direct microscopic count and Standard plate count, Presumptive test for coliforms.

UNIT II

Testing the quality of milk - Methylene blue reductase test, Resazurin test and alkaline phosphatase test.

UNIT III

Isolation of microbes from fermented foods – bacteria, fungi and yeast.

UNIT IV

Isolation of bacteria, fungi and yeast from spoiled food.

UNIT V

Analysis of enzyme producers.

Production and detection of aflatoxins from spoiled food.

LPCB and Gram staining.

Text Books:

1.	Ray B. and Bhunia A. (2013). Fundamentals of Food Microbiology. (5 th Edition). CRC Press.
2.	Garg N., Garg K. and Mukerji K. G. (2013). I K. International Pvt. Ltd.
3.	Doyle M. P., Buchanan R. L. (2012). Food Microbiology: Fundamentals and Frontiers. (4 th Edition). American Society for Microbiology Press.
4.	Robinson R. K. (2000). Dairy Microbiology 3 rd Edition , Elsevier Applied Science, London.
5.	Adams M.R, and Moss M.D, (2005). Food Microbiology 4 th Edition, New Age International Pvt. Ltd., Publishers. First edition.

References Books.:

1.	Hobbs, B.C. and Roberts, D, (1968), Food Poisoning and Food Hygiene 7 th Edition Edward Arnold: London.
2.	Vijaya R K, (2004). Food Microbiology 1 st Edition. MJP Publishers, Chennai.
3.	Banwarst. G.J. (2003). Basic Food Microbiology 2 nd Edition, CBS Publishers and distributors.
4.	Narang S. P. (2004). Food Microbiology – Methods of Enumeration. APH Publishing Corporation, New Delhi.
5.	Jay J. M., Loessner M. J. and Golden D.A. (2006). Modern Food Microbiology. (7 th Edition). Springer.

Web Resources:

1.	https://www.fssai.gov.in
2.	https://www.who.int/news-room/fact-sheets/detail/food-safety
3.	https://academic.oup.com/bioscience/article/65/8/758/240222
4.	https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-_A_review
5.	https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_StarterCultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	23PMB4CC12 P	Practical- IV					6	4			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	□	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Number of Matches (□) = 44 Relationship: High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER IV

Course Code: 23PMB4EC61
Instruction Hours: 4
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

MARINE MICROBIOLOGY

Course Objectives:

- Gain fundamental knowledge of marine environment and the microbial communities inhabiting the oceans.
- Discuss the metabolic diversity of marine microorganisms and their interrelationships.
- Explain the survival of microorganisms in extreme environments
- Illustrate pathogens and contaminants in sea foods.
- Describe the applications of marine biotechnological products and their future role in a rapidly changing planet.

Course Outcomes

CO1: Apply the knowledge on marine microbial communities and their interactions.

CO2: Illustrate the role of marine microorganisms in biogeochemical cycles.

CO3: Categorize the extreme environments in the oceans and the survival mechanisms adapted by the microorganisms living in these environments.

CO4: Identify the diseases affecting marine organisms and its diagnosis

CO5: Evaluate the marine microorganisms as a resource for novel microbial products.

UNIT I

Marine microbial environment - Benthic & littoral zone, salt pan, mangroves and estuarine microbes, microbial loop. Marine microbial communities – Bacteria, fungi, protozoa. Microbial interactions – Endosymbionts and Ectosymbionts.

UNIT II

Dynamics of Marine Microbes - Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming – Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization – phosphorus cycle. Decomposition of organic matter. Bioleaching and biodeterioration of natural and synthetic materials.

UNIT III

Marine extremophiles: Mechanism of survival at extreme environments – Adaptive mechanisms in thermophilic, alkalophilic, osmophilic, barophilic, psychrophilic hyperthermophilic and halophilic microorganisms – Importance in biotechnology.

UNIT IV

Marine Microbial Diseases: Aqua culture pathogens & Water borne pathogens -*Aeromonas*, *Vibrio*, *Salmonella*, *Pseudomonas*, *Leptospira*, *Corynebacteria* and viral diseases. Rapid diagnosis of contamination in sea foods and aquaculture products.

UNIT V

Applications of Marine Microbial Biotechnology: Production and applications of marine microbial products – Enzymes, Antibiotics, Organic acids, Toxins, Biosurfactants and Pigments. Sea food preservation methods. Probiotic bacteria and their importance in aquaculture.

Text Books:

1.	Munn C. B. (2019). Marine Microbiology: Ecology and Applications. (3 rd Edition). CRC Press. ISBN:9780367183561.
2.	Bhakuni, D.S. and Rawat D. S. (2005). Bioactive Marine Natural Products. Anamaya Publishers, New Delhi. ISBN:1-4020-3472-5.
3.	Brock T. D. (2011). Thermophilic Microorganisms and Life at High Temperatures. Springer. ISBN-13:978-1461262862 / ISBN-10:1461262860.
4.	Nybakken, J.W. (2001). Marine Biology. (5 th Edition). Benjamin Cummings. ISBN:0321030761 9780321030764.
5.	Veena. (Understanding marine biology. Discovery Publishing.

Reference Books:

1.	Maier R. M., Pepper I. L. and Gerba C. P. (2006). Environmental Microbiology. (2 nd Edition). Academic Press. ISBN:978-0-12-370519-8.
2.	Belkin S. and Colwell R. R. (2005). Oceans and Health: Pathogens in the Marine Environment. Springer. ISBN:978-0-387-23708-4.
3.	Scheper T. (2009). Advances in Biochemical Engineering/Biotechnology- Marine Biotechnology. Springer. ISBN:978-3-540-69356-7. E-ISBN:978-3-540-69357-4.
4.	Gasol J. M. and Kirchman D. L. (Eds.). (2018). Microbial Ecology of the Oceans. (3 rd Edition). Wiley-Blackwell. ISBN:978-1-119-10718-7.
5.	Kim S. K. (2019). Essentials of Marine Biotechnology. Springer.

Web Resources:

1.	https://link.springer.com/content/pdf/bfm%3A978-0-387-23709-1%2F1
2.	https://www.researchgate.net/publication/285931262_Bioactive_Marine_Natural_Products
3.	http://link.springer.com/content/pdf/bfm%3A978-3-642-03470-1%2F1.pdf
4.	https://link.springer.com/book/10.1007/b102184
5.	https://www.wiley.com/en-bs/Microbial+Ecology+of+the+Oceans%2C+3rd+Edition-p-9781119107187

Semester	Code	TitleoftheCourse					Hours	Credits			
IV	23PMB4EC61	Marine Microbiology					4	3			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓		✓	✓	✓		✓	✓	✓	
Number ofMatches(□) =42 Relationship:High											

Relationship Matrix for COs, Pos and PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER IV

Course Code: 23PMB4EC62
Instruction Hours: 4
Credits: 3

Exam Hours: 3
Internal Marks: 25
External Marks: 75

LIFE SCIENCES FOR COMPETITIVE EXAMINATIONS

Course Objectives:

- Impart knowledge on structure, metabolism and function of biomolecules
- Understand the importance of inheritance biology.
- Discuss in-depth about the different types of ecosystems and their importance.
- Outline the major drivers in biodiversity and various conservation approaches.
- Introduce basic concepts of evolution and biological clock.

Course Outcomes:

CO1: Define, classify and assess the structure, biological functions and interactions of Biomolecules.

CO2: Validate the knowledge of collective and progressive notions of cellular organization.

CO3: Assess and describe the importance of inheritance biology.

CO4: Establish acquaintance and understanding of ecology & Biodiversity in a broader sense.

CO5: Understand the processes of evolution, relate with natural selection, adaptation and speciation.

UNIT I

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics.

UNIT II

Cellular Organisation, Cell division and cell cycle, Membrane structure and function, Organization of genes and chromosomes, Structural organization and function of intracellular organelles, DNA replication, repair and recombination, Protein synthesis and processing.

UNIT III

Inheritance Biology, Mendelian principles- Dominance, segregation, independent assortment, Linkage and Gene mapping, Karyotyping, Extrachromosomal inheritance - Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics- Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders

UNIT IV

Ecology- Habitat and Niche, biotic and abiotic interactions, Biome- biogeographical zones of India. Ecological Succession, Population Ecology- Characteristics of a population; population growth curves, Environmental pollution-global environmental change, Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Biodiversity Management approaches. Indian case studies on Conservation/Management strategy (Project Tiger, Biosphere Reserves).

UNIT V

Evolution and Behaviour- Evolution - Theories- Darwin's, Lamarck's, Oparin Haldane. Paleontological, Embryological and Molecular evidences. Hardy Weinberg's Law. Speciation; Allopatricity and Sympatricity. Adaptive radiation and Convergent evolution; Sexual selection; Co-evolution. Altruism, Biological clocks, Migration and Parental care. Molecular Evolution- Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny.

Text Books:

1.	Nelson D. L. and Cox M. M. (2008). Lehningers Principles of Biochemistry. (5 th Edition). W.H. Freeman and Company.
2.	Chapman J. L. (1998). Ecology: Principles and Applications. (2 nd Edition). Cambridge University Press.
3.	Krishnamurthy V. K. (2003). Textbook of Biodiversity. Science Publishers.
4.	Rogers A. L. (2011). Evidence of Evolution. University of Chicago Press. Chicago.
5.	Stites D.P., Abba I. Terr, Parslow T.G. (1997). <u>Medical Immunology</u> . 9 th Edn, Prentice-Hall Inc.

Reference Books:

1.	Pontarotti P. (2018). Origin and Evolution of biodiversity. (1 st Edition). Springer.
2.	Verma P. S. and Agarwal V. K. (2004). Cell biology, Genetics, Molecular Biology, Evolution and Ecology. (2 nd Edition). S Chand publication.
3.	Lewin R. and Foley R. (2004). Principles of Human Evolution. (2 nd Edition). Black well Publishing Company.
4.	Boyer R.F. (2002) <u>Modern Experimental Biochemistry</u> 3 rd Edition. Pearson Education.
5.	Wilson K., Walker J., Clokie S and Hofmann A. (2018) <u>Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology</u> 8 th Edition Cambridge University Press.

Web Resources:

1.	https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_
2.	https://www.livescience.com/474-controversy-evolution-works.html .
3.	https://www.examrace.com/Study-Material/Life-Sciences/
4.	https://www.kopykitab.com/Methods-In-Biology-Life-Science-Study-Material-For-CSIR-NET-Exam-by-Panel-Of-Experts
5.	https://www.erforum.net/2017/01/life-science-biology-handwritten-notes-for-competitive-exams.html

Semester	Code	TitleoftheCourse					Hours	Credits			
IV	23PMB4EC62	Life Sciences for Competitive Examinations					4	3			
Course Outcomes (COs)	ProgrammeOutcomes(POs)					ProgrammeSpecificOutcomes(PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓		
CO2	✓	✓	✓	✓		✓		✓	✓		
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓		✓	✓	✓		✓	✓	✓	
Number ofMatches(□) = 42 Relationship: High											

Relationship MatrixforCOs,POsand PSOs

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	VeryPoor	Poor	Moderate	High	VeryHigh

SEMESTER IV

Course Code: 22PMB4SE1
Instruction Hours: 2
Credits: 2

Exam Hours: 3
Internal Marks: 25
External Marks: 75

MICROBIAL QUALITY CONTROL AND TESTING

Course Objectives:

- Explain various microbiological quality standards for food, water and air regulatory practices and policies.
- Discuss collection, processing and preservation of water samples from industries in different areas
- Enumeration and isolation of microorganism from the water samples.
- Enumeration and isolation of microorganism from the air samples.
- Gain knowledge on sterility testing of different components in industries and quality control techniques

Course Outcomes:

CO1: Apply knowledge in quality analysis techniques suitable for industries.

CO2: Perform water managements, water harvesting and treat sewage, water pollutions and remedies

CO3: Detect portability of water. Test water quality.

CO4: Impart knowledge on bioaerosols, impact and prevention

CO5: Apply quality control techniques for food and pharma products

UNIT I

Concepts of quality control techniques - quality assurance, Total Quality Management (TQM) Continuous Quality Improvement (CQI) Quality Assurance (QA) pre analytical and post analytical techniques, ATCC, MTCC, microbial based assay.

UNIT II

Waste water microbiology – types and sources of contamination, prevention of water borne diseases. Water management, water harvesting, water recycling. Characteristics of waste water from industries - Sugar factory, Pulp & Paper mill, Distillery, Textile, Engineering, Food Industry, Domestic waste. Waste water treatment plant types and quality control. Water pollution causes and remedies.

UNIT III

Microflora of water. Microbiological analysis of water sample. Microbiological analysis of water sample collection, drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests Control of microbes in water: Water borne pathogens, water borne diseases. Control of water borne pathogens - Precipitation, chemical disinfection, filtration, high temperature, UV light.

UNIT IV

Microflora of air - Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres. Collection of air samples and analysis. Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, isolation and Identification. Control Measures of Bioaerosols - UV light, HEPA filters, desiccation, Incineration.

UNIT V

Quality control in food - Food X ray inspection, PPE Equipment, IoT sensors, preventive quality control and reality quality control. Quality control of pharma products. Quality assurance framework, assessment of pharmaceutical quality, determinants of pharmaceutical quality, practical approaches to quality assurance.

Text Books:

1.	Aneja R. P., Mathur B.N., Chandan R. C. and Banerjee, A. K. (2002). Experiments in Microbiology.
2.	Adams M. R. and Moss M. O. (2006). Food Microbiology. (2 nd Edition). Royal Society of Chemistry.
3.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4.	Cappuccino, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6 th Edition). Pearson Education, Publication, New Delhi.
5.	Rosamund M. Baird., Norman A. (2019). Handbook of Microbiological quality control in Pharmaceuticals and Medical Devices. CRC Press.

Reference Books:

1.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2 nd Edition). - Taylor & Francis.
2.	Sundararaj T. (2003). Microbiology Laboratory Manual. (2 nd Edition). Published by A. Sundararaj
3.	Hoges N. A., Denyer S P. and Baird R.M. (2003). Handbook of microbiological quality control. Microbial Quality Assurance in Pharmaceuticals, cosmetics & Toiletries. by Sally F. Bloomfield
4.	Amitava Mitra. Fundamentals of Quality control and Improvement. (3 rd Edition). Wiley Publications
5.	David Roesti, Marcel Goverde (2019). Pharmaceutical Microbiological Quality Assurance and control: Practical guide for non- sterile Manufacturing. Wiley Publishers.

Web Resources:

1.	https://www.researchgate.net › publication › 320730681
2.	https://www.fssai.gov.in
3.	https://mofpi.nic.in/Schemes/implementation-haccp-iso-22000-iso-9000-ghp-gmp-etc
4.	https://www.who.int/news-room/fact-sheets/detail/food-safety
5.	https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines

Relationship Matrix for COs, POs and PSOs

Semester	Code	Title of the Course					Hours	Credits			
IV	23PMB4SE1	Microbial Quality Control and Testing					2	2-			
Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓	
CO2	✓	✓	✓	✓		✓		✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Number of Matches (✓) = 45 Relationship: Very High											

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER IV

Course Code: 22PMB4SE2
Instruction Hours: 2
Credits: 2

Exam Hours: 3
Internal Marks: 25
External Marks: 75

SOFT SKILL

OBJECTIVES:

- To develop the language skills of students
- To enhance the lexical, grammatical and socio-linguistic and communicative competence of first year physical sciences students
- Focus on developing students' knowledge of domain specific registers and the required language skills.
- To develop strategic competence that will help in efficient communication
- To sharpen students' critical thinking skills

Course Outcomes:

- CO1: Recognize their own ability to improve their own competence in using the language
CO2: Use language for speaking with confidence in an intelligible and acceptable manner
CO3: Understand the importance of reading for life
CO4: Read independently unfamiliar texts with comprehension
CO5: Understand the importance of writing in academic life

UNIT 1

COMMUNICATION

1. Listening: Listening to instructions
2. Speaking: Telephone etiquette and Official phone conversations
3. Reading short passages (3 passages, one from each – Botany, Zoology, Biochemistry/Microbiology/Health)
4. Writing: Letters and Emails in professional context
5. Grammar in Context: Wh and yes or no, Q tags Imperatives

UNIT II

DESCRIPTION Listening – Listening to process description Speaking - Role play Formal: With faculty and mentors in academic environment, workplace communication Informal: With peers in academic environment, workplace communication Reading – Reading passages on plant world, animal world, health Writing – Writing sentence definitions (e.g. species) and extended definitions (e.g. Taxonomy) Picture Description – Description of creatures and their habitat Grammar in Context: Connectives and linkers. Vocabulary – Synonyms (register) - Compare & contrast expressions.

UNIT III

NEGOTIATION STRATEGIES Listening - Listening to interviews of specialists / inventors in fields (Subject specific) Speaking – Brainstorming. (mind mapping). Small group discussions (subject specific) Reading – longer Reading text. (Comprehensive passages) Writing – Essay Writing (250 word essay on topics related to subject area, like pollution, use of pesticides in cultivation, healthy lifestyle, environment consciousness) Grammar in Context: Active voice & Passive voice – If conditional – Vocabulary: -Collocations -Phrasal verbs

UNIT IV

PRESENTATION SKILLS Listening - Listening to presentation. Listening to lectures. Watching – documentaries (discovery / history channel) Speaking –Short speech - Making formal presentations (PPT) Reading – Reading a written speech by eminent personalities in the relevant field /Short poems / Short biography. Writing - Writing Recommendations Interpreting visuals - charts/ tables/flow diagrams/ Grammar in Context – Modals Vocabulary (register) - Single word substitution

UNIT V

CRITICAL THINKING SKILLS Listening - Listening to advertisements/news and brief documentary films (with subtitles) Speaking – Simple problems and suggesting solutions. Reading: Motivational stories on Professional Competence, Professional Ethics and Life Skills (subject-specific) Writing Studying problem and finding solutions- (Essay in 200 words) Grammar-Make simple sentences Vocabulary -Fixed expressions