ST. MARY'S COLLEGE (Autonomous)

(Re-accredited with 'A^{+}' Grade by NAAC)

Thoothukudi-628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

M.Sc. Microbiology

School of Biological Sciences

Outcome Based Curriculum

(W.e.f.2023)

Preamble

Microbiology is a wide area of science that includes Bacteriology, Virology, Mycology, Phycology, Parasitology and other branches of biology. Microbiology is the study of microorganisms which are unicellular or cell cluster microscopic organisms this include eukaryotes such as Fungi and protests and prokaryotes such as bacteria andcertain algae also viruses are included, the scope of microbiology in huge and have involvement in various fields such as pharmacy, medicine, clinical, research, agriculture, dairy industry, water industry, nanotechnology and chemical technology.

Vision

To make young woman as an effective science personalities through experimental

scientific education.

Mission

To empower and enrich women with scientific knowledge so that they are skilled to compete in this global sphere of education as an eminent personalities.

Programme Outcome:

PO No.	After completion of the Postgraduate programme the students of St. Mary's College will be able to
PO 1	acquire expertise knowledge in their respective disciplines and become professionals.
PO 2	develop critical/logical thinking skills, managerial skills and become locally, nationally & globally competent and be a lifelong learner
PO 3	pursue research / higher learning programme & apply their experiment and research skills to analyse and solve complex problems.
PO 4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO 5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Programme Specific Outcome:

PSO No	Upon completion of M.Sc. Microbiology Degree Programme, the Postgraduates will be able to
PSO-1	Prepare the students in varied disciplines like agriculture, industry - medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement.
PSO-2	Create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO-3	Design and implement good laboratory practices, following ethical values, leading the organization towards growth and development
PSO-4	Contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.
PSO-5	Develop as an empowered and economically independent women by various laboratory techniques

ST. MARY'S COLLEGE (Autonomous) THOOTHUKUDI

Department of Microbiology

PG Course Structure (W.e.f.2023)

Semester I

Components	Course Code	Course Title	Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	23PMIC11	General Microbiology and Microbial Diversity	7	5	25	75	100
Core II	23PMIC12	Immunology, Immunomics and Microbial Genetics	7	5	25	75	100
Core Practical I	23PMICR1	Practical-I	6	4	40	60	100
Discipline Specific Elective I	23PMIE11/ 23PMIE12	**Health Hygiene**/ Forensic Science	5	4	25	75	100
Discipline Specific Elective II	23PMIE13/ 23PMIE14	**Bioinstrumentation**/ Clinical Diagnostic Microbiology	5	4	25	75	100
MOOC (Compulsory)				+2			
			30	**22+2**			

Semester II

Components	Course Code	Course Title	Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core III	23PMIC21	Medical Bacteriology and Mycology	5	5	25	75	100
Core IV	23PMIC22	Medical Virology and Parasitology	5	5	25	75	100
Core Practical II	23PMICR2	Practicals in Medical Bacteriology, Mycology, Medical Virology and Parasitology	4	2	40	60	100
Discipline Specific Elective III	23PMIE21/ 23PMIE22	**Bioremediation**/ Epidemiology	4	3	25	75	100
Discipline Specific Elective IV	23PMIE23/ 23PMIE24	**Bioinformatics** / Toxicology	4	3	25	75	100
Discipline Specific Elective Practical I	23PMIER1	Practicals in Bioremediation and Bioinformatics	4	2	40	60	100
Skill Enhancement Course I (Discipline Specific)	23PMISE1	Vermitechnology	4	2	25	75	100
		Total	**30**	**22**			

Semester III

Components	Course Code	Course Title	Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core V	23PMIC31	Soil and Agricultural Microbiology	6	5	25	75	100
Core VI	23PMIC32	Molecular Biology and Recombinant DNA Technology	5	5	25	75	100
Core VII	23PMIC33	Fermentation Technology and Pharmaceutical Microbiology	5	5	25	75	100
Core Practical III	23PMICR3	Practical in Soil and Agricultural Microbiology	4	2	40	60	100
Core Practical IV	23PMICR4	Practical in Molecular Biology, Recombinant DNA Technology , Fermentation Technology and Pharmaceutical Microbiology	4	2	40	60	100
Discipline Specific Elective V	23PMIE31/ 23PMIE32	**Biosafety, Bioethics and IPR/** Water Conservation and Water Treatment	3	3	25	75	100
Skill Enhancement Course II (Discipline Specific)	23PMISE2	Cosmetic Microbiology	3	2	25	75	100
Internship / Self Study (Optional)	23PMII31/ 23PMISS1	------- Sea Food Processing and Preservation		+2		50	50
			30	**24+2**			

Semester IV

Components	Course Code	Course Title	Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core VIII	23PMIC41	Food and Dairy Microbiology	4	4	25	75	100
Core IX	23PMIC42	Research Methodology and Biostatistics	4	4	25	75	100
Core X	23PMIC43	Marine Microbiology	4	3	25	75	100
Core Practical V	23PMICR5	Practical in Food and Dairy Microbiology	4	2	40	60	100
Core Practical VI	23PMICR6	Practical in Research Methodology, Biostatistics and Marine Microbiology	4	2	40	60	100
Discipline Specific Elective VI	23PMIE41/ 23PMIE42	Bioenergy/ **Microbial Quality Control and Testing**	4	3	25	75	100
Core XI (Project)	23PMIP41	Project and Viva Voce	6	4	40	60	100
			30	**22**			

Note:

1. It is mandatory for all I PG students to complete a MOOC course in the Swayam NPTEL Portal. Two credits will be awarded to the students who successfully pass the MOOC course in the Portal. Students who fail to pass in their first and second attempts via the Swayam NPTEL Portal will be eligible to take a supplementary exam given by the college for which one credit will be given.
2. Internship can be completed during the second semester vacation.

Semester	Hours	Credits	Extra Credits
I	30	22	--
II	30	22	2
III	30	24	2
IV	30	22	--
Total	120	90	4

Master of Science (Microbiology)

Courses	Number of Courses	No. of Hours	Credits	Extra Credits
Core Theory	10	52	46	--
Core Practical	6	26	14	--
Discipline Specific Elective	6	25	20	--
Discipline Specific Elective Practical	1	4	2	
Group Project	1	6	4	--
Skill Enhancement Course	2	7	4	--
MOOC (Compulsory)	1	--	-	2
Internship/Self Study Paper (Optional)	1	--	-	2
Total		**120**	**90**	**4**

SEMESTER I			
Core I General Microbiology and Microbial Diversity			
Course Code : 23PMIC11	**Hrs/ Week: 7**	**Hrs/ Sem: 105**	**Credits: 5**

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:

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	K4
CO2	Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.	K2
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.	K1
CO4	Produce aseptic conditions by following good laboratory practices.	K3
CO5	Evaluate and cultivate a variety of extremophiles following standard protocols for industrial applications.	K5

SEMESTER I			
Core I General Microbiology and Microbial Diversity			
Course Code: 23PMIC11	**Hrs/ Week: 7**	**Hrs/ Sem: 105**	**Credits: 5**

Unit I **(21hrs)**

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 **(21hrs)**

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 **(21hrs)**

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 **(21hrs)**

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 **(21hrs)**

Biodiversity - Introduction to microbial biodiversity – Thermophiles - Classification, Thermophilic Archaebacteria 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. (10th Edition). Universities Press (India) Pvt. Ltd.

2. Chan E.C.S., Pelczar M. J. Jr. and Krieg N. R. (2010). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.

3. Prescott L. M., Harley J. P. and Klein D. A. (2004). Microbiology. (6th 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.

Books for Reference:

1. Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12th Edition).Pearson, London, United Kingdom

2. Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3rd Edition). Cambridge University Press, Cambridge.

3. Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elseiver Academic Press, California.

4. Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2nd Edition). Books / Cole Thomson Learning, UK.

5. Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15th Edition). Pearson.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	2	2	1	1	2	2	3	2
CO-2	2	3	1	1	2	2	1	2	2	3
CO-3	3	2	1	3	2	3	2	1	1	3
CO-4	2	1	2	2	3	3	3	1	2	1
CO-5	2	3	1	1	3	2	2	3	3	1
Ave.	2.4	2.2	1.4	1.8	2.2	2.2	2.0	1.8	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER I			
Core II Immunology, Immunomics and Microbial Genetics			
Course Code : 23PMIC12	**Hrs/ Week: 7**	**Hrs/ Sem: 105**	**Credits: 5**

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 Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Describe the immune response to a variety of antigens. Identify different immune cells involved in immunity.	K1
CO2	Discriminate the significance of MHC molecules in immune response and antibody production.	K5
CO3	Predict antibodies and evaluate immunological assays in patient samples.	K3
CO4	Analyze genomic DNA of prokaryotes and eukaryotes.	K4
CO5	Summarize gene transfer mechanisms for experimental study.	K2

SEMESTER I			
Core II Immunology, Immunomics and Microbial Genetics			
Course Code : 23PMIC12	**Hrs/ Week: 7**	**Hrs/ Sem: 105**	**Credits: 5**

Unit I: (21 Hrs)

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: (21 Hrs)

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. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.

Unit III: (21 Hrs)

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D- antigens.

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. Immune regulation mechanisms – immuno-induction, immuno- suppression, immuno-tolerance, immuno-potentiation,

Immunomodulation. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants.

Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology.

Unit IV: (21 Hrs)

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: (21 Hrs)

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. Importance of transposable elements in horizontal transfer of genes and evolution.

Text Books:

1. Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.

2. Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.

3. Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10th Edition). Elsevier.

4. Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.

5. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd.

Books for Reference:

1. Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.

2. Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell.

3. Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4th Edition). Wiley-Blackwell.

4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

5. Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcome			
	PO - 1	PO -2	PO -3	PO -4	PO -5	PSO - 1	PSO - 2	PSO - 3	PSO - 4
CO - 1	3	1	2	1	1	3	1	1	2
CO – 2	3	1	2	1	1	3	1	1	2
CO - 3	3	1	3	1	3	2	1	1	1
CO - 4	2	1	2	1	1	1	1	2	1
CO - 5	3	1	3	2	3	3	2	3	3
Ave.	2.8	1	2.4	1.2	1.8	2.4	1.2	1.6	1.8

Mapping	<40%	≥40% and < 70%	≥70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER I			
Core Practical I			
Course Code: 23PMICR1	**Hrs/ Week: 6**	**Hrs/ Sem: 90**	**Credits: 4**

Objectives:

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

Course Outcome :

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Describe microscopic techniques and staining methods in the identification and differentiation of microbes.	K1
CO2	Express the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	K2
CO3	evaluate immunological reactions to aid diagnosis.	K5
CO4	Analyze the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	K4
CO5	Manipulate DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	K3

SEMESTER I			
Core Practical I			
Course Code: 23PMICR1	**Hrs/ Week: 6**	**Hrs/ Sem: 90**	**Credits: 4**

Unit I:

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

Dark field microscopy – Motility of Spirochetes.

Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtrati Quality control check for each method.

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

Unit II:

Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, 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, a culture technique. Aseptic transfer.

Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate. E 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' radial immunodiffusion (SRID)

Immuno-electrophoresis and staining of precipitin lines- Rocket immuno electrophore 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.

   Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6th Edition). Pearson Education, Publication, New Delhi.

2. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -Taylor &Francis.

3. Rich R. R., Fleisher T. A., Shearer W. T., Schroeder H, Frew A. J. and Weyand C. M. (2018). Clinical Immunology: Principles and Practice. (5th Edition). Elsevier.

4. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

Books for Reference:

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.

2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.

3. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th 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. (3rd Edition). John Wileys and Sons Ltd. 2012.

5. Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt Ltd.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (I			
	PO - 1	PO -2	PO -3	PO -4	PO -5	PSO - 1	PSO - 2	PSO - 3	PSO - 4
CO - 1	3	1	2	1	3	3	1	3	1
CO – 2	3	1	2	1	1	3	1	1	2
CO - 3	2	1	2	1	3	3	1	1	1
CO - 4	2	1	2	1	1	3	2	3	1
CO - 5	3	1	3	2	3	3	2	3	3
Ave.	2.6	1	2.2	1.2	2.2	3	1.4	2.2	1.6

Mapping	<40%	≥40% and < 70%	≥70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER I			
Discipline Specific Elective I Health Hygiene			
Course Code : 23PMIE11	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

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 Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Describe the knowledge on hygiene and live healthy.	K1
CO2	Summarize insights on health laws for food safety and hygiene.	K2
CO3	Know health, physical exercises and their importance.	K3
CO4	Outline on mental hygiene and involved in mental hygiene.	K4
CO5	Evaluate the various health and health education programmes by the government.	K5

SEMESTER I			
Discipline Specific Elective I Health Hygiene			
Course Code : 23PMIE11	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Unit I **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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

Text Books

1. Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4th Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

2. Swaminathan (1995) Food& Nutrition (Vol I) (2nd Edition). The Bangalore Printing &Publishing Co Ltd., Bangalore.

3. Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology.(10th 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.,).

Books for Reference

1. Khader V. (2000) Food, Nutrition and Health, Kalyan Publishers, New Delhi.

2. Srilakshmi, B. (2010) Food Science, (5th 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

1. Srilakshmi, 2002, Dietetics, New Age Publications, India

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	2	2	1	1	2	2	3	2
CO-2	2	3	2	1	2	2	1	1	2	3
CO-3	3	2	3	3	2	2	2	2	1	3
CO-4	2	1	2	2	3	2	3	2	2	1
CO-5	2	3	2	2	3	3	2	2	3	1
Ave.	2.4	2.2	2.2	2.0	2.2	2.0	2.0	1.8	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER I			
Discipline Specific Elective I Forensic Science			
Course Code : 23PMIE12	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

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 Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Identify the scope and need of forensic science in the present scenario.	K1
CO2	Plan for the organizational setup and functioning of forensic science laboratories.	K2
CO3	Analyze the biological samples found at the crime scene.	K3
CO4	Perform extraction and identification of DNA obtained from body fluids.	K4
CO5	Discuss the concept of forensic toxicology.	K5

SEMESTER I			
Discipline Specific Elective I Forensic Science			
Course Code : 23PMIE12	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Unit I **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3. Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4. Sharma B.R (2020) Forensic science in criminal investigation and trials. (6th Edition)Universal Press.
5. Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12th Edition).Pearson Press.

Books for Reference

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, (3rd Edition).

CRC Press, New York. ISBN-10:1498720196.

3. Lincoln, P.J. and Thomson, J. (1998). (2nd Edition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4. Val McDermid (2014). Forensics. (2nd Edition). ISBN 9780802125156.
5. Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2nd Edition). CRC Press.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	2	2	1	1	2	2	3	2
CO-2	2	3	2	1	2	2	1	1	2	3
CO-3	3	2	3	3	2	2	2	2	1	3
CO-4	2	1	2	2	3	2	3	2	2	1
CO-5	2	3	2	2	3	3	2	2	3	1
Ave.	2.4	2.2	2.2	2.0	2.2	2.0	2.0	1.8	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER I			
Discipline Specific Elective II Bioinstrumentation			
Course Code : 23PMIE13	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

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 outcome:

CO No	Upon completion of this course students will be able to	Cognitive Level
CO1	Describe the use of the laboratory instruments- laminar air flow, pH meter, centrifugation methods, biosafety cabinets following SOP.	K1
CO2	Apply chromatography techniques in the separation of biomolecules.	K3
CO3	Analyze molecular techniques like mutagenesis and their detection.	K4
CO4	Estimate molecules in biological samples by adopting UV spectroscopic techniques.	K2
CO5	Evaluate the cultivation of organisms anaerobically.	K5

SEMESTER I			
Discipline Specific Elective II Bioinstrumentation			
Course Code :23PMIE13	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Unit I: (15 Hrs)

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 co-efficient; Principles, methodology and applications of differential, rate zonal and density gradient centrifugation - Applications in determination of molecular weight.

Unit II: (15 Hrs)

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: (15 Hrs)

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: (15 Hrs)

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: (15 Hrs)

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. (3rd Edition). Prentice Hall.

5. Jayaraman J. (2011). Laboratory Manual in Biochemistry. (2ndEdition). Wiley Eastrn Ltd., New Delhi.

Books for References:

1. Pavia D. L. (2012) Spectroscopy (4th Edition). Cengage.

2. Skoog A. and West M. (2014). Principles of Instrumental Analysis. (14th Edition). W.B.Saunders Co., Philadephia.

3. Miller J. M. (2007). Chromatography: Concepts and Contrasts (2nd Edition) Wiley-Blackwell.

4. Gurumani N. (2006). Research Methodology for Biological Sciences. (1st Edition) MJP Publishers.

5. Ponmurugan P. and Gangathara P. B. (2012). Biotechniques. (1st Edition). MJP Publishers.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO – 1	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO – 2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**3**
CO – 3	**3**	**2**	**2**	**3**	**2**	**3**	**1**	**3**	**3**	**3**
CO – 4	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**3**
CO – 5	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**3**
Ave.	**3**	**2.4**	**2.2**	**2.6**	**2**	**2.6**	**1.4**	**3**	**2.6**	**3**

Mapping	**<40%**	**≥40% and < 70%**	**≥ 70%**
Relation	**Low level**	**Medium level**	**High level**
Scale	**1**	**2**	**3**

SEMESTER I			
Discipline Specific Elective II Clinical and Diagnostic Microbiology			
Course Code : 23PMIE14	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

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 outcome:

CO No	**Upon completion of this course students will be able to**	**Cognitive Level**
CO1	Apply Laboratory safety procedures and hospital waste disposal strategies.	K1
CO2	Collect various clinical specimens, handle, preserve and process safely.	K3
CO3	Identify the causative agents of diseases by conventional and molecular methods following standard protocols.	K4
CO4	Assess the antimicrobial susceptibility pattern of pathogens.	K2
CO5	Trace the sources of nosocomial infection and recommend control measures.	K5

SEMESTER I			
Discipline Specific Elective II Clinical and Diagnostic Microbiology			
Course Code : 23PMIE14	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 4**

Unit I **(15 hrs)**

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 **(15 hrs)**

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

Unit III **(15 hrs)**

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 **(15 hrs)**

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 **(15 hrs)**

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

Books for reference

1. Murray P. R., Baron E. J., Jorgenson J. H., Pfaller M. A. and Yolken R.H. (2003). Manual of Clinical Microbiology. (8th 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. (9th Edition). Elsevier. EBook ISBN:9780323550277. Hardcover ISBN:9780323482554.

3. Ridgway G. L., Stokes E. J. and Wren M. W. D. (1987). Clinical Microbiology 7th 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. (7th Edition). Jones & Bartlett Learning. ISBN:1284322378 9781284322378.
5. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press. ISBN-13:978-0-521-67631-1 / ISBN-10:0-521-67631-2.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	**Programme Outcomes (PO)**					**Programme Specific Outcomes (PSO)**				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO – 1	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO – 2	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**3**
CO – 3	**3**	**2**	**2**	**3**	**2**	**3**	**1**	**3**	**3**	**3**
CO – 4	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**3**
CO – 5	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**3**	**3**
Ave.	**3**	**2.4**	**2.2**	**2.6**	**2**	**2.6**	**1.4**	**3**	**2.6**	**3**

6.

7.

Mapping	**<40%**	**≥40% and < 70%**	**≥ 70%**
Relation	**Low level**	**Medium level**	**High level**
Scale	**1**	**2**	**3**

SEMESTER II			
Core III Medical Bacteriology and Mycology			
Course Code : 23PMIC21	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 5**

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 Outcome:

CO No	**Upon completion of this course, students will be able to**	**CL**
CO1	Discuss about Collection, transport and process of various kinds of clinical specimens.	K1
CO2	Analyze various bacteria based on morphology and pathogenesis.	K3
CO3	Evaluate various treatment methods for bacterial disease.	K5
CO4	create various methods detect fungi in clinical samples and apply knowledge on antifungal agents..	K4
CO5	Discuss various immunodiagnostic method to detect fungal infections.	K2

SEMESTER II			
Core III Medical Bacteriology and Mycology			
Course Code : 23PMIC21	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 5**

Unit I: (15 Hrs)

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 – Guinea pigs and mice.

Unit II: (15 Hrs)

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: (15 Hrs)

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

Unit IV: (15 Hrs)

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: (15 Hrs)

Dimorphic fungi causing Systemic mycoses, *Histoplasma, Blastomyces.* Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immuno compromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis.

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,(18th Edition). Churchill Livingstone, London.

3. Finegold, S. M. (2000) Diagnostic Microbiology, (10th Edition). C.V. MosbyCompany, St. Louis.

4. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). Introductory Mycology,(4th Edition). Wiley Publishers.

5. Chander J. (2018). Textbook of Medical Mycology. (4th Edition). Jaypee brothersMedical Publishers.

Books for Reference

1. Salle A. J. (2007). Fundamental Principles of Bacteriology. (4th Edition). TataMcGraw-Hill Publications.

2. Collee J.C. Duguid J.P. Foraser, A.C, Marimon B.P, (1996). Mackie & McCartneyPractical Medical Microbiology. 14thedn, Churchill Livingston.

3. Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.- Part 22ndedn.Cambridge University Press.

4. Topley and Wilson's. (1998). Principles of Bacteriology.9th edn. Edward Arnold,London.

5. Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology.Pfaller. 7th edn. Elsevier, Mosby Saunders.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO – 1	2	2	2	3	2	3	3	3	3	2
CO – 2	3	3	2	2	2	3	2	3	2	2
CO – 3	3	3	2	3	1	3	3	3	3	2
CO – 4	2	3	2	2	2	3	2	3	1	2
CO – 5	3	3	1	2	1	3	3	3	2	2
Ave.	2.6	2.8	1.8	2.4	1.6	3	2.6	3	2.2	2

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER II			
Core IV - Medical Virology and Parasitology			
Course Code: 23PMIC22	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits:5**

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 Outcome:

CO. No	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO1	Manipulate cultivation of viruses by different methods and aid in diagnosis. Perform purification and viral assay.	K3
CO2	Investigate the symptoms of viral infections and presumptively identify the viral disease.	K4
CO3	Explain various viral diseases by different methods.(serological, conventional and molecular)	K2
CO4	recommend public about the spread, control and prevention ofparasitic diseases.	K5
CO5	Identify the protozoans and helminthes present in stool and blood specimens.	K1

SEMESTER II			
Core IV Medical Virology and Parasitology			
Course Code: 23PMIC22	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits:5**

Unit I: **(15 hrs)**

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

Unit II: **(15 hrs)**

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, Rhabdo, Rota, HIV, Hepatitisviruses, Arbo – Dengue virus, Ebola virus.

Unit III: **(15 hrs)**

Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Diagnosis of viral infections –conventional serological and molecular methods. Antiviral agents and viral vaccines.

Unit IV: **(15 hrs)**

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

Unit V: **(15 hrs)**

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia Solium* - Trematodes – *Fasciola hepatica*, *Schistosomes* - Nematodes - *Ascaris*, *Strongyloides* and *Wuchereria*.

Text Books

1. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10thEdition). 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. (5th Edition). CBS Publishers& Distributors Pvt. Ltd. New Delhi.

Books for Reference:

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	3	2	3	3	2	1	2	2
CO-2	2	2	2	3	2	2	3	2	1	3
CO-3	3	2	3	2	1	2	3	3	2	1
CO-4	2	3	2	1	2	2	1	3	3	2
CO-5	2	3	2	3	3	3	1	2	2	3
Ave.	2.4	2.2	2.4	2.2	2.2	2.4	2.0	2.2	2.0	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Core Practical II Practicals in Medical Bacteriology, Mycology, Medical Virology and Parasitology			
Course Code : 23PMICR2	**Hrs/Week : 4**	**Hrs/Sem : 60**	**Credits : 2**

Objectives

- Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
- Impart knowledge on fungal infections and its diagnosis.
- Diagnose parasitic infection

Course Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Examine different clinical samples, transport, culture and examination.	K4
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	K1
CO3	Produce diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	K3
CO4	compare antibiotic sensitivity tests with the standard tests.	K2
CO5	Evaluate common arthropods	K5

SEMESTER II			
Core Practical II Practicals in Medical Bacteriology, Mycology, Medical Virology and Parasitology			
Course Code : 23PMICR2	**Hrs/Week : 4**	**Hrs/Sem : 60**	**Credits : 2**

1. Isolation and identification of bacterial pathogens from clinical specimens (Throat, skin, urine,stool)
2. Biochemical identification tests.
3. Antimicrobial sensitivity testing - Kirby Bauer method.
4. Minimum inhibitory concentration (MIC) test.
5. Mounting and staining of VAM spores.
6. Examination of different fungi by Lactophenol cotton blue staining.
7. Cultivation of fungi and their identification - *Mucor, Rhizopus, Aspergillus, Penicillium.*
8. Microscopic observation of different asexual fungal spores.
9. Isolation of bacteriophage from natural sources
10. Cultivation of viruses –Egg Inoculation methods (Demonstration)
11. Diagnosis of Viral Infections –ELISA –HIA.
12. Viral inclusions and CPE-stained smears. (Demonstration)
13. Examination of parasites in clinical specimens - Ova/cysts in faeces.
14. Concentration methods – Floatation methods - Zinc sulphate methods
15. Sedimentation methods- Formal ether method.
16. Blood smear examination for malarial parasites - Thin smear – Thick smear
17. Identification of common arthropods of medical importance - spotters of *Anopheles,Glossina, Phlebotomus, Aedes,* Ticks and mites.

Text Books:

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2nd 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. Cappuccimo, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual,(6thEdition). Pearson Education, Publication, New Delhi.

5. Morag C. and Timbury M.C. (1994). Medical Virology. 4th edn. Blackwell ScientificPublishers.

Books for References:

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO – 1	3	2	3	3	1	3	2	3	2	3
CO – 2	3	2	2	3	2	3	2	3	2	3
CO – 3	3	2	1	3	1	3	1	2	2	3
CO – 4	3	2	3	3	2	3	2	2	2	3
CO – 5	3	2	2	3	1	2	1	2	2	3
Ave.	3	2	2.2	3	1.4	2.8	1.6	2.4	2	3

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER II			
Discipline Specific Elective III Bioremediation			
Course Code: 23PMIE21	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Objectives:

- To provide learners the nature and importance of bioremediation and familiarize the roleof plants and their associated microbes in remediation and management of environmental pollution
- To motivate learners to explore microorganisms with nutrients that will enable themto destroy the contaminants and to reduce, detoxify, degrade or transform more toxic pollutants to a less toxic.

Course outcome:

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	Differentiate Ex-situ bioremediation and In-situ bioremediation.	K2
CO-2	Describe the roles of organisms in bioremediation	K1
CO-3	Demonstrate microbial processes necessary for optimization	K3
CO-4	recommend the methods ofdetoxification	K5
CO-5	Analyze and design engineered solutions to environmental problems	K4

SEMESTER II			
Discipline Specific Elective III Bioremediation			
Course Code: 23PMIE21	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Unit I **(12 Hrs)**

Bioremediation - process and organisms involved. Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation.

Unit II **(12 Hrs)**

Microbes involved in aerobic and anaerobic processes in nature. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.

Unit III **(12 Hrs)**

Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulpindustries. Aerobic and anaerobic digesters – design.

Unit IV **(12 Hrs)**

Microbial leaching of ores - process, microorganisms involved and metal recovery with specialreference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Biodegradable of plastics

Unit V **(12 Hrs)**

Phytoremediation of heavy metals in soil - Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic amendmentsin multi metal contaminated mine sites.

Text Books

1. Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition).Galgotia Publications.
2. Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition).Printice-Hall, India.
3. Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJPPublishers

Books for Reference

1. Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1st Edition). Apple Academic Press.
2. Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.
3. Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.
4. Atlas, R.M & Bartha, R. (2000). Microbial Ecology. Addison Wesley Longman Inc.
5. Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1st edition. I.K. International Publishing House Pvt. Ltd.

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	2	3	2	3	2	2	2
CO-2	2	3	1	2	2	1	2	2	3	3
CO-3	3	3	2	3	3	2	2	3	3	1
CO-4	2	3	2	1	2	3	1	2	2	2
CO-5	2	1	3	2	2	2	3	3	2	3
Ave.	2.4	2.6	2..0	2.0	2.4	2.0	2.2	2.4	2.4	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Discipline Specific Elective III Epidemiology			
Course Code: 23PMIE22	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Objectives

- Describe the role of epidemiology in public health.
- Explain about epidemiology tools and disease surveillance methods.
- Analyze various communicable and non-communicable diseases in India.
- Discuss on mechanism of antimicrobial resistance.
- Outline on National health programmes that have been designed to address the issues.

Course outcome

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	Produce the knowledge acquired on concepts of epidemiology to clinical and public health environment.	K3
CO-2	Describe various strategies to trace the epidemiology.	K1
CO-3	Interpret the control of communicable and non-communicable diseases.	K2
CO-4	Analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management.	K4
CO-5	Estimate National control programs related to Communicable and Non-Communicable diseases with the public.	K5

SEMESTER II			
Discipline Specific Elective III Epidemiology			
Course Code: 23PMIE22	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Unit I **(12 Hrs)**

Fundamentals of epidemiology - Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission -Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - Factors, routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis.

Unit II **(12 Hrs)**

Tools of Epidemiology - Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology - Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies - Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.

Unit III **(12 Hrs)**

Epidemiological aspects of diseases of national importance - Background to communicable and non-communicable diseases. Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Mucor mycosis, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.

Unit IV **(12 Hrs)**

Mechanisms of Antimicrobial resistance - Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Hospital acquired infections - Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of *Pseudomonas, Acinetobacter, Clostridium difficile,* HBV, HCV, Rotavirus*, Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and management of nosocomial infections.

Unit V **(12 Hrs)**

National Programmes related to Communicable and Non-Communicable diseases - National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, Vector Borne Disease Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme. Biochemical and immunological tools in epidemiology - Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Curie Point PyMS (Pyrolysis Mass spectrometry), Protein profiling, Molecular typing methods.

Text Books

1. Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of Epidemiology in Public Health Practice., (3rd Edition). CDC.
2. Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
4. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.

5.Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology.5th edn. Blackwell Scientific Publishers.

Books for References

1. Bhopal R. S. (2016).Concepts of Epidemiology - An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. (3rd Edition). Oxford University Press, New York.
2. Celentano D. D. and Szklo M. (2018). Gordis Epidemiology. (6th Edition). Elseiver, USA.
3. Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
5. Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London.

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	3	1	2	3	2	3	2	2	2
CO-2	3	2	1	3	2	3	2	2	1	3
CO-3	3	2	2	3	3	2	2	3	3	1
CO-4	3	3	2	2	2	3	1	2	2	2
CO-5	2	2	3	2	2	2	3	2	2	3
Ave.	2.6	2.4	1.8	2.4	2.6	2.2	2.2	2.2	2.0	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Discipline Specific Elective IV Bioinformatics			
Course Code: 23PMIE23	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Objectives

- To provide knowledge and understanding of the principles and conceptsbioinformatics. introduced most of the effectively used Bioinformatics databases
- To motivate and introduce most of the effectively used Bioinformatics databasesand their applications in the field of Bioinformatics.

Course outcome:

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	describe how to access to databases that provides information on nucleic acids and proteins	K1
CO-2	summarize to Construct phylogenetic tree	K2
CO-3	know to Predict the structure of proteins.	K3
CO-4	outline the bioinformatics methods can be used to relate sequence to structure and function	K4
CO-5	evaluate the drug ligand interactions and molecular docking.	K5

SEMESTER II			
Discipline Specific Elective IV Bioinformatics			
Course Code: 23PMIE23	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Unit I **(12 hrs)**

Origin of Bioinformatics, Scope of Bioinformatics, Branches of Bioinformatics: Genomics, Proteomics, Transcriptomics. Biological Data Mining –Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – 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 **(12 hrs)**

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 **(12 hrs)**

Computational Protein Structure prediction – Secondary structure – Homology modelling-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 **(12 hrs)**

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.

Unit V **(12 hrs)**

Molecular Docking- Flexible - Rigid docking- Target- Ligand Preparation-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 Immunoinformatic and Vaccine Development.

Text Books

1. Lesk A. M. (2002). Introduction to Bioinformatics. (4th Edition). Oxford UniversityPress.
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) (4th Edition). Prentice-Hall of India Pvt.Ltd.
4. Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. AddisionWesley Longman Limited, England.
5. Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2nd edn.CBS Publishers, New Delhi.

Books for Reference

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 (2nd Edition).CBS Publishers and Distributors (Pvt.) Ltd.
4. Xiong J, (2011). Essential bioinformatics, First south Indian Edition, Cambridge University Press.
5. Harshawardhan P.Bal, (2006). Bioinformatics Principles and Applications, TataMcGraw-Hill Publishing Company Limited.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	3	2	3	1	2	1	2	2
CO-2	2	3	2	3	2	2	1	2	1	3
CO-3	3	2	3	2	1	2	3	2	2	1
CO-4	2	3	1	1	2	2	1	3	2	3
CO-5	2	3	2	2	3	3	1	2	2	3
Ave.	2.2	2.4	2.2	2.0	2.2	2.0	1.6	2.0	1.8	2.4

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Discipline Specific Elective IV Toxicology			
Course Code: 23PMIE24	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Objectives:

- Recognize the various categories of environmental toxins and their hazardous consequence
- Enhance the knowledge of underlying etiology of diseases
- Strengthen the evidence for a causal link between the exposure of hazardous agent and the development of diseases
- Illustrate various techniques to isolate and characterize the toxin
- Examine, interpret and discuss the certainty of toxic substances, proposing the deep understanding of medicinal and industrial applications

Course Outcomes

CO NO	On completion of this course, students will;	Cognitive Level
CO1	examine the adverse effects of toxin and its potential role in research.	K4
CO2	Describe the toxicity, properties and mode of actions of microbial toxins.	K1
CO3	illustrate the mode of actions and their biological significance.	K2
CO4	evaluate the toxicity level with the help of advanced techniques.	K5
CO5	produce the various natures of application of toxic substances.	K3

SEMESTER II			
Discipline Specific Elective IV Toxicology			
Course Code: 23PMIE24	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Unit I **(12 Hrs)**

General Introduction - Definition of toxins, different categories of toxins and venoms, recent trends in venom and toxin research.

Unit II **(12 Hrs)**

Bacterial toxins - Bacterial toxins Bacterial toxinogenesis, endotoxins, exotoxins, exotoxins, bacterial protein toxins with special reference to cholera, diphtheria and tetanus toxins, molecular mechanism of action of endotoxins, exotoxins, enterotoxins, neurotoxins and mycotoxins.

Unit III **(12 Hrs)**

Plant toxic proteins, impact of plant toxin on human, natural toxins in food, plants, allelopathy. Toxins from snake venom Snakes and Biological significance of their venoms, composition of snake venom, evolution of venom, 3D structure of some important venom constituents and their mechanism of action (phospholipase A2, cardiotoxin, neurotoxin) three-finger toxins, anti-venom and medicinal plants in treatment of snakebite patients.

Unit IV **(12 Hrs)**

Tools for isolation and characterization of toxins - Multidimensional chromatographic techniques (gel-filtration, ion-exchange reverse-phase HPLC, SDS-PAGE, 2-dimensional gel electrophoresis), toxin mass fingerprinting, N-terminal peptide sequencing, analysis of protein data by using proteomics software.

Unit V **(12 Hrs)**

Medicinal and industrial applications of venoms and toxins. Use of toxin in neurobiology and muscular research, anticancer drug, diagnosis of haemostatic disorders, antibacterial agents, bioinsecticides and other industrial applications.

Text Books:

1. Holst O. (2008). Bacterial Toxin –Methods & Protocols. Humana Press.ISBN 9781592590520.
2. Shier W. T. (1990). Handbook of Toxinology. CRC Press. ISBN 9780824783747.
3. Wilson K. and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. (7thEdition). Cambridge University Press India Pvt.Ltd. ISBN 1-4051-3544-1.
4. Pholtan Rajeev S.R. (2021Pictorial hand book for toxinology. Rudra Publications.
5. Cora Lancester. (2015). Molecular Toxinology Handbook. Callisto Reference

Books for Reference:

1. Reilly M. J. (2018). Bioinstrumentation. CBS Publishers and Distributors Pvt Ltd. ISBN 13 978-8123928395.
2. Greenberg M., Hamilton R., Phillips S. and McCluskey G. J. (2003). Occupational, Industrial and Environmental Toxicology. St Louis: C.V. Mosby.
3. Wiley-Vch. (2005). Ullmann's Industrial Toxicology. New York: John Wiley & Sons.
4. Winder C. and Stacey N.H. and Boca Raton F. L. (2004). Occupational Toxicology. (2nd Edition). CRC Press.
5. Gopalakrishnakone (2015). Biological Toxins and Bioterrorism. Springer.

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	1	3	1	3	2	3	2
CO-2	2	1	2	3	2	3	3	2	2	3
CO-3	3	1	2	1	3	1	2	2	3	1
CO-4	3	3	2	1	2	3	2	2	3	2
CO-5	1	2	2	2	3	2	3	3	2	3
Ave.	2.4	1.8	2.2	1.6	2.6	2.0	2.6	2.2	2.6	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Discipline Specific Elective Practical I Practicals in Bioremediation and Bioinformatics			
Course Code: 23PMIER1	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:2**

Objectives

- To study the biochemical identification of the bacteria.
- To discuss on the different phases of microbial growth.
- To explain the basic concepts of microbial growth based on nutritional requirements
- To demonstrate the basic principle of microbial metabolism

Course outcome:

CO No	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO-1	Relate the role microbes in remediation and management of environmental pollution	K1
CO-2	Solve the risks caused by plastic and organic pollutant	K2
CO-3	Know the algorithms used in Pairwise and Multiple alignments	K3
CO-4	Outline the methodologies used for database searching, and determining the accuracies of database search.	K4
CO-5	Evaluate the aanalysis and development of models for better interpretation of biological data to extract knowledge.	K5

SEMESTER II			
Discipline Specific Elective Practical I Practicals in Bioremediation and Bioinformatics			
Course Code:23PMIER1	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:2**

Practicals:

1. Study on effect of bacterial degradation on polythene
2. Isolation and identification of phenol degrading bacteria from soil environment
3. Enrichment and isolation of bacteria that degrade organic pollutant
4. Municipal waste water treatment
5. Biochemical oxygen demand and survey of water pollutant (Demonstration)
6. Isolation and assessment of hydrocarbon degradation ability of bacteria from oil spill premises
7. Exploration of the resources available in NCBI and PUBMED
8. Retrieval of a GenBank Entry using an accession number
9. Retrieval and analysis of a gene sequence "AF375082" in FASTA format
10. Finding the official Symbol, alias name, chromosome number and ID for gene using NCBI
11. Retrieval and analysis of a protein sequence from protein database
12. Primary structure analysis of a protein
13. Secondary structure analysis of a protein
14. Tertiary protein structure analysis using RASMOL
15. Pair-wise and multiple sequence alignment using ClustalW
16. Pair-wise and multiple sequence alignment using BLAST
17. Alignment of two Sequences and determination of PAM Scoring Matrix
18. Alignment of two Sequences and determination of BLOSUM Scoring Matrix
19. Similarity Search using BLAST and Interpretation of Results
20. Conversion of Gene Sequence into its Corresponding Amino Acid Sequence

Text Books

1. L. Pepper, C.P. Gerba and T. J. Gentry (2014) Environmental Microbiology, A Lab manual. Harley and Klein. TMH Publication.
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004

4. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999 Old editions

Books for Reference

1. Adel M. Mahasneh, Salwa M. Bdour(2006) Microbiology Laboratory Manual, New Age Publication
2. Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Essential Bioinformatics by Jin xiong., Cambridge University press, New York.2006
4. Fundamentals of Bioinformatics and Computational Biology: Methods and Exercises in MATLAB by Gautam B. Singh, Springer, 1st Ed. (2015) ISBN: 978-3-319-11403-3
5. Bioinformatics An Introduction by Ramsden Jeremy, Springer 2021, ISBN: 9783030456078
6. Essential Bioinformatics by Jin Xiong, Cambridge University Press, ISBN-13 978-0-51116815-4 eBook; 978-0-521-84098-9 hardcopy

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	2	1	3	2	3	3	3	2
CO-2	2	2	2	3	3	3	3	2	2	3
CO-3	3	3	3	1	3	3	2	2	3	2
CO-4	3	3	2	3	2	3	2	3	3	2
CO-5	2	3	2	2	3	2	3	2	2	3
Ave.	2.4	2.6	2.2	2.0	2.8	2.6	2.6	2.4	2.4	2.4

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Skill Enhancement Course I Vermitechnology			
Code: 23PMISE1	**Hrs/Week:4**	**Hrs/Sem:60**	**Credit:2**

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:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe Vermicomposting is an eco-friendly, economically and socially acceptable technology.	K1
CO-2	Illustrate that Vermitechnology is useful for stabilization and recycling of both industrial and domestic organic waste.	K2
CO-3	Manipulate Vermitechnology to improve the soil texture, soil aeration, improve the water retention capacity in the soil.	K3
CO-4	Analyze the ethical principles and commit to pledge responsibilities to protect and save environment.	K4
CO-5	Evaluate and prove that the Earthworms are having the capacity to observe heavy metals into their body tissues and converting the soil without heavy metals.	K5

SEMESTER II			
Skill Enhancement Course I Vermitechnology			
Code: 23PMISE1	**Hrs/Week:4**	**Hrs/Sem:60**	**Credit:2**

UNIT I **(12 Hrs)**

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. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.

UNIT II **(12 Hrs)**

Earthworm Biology and Rearing - Key to identify the species of earthworms. general characters of Annelida, the habitat of earthworm (soil), diversity of earthworms, collection of earthworms, preservation of earthworms. Interaction of earthworms with other organisms

UNIT III **(12 Hrs)**

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 **(12 Hrs)**

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 **(12 Hrs)**

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. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R, 1991. *Oyster Mushrooms, Department of Plant Pathology,* Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan,M. 1990.*Food and Nutrition*. Bappco, The Bangalore Printing and Publishing Co.Ltd., No. 88, Mysore Road, Bangalore-560018.
3. NitaBahl, 1988. *Handbook of Mushrooms,* II Edition,Vol.I & Vol.II.

Books for Reference:

1. Biswas S., Datta M. and N gachanS.V.2012.*Mushrooms: A Manual for Cultivation,* PHI.
2. Zadrazil F. and GrabbeK.1983.*Edible Mushroom, Biotechnology*Vol.3,Weinheim:Verlag Chemie, Berlin
3. Changs T. and Hayanes W.A.(Ed.)1978. *Biology and Cultivation of Edible Mushrooms.* Academic Press. NewYork.
4. Tewari, Pankaj Kapoor,S.C.,1988.*Mushroom cultivation,* Mittal Publications, Delhi.

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO - 1	PO -2	PO -3	PO -4	PO -5	PSO - 1	PSO - 2	PSO - 3	PSO - 4	PSO -5
CO - 1	3	1	2	3	3	3	2	3	1	3
CO – 2	3	1	2	2	1	3	1	1	2	3
CO - 3	2	1	2	1	3	3	2	2	3	3
CO - 4	2	1	2	1	2	3	2	2	2	3
CO - 5	3	1	3	2	2	3	2	3	3	2
Ave.	2.6	1	2.2	1.8	2.2	3	1.8	2.2	2.2	2.8

Mapping	<40%	≥40% and < 70%	≥70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER III			
Core V Soil and Agricultural Microbiology			
Course Code : 23PMIC31	**Hrs/ Week: 6**	**Hrs/ Sem: 90**	**Credits: 5**

Objectives:

- To provide the learners with the best learning experience in Soil and agricultural Microbiology by providing standard education and enabling the students to become entrepreneurs and sociallyresponsible.
- To develop young students with active and creative minds in the field of microbiology
- To enabling the students to become entrepreneur by applying the microbial technology.
- To motivate learners to contribute to sustainable development of nation through environmentalprotection and social responsibility

Course Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Examine the ecological groups of microbes and properties of soil	K4
CO-2	Describe about the soil fertility	K1
CO-3	Restate the previous basic knowledge about nitrogen fixing Microbes	K2
CO-4	Estimate about plant microbe interaction.	K5
CO-5	Relate basic knowledge about important of plant microbe interaction for different layers (rhizosphere, phyllosphere)	K3

SEMESTER III			
Core V Soil and Agricultural Microbiology			
Course Code : 23PMIC31	**Hrs/ Week: 6**	**Hrs/ Sem: 90**	**Credits: 5**

Unit I: (18 Hrs)

Introduction and concepts of agricultural microbiology- soil microorganisms – bacteria (Cyanobacteria and Actinomycetes), algae, fungi, protozoans, nematodes and viruses - Soil formation - Soil properties – Physical and chemical - Role of microbes in soil fertility. Soil fertility evaluation and improvement.

Unit II: (18 Hrs)

Biogeochemical cycles – Carbon, Phosphorus, Sulphur, Iron, Nitrogen - Symbiotic nitrogen fixation (*Rhizobium, Frankia*), non- symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); Nitrogenase enzyme, nif genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of Biological Nitrogen Fixation.

Unit III: (18 Hrs)

Interrelationships between plants and microorganisms and their interactions with plants. Microbial associations in Spermosphere, Phytosphere, Rhizosphere (*Mycorrhiza* types and importance to agriculture) – Phyllosphere (*Anabaena-Azolla*) - decomposition of organic Matter by microorganisms - cellulose, hemicellulose, lignin. Humus formation.

Unit IV: (18 Hrs)

Plant pathogens: Bacterial – *Xanthomonas*, *Agrobacterium*, Fungal – *Cercospora*, *Pyricularia*, Viral – TMV, Bunchy top virus) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant diseases. Plant's resistance to pathogens. Molecular basis of Plant disease control along with cultural practices, chemical and biological control.

Unit V: (18 Hrs)

Principles of mass production, Quality Control and Field applications - Bacterial bio fertilizer: *Rhizobium, Azotobacter- Azopirillum*,– Phosphobacteria. Algal biofertilizer - Blue green algae, Azolla. Fungal biofertilizers - Mycorrhizae – ecto and endo mycorrhiza. Biopesticides – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis, B. papillae* & *Pseudomonas* sp.), Fungal (*Beaveria* sp., *Metarrhizium* sp. & *Verticillium* sp.), Protozoan (*Mattesia* sp., *Nosema* sp., & *Lambornella* sp.)

Text books:

1. Subba Rao. N. S. (2017). Soil Microbiology. (5th Edition). MedTech Publishers.
2. Dubey R.C. and Maheswari D.K. (2006). A text book of Microbiology. S. Chand and Company Ltd. Reprint. New Delhi:
3. Rangaswami. G. and Mahadevan. A. (2006). Diseases of Crop Plants in India. (4th Edition). Prentice–Hall of India Pvt. Ltd.

Books for Reference:

1. Bridgewater L. (2012). Standard Methods for the Examination of Water and Wastewater. American Public Health Association.
2. SahaT.K. Ecology and Environmental Biology (2010). Books and Allied Pvt. Ltd. Kolkata:
3. Subba Rao. N.S. (2005). Soil microorganisms and Plant Growth. (4th Edition). Oxford and IBH Publishing Pvt. Ltd.
4. Atlas R.M, and BarthaM. (2003). Microbial Ecology –Fundamentals and applications. Benjamin & Cummings. California:

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	2	1	3	2	2	1	1
CO-2	1	2	1	3	2	3	2	2	1	2
CO-3	2	3	2	2	3	2	2	3	1	2
CO-4	2	2	2	2	3	3	2	2	2	2
CO-5	2	2	2	3	2	3	2	2	1	1
Ave.	1.8	2.2	1.6	2.4	2.2	2.8	2	2.2	1.2	1.6

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER III			
Core VI Molecular Biology and Recombinant DNA Technology			
Course Code : 23PMIC32	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 5**

Objectives:

- Provide knowledge on the structure, replication and repair mechanisms of DNA. Illustrate the structure, functions and significance of RNA.
- Discuss the gene regulatory mpechanisms 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 Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	mine, demonstrate and appreciate DNA replication and protein synthesis.	K4
CO2	the types of mutation and its impact on microbes. Illustrate various strategies on gene cloning.	K1
CO3	Analyze, modify and characterize DNA modifying enzymes.	K5
CO4	Illustratively assess the molecular techniques for DNA and protein analysis.	K2
CO5	Implement the applications of Genetic Engineering in the field of agriculture and medicine towards scientific research.	K3

SEMESTER III			
Core VI Molecular Biology and Recombinant DNA Technology			
Course Code : 23PMIC32	**Hrs/Week : 5**	**Hrs/Sem : 75**	**Credits : 5**

Unit I: (15 Hrs)

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

Unit II: (15 Hrs)

Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Mutation and its types - base substitutions, frame shift, deletion insertion, silent mutation. Chemical mutagenesis. Detection and analysis of mutations (Replica plating, Antibiotic enrichment, Ames test). Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair.

Unit III: (15 Hrs)

Tools and methods in gene cloning. Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques - electroporation, microinjection, protoplast fusion and microparticle bombardment. Screening for recombinants. Gene cloning vectors for prokaryotes and eukaryotes - cloning properties and types of plasmids vectors (pBR322) - Phage Vectors (M13), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors. Shuttle vectors – merits and demerits.

Unit IV: (15 Hrs)

Genomic DNA and cDNA library - Construction and Screening. Characterization of cloned DNA: Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking, Sanger's method and automated sequencing methods. Protein engineering and techniques Site directed mutagenesis – methods - Design and construction of novel proteins and enzymes.

Unit V: (15 Hrs)

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. Transgenic Plants.

Animal biotechnology – equipment and media used for animal cell culture technology. Applications of animal cell cultures. Applications of Genetic Engineering - transgenic animals, Monoclonal Antibodies in Therapy- 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. (4th Edition). Narosa Publishing House, New Delhi.
2. Maloy S. R. Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing House Pvt. Ltd.
3. Snusted D.P. and Simmons M. J. (2019). Principles of Genetics. (7th Edition). John Wiley and Soms, Inc.
4. Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd.
5. Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing.

Books for Reference

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO – 1	3	2	1	1	2	3	3	3	3	2
CO – 2	3	3	2	1	1	3	2	3	2	2
CO – 3	3	3	2	1	1	3	3	3	3	2
CO – 4	2	3	2	2	1	3	2	3	1	2
CO – 5	3	3	1	2	3	3	3	3	2	2
Ave.	2.8	2.8	1.6	1.4	1.6	3	2.6	3	2.2	2

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER III			
Core VII Fermentation Technology and Pharmaceutical Microbiology			
Course Code: 23PMIC33	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:5**

Objectives:

- To discuss about fermentation and its types, sensitize on fermenter design and types.
- To explain about importance of contamination and spoilage of pharmaceutical products and methods of quality control
- To describe essential knowledge on pharmaceutical microbiology
- To be familiarize with the methods of improving industrially important strain

Course outcome

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	Quote different types of fermentation process	K1
CO-2	Interpret the importance of instrumentation and control and applications of computer in fermentation technology	K2
CO-3	Demonstrate the methods of recovery and purification of fermentative products	K3
CO-4	Analyse the contamination and spoilage of pharmaceutical products	K4
CO-5	Evaluate therapeutic products from microbes and its applications	K5

SEMESTER III			
Core VII Fermentation Technology and Pharmaceutical Microbiology			
Course Code: 23PMIC33	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:5**

Unit I **(15Hrs)**

Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Development of inoculums for fermentation process. Media for industrial fermentation - Growth of inoculums, fermenter pre-culture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

Unit II **(15Hrs)**

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

Unit III **(15Hrs)**

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..

Unit IV **(15Hrs)**

Overview of pharmaceutical microbiology - Ecology of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures. Contamination and spoilage of pharmaceutical products -ophthalmologic preparation

Unit V **(15Hrs)**

Production of pharmaceutical products and quality assurance – Vaccines, immunodiagnostics, immuno-sera, immunoglobulin. - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.

Text Books

1. Patel A. H. (2016). Industrial Microbiology. (2nd Edition). Laxmi Publications, New Delhi.
2. Casida L. E. J. R. (2019). Industrial Microbiology. New Age International Publishers
3. Sathyanarayana U. (2005). Biotechnology. (1st Edition). Books and Allied (P) Ltd.
4. Reed G. (2004). Prescott and Dunn's Industrial Microbiology. (4th Edition). CBS Publishers & Distributors

5. Waites M. J., Morgan N. L., Rockey J. S. and Higton G. (2013). Industrial Microbiology: An Introduction. Wiley Blackwell Publishers.

Books for Reference

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

.

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/penicilli n.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/

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	1	2	3	2	2	2	1	2	2	2
CO-2	2	2	1	1	3	2	3	2	1	3
CO-3	3	2	2	2	3	1	2	2	3	2
CO-4	2	2	1	2	2	3	3	2	2	1
CO-5	2	1	2	1	2	1	2	1	1	2
Ave.	2	1.8	1.8	1.6	2.4	1.8	2.2	2.0	1.8	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER III			
Core Practical III Practical in Soil and Agricultural Microbiology			
Course Code: 23PMICR3	**Hrs /Week: 4**	**Hrs/Sem: 60**	**Credits: 2**

Objectives:

- To impart skill on isolation of various microbes from soil and plant.
- To enhance advanced level laboratory training in Soil and Agricultural Microbiology.

Course Outcomes:

C O No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Outline the isolation of various soil microbes	K4
CO -2	Infer quantitative assay of microbes from air borne.	K2
CO-3	Predict the preparation of bio fertilizer and its assay	K3
CO-4	Describe the isolation of phosphate solubilizing bacteria and nitrogen fixing bacteria	K1
CO-5	Evaluate antagonism between microorganisms	K5

SEMESTER III			
Core Practical III Practical in Soil and Agricultural Microbiology			
Course Code: 23PMICR3	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 2**

1. Isolation of microorganisms from soil.
2. Testing antagonistic activity of soil microorganisms.
3. Estimation of soil mineral contents a) nitrate b) sulphate c) phosphate.
4. Effect of high salt concentration on microbial growth.
5. Quantitative assay of microbes in Rhizosphere.
6. Quantitative assay of microbes in phyllosphere.
7. Determination of soil pH.
8. Determination of soil temperature.
9. Isolation of Phosphate solubilizing bacteria & fungi
10. Isolation of *Rhizobium sp* from root nodules of leguminous plants.
11. Isolation of *Azotobacter sp* from soil.
12. Isolation of *Azospirillum sp* from soil.
13. Identification of Cyanobacteria from soil. (*Anabaena* and *Nostoc*).
14. Preparation of biofertilizer
15. Assay of bio fertilizer (Seed treatment, Seedling treatment, Soil inoculation, Measurement of root and shoot system (Demonstration).

Books for Reference:

1. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi. (2012). Laboratory manual for Microbiology, Biochemistryand Molecular Biology. Scientific Publishers, India.
2. Gunasekaran. P. (2005). *Laboratory Manual in Microbiology*. New Age International Ltd.,Publishers, 1 st edition. New Delhi.
3. Dubey, R.C. and Maheswari,D.K. (2002). *Practical Microbiology*. Chand and Company Ltd., 2nd edition. India.
4. Aneja K.R. *Experiments in Microbiology, Plant Pathology and Biotechnology. (*1993) New Age International Publishers, 4th edition, New Delhi.
5. Harold J. Benson, Alfred E. Brown (2006). - *Benson's Microbiological applications: Laboratory manual in General Microbiology.* International Edition, McGraw Hill Higher Education

Web Resource

1. file:///C:/Users/Admin/Downloads/10.1515_opag-2021-0215.pdf
2. https://lawr.ucdavis.edu/classes/ssc107/SSC107Syllabus/chapter8-01.pdf
3. https://strathprints.strath.ac.uk/18874/1/9.pdf

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	2	1	3	2	2	1	1
CO-2	1	2	1	3	2	3	3	2	2	2
CO-3	2	3	2	2	3	2	3	2	1	3
CO-4	2	2	2	2	3	3	2	2	2	2
CO-5	2	2	2	3	2	3	2	2	1	1
Ave.	1.8	2.2	1.6	2.4	2.2	2.8	2.4	2	1.4	1.8

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER III

SEMESTER III			
Core Practical IV Practical in Molecular Biology, Recombinant DNA Technology, Fermentation Technology and Pharmaceutical Microbiology			
Course Code: 23PMICR4	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 2**

Course objective

- To learn about sterility testing and understand spoilage of pharmaceutical products
- To illustrate the significance of artificial transformation and mutations.
- To make learners familiarize with preparation of fermented products
- To discuss blotting techniques and PCR.

Course outcome

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	Examine various molecular techniques for gene manipulation and detection of mutants.	K4
CO-2	Experiment novel research with techniques like PCR and blotting analysis.	K3
CO-3	Relate the production of various fermented products	K2
CO-4	Evaluate the protocol for sterility testing of pharmaceutical products	K5
CO-5	Define the parameters for bioreactor development	K1

Core Practical IV Practical in Molecular Biology, Recombinant DNA Technology, Fermentation Technology and Pharmaceutical Microbiology			
Course Code: 23PMICR4	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 2**

1. Artificial Transformation
2. Detection of Antibiotic resistant mutants
3. Identification of mutants by replica plating method
4. Amplification of DNA by PCR (Demonstration)
5. Agarose Gel Electrophoresis
6. Isolation of induced mutant by UV
7. Genetic recombination in Bacteria by conjugation (Demonstration)
8. Plasmid DNA isolation from *E.coli*
9. Western blotting (Demonstration)
10. Southern blotting (Demonstration)
11. Isolation of streptomycin producing bacteria from soil
12. Microbial enzyme production – Amylase
13. Sterility testing of pharmaceutical products
14. Microbial productions of citric acid
15. Production of wine from apple
16. Culturing and characterization of actinomycetes used in pharmaceutical industry
17. Production of vinegar
18. Detection of sugars and amino acids from fermentation broth by Paper Chromatography
19. Design and composition of media for industrial fermentation (Demonstration)

Books for Reference

1. Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.

2. Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.

3. Cappuccino, J.G., Sherman,S (2002) Microbiology. A Laboratory Manual

Benjamin Cummings Publishing Company

Web Resources

1. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004080644112092madhu_gupta_zool_Western_Blotting.pdf
2. https://www.onlinebiologynotes.com/southern-blotting-principle-procedure-application/
3. https://byjus.com/neet/design-and-composition-of-media-for-fermentation/
4. https://microbenotes.com/bacterial-conjugation/

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	2	3	2	3	2	2	2
CO-2	2	3	1	2	2	1	2	2	3	3
CO-3	3	3	2	3	3	2	2	3	3	1
CO-4	2	3	2	1	2	3	1	2	2	2
CO-5	2	1	3	2	2	2	3	3	2	3
Ave.	2.4	2.6	2..0	2.0	2.4	2.0	2.2	2.4	2.4	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER III			
Discipline Specific Elective V Biosafety, Bioethics and IPR			
Course code: 23PMIE31	**Hrs/Week: 3**	**Hrs/Sem: 45**	**Credit: 3**

Objectives

- Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment.
- Develop strategies for the use of genetically modified organisms and Hazardous materials

Course Outcome:

CO No	Upon completion of this course, students Will be able to	Cognitive Level
CO-1	Describe 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	K1
CO-2	Summarize and discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotechnological products.	K2
CO-3	Known familiarize fundamental aspects of Intellectual property Rights in the development and management of innovative projects in industries.	K3
CO-4	Outline knowledge about bioethics, biodiversity and genetically modified foods and food crops	K4
CO-5	Evaluate the students with an understanding of bioethics in research associated with medicine	K5

SEMESTER III			
Discipline Specific Elective V Biosafety, Bioethics and IPR			
Course code: 23PMIE31	**Hrs/Week: 3**	**Hrs/Sem: 45**	**Credit:3**

Unit-I: **(9 hrs)**

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.

Unit-II: **(9 hrs)**

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: **(9 hrs)**

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.

Unit IV: **(9 hrs)**

Introduction to bioethics - need of bioethics and applications. Biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - to genetically modified foods and food crops, organisms and their possible health implications

Unit V: **(9 hrs)**

Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, 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.

Text Books

1. Usharani .B, S Anbazhagi, C K Vidya, (2019). Biosafety in Microbiological Laboratories- 1st Edition, Notion Press, ISBN-101645878856
2. Satheesh.M.K., (2009). Bioethics and Biosafety- 1st Edition, J. K International Publishing House Pvt. Ltd: Delhi, ISBN :9788190675703
3. DeepaGoel and ShominiParashar, (2013). IPR, Biosaftey and Bioethics- 1st Edition, Pearson education: Chennai, ISBN-13: 978-8131774700
4. Rajmohan Joshi (2006). Biosafety and Bioethics. Gyan Books publisher.

Books for Reference

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited, ISBN-10: 9386668572

2. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited, ISBN : 9788120349896

3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis, ISBN-10: 8131251659.

4. Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, Abdulrazak B. Ibrahim, Benjamin Ewa Ubi (2022). Biosafety and Bioethics in Biotechnology-Policy, Advocacy, and Capacity Building,1st edition. CRC Press

5. Sree Krishna. V (2007). Bioethics and Biosafety in Biotechnology. New age international publishers.

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.htm

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	3	2	3	1	2	1	2	2
CO-2	2	3	2	3	2	2	1	2	1	3
CO-3	3	2	3	2	1	2	3	2	2	1
CO-4	2	3	1	1	2	2	1	3	2	3
CO-5	2	3	2	2	3	3	1	2	2	3
Ave.	2.2	2.4	2.2	2.0	2.2	2.0	1.6	2.0	1.8	2.4

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER III			
Discipline Specific Elective V Water Conservation and Water Treatment			
Course Code: 23PMIE32	**Hrs/Week:3**	**Hrs/Sem:45**	**Credits:3**

Objectives:

- To explain impact of societal and climatic changes in water supply
- To be familiar with the methods of water treatment technologies and schemes for water conservation
- To acquire knowledge for identifying the quality of water by standard methods
- To assess the impact of HWTS

Course outcome

CO No	Upon completion of this course,students will be able to	Cognitive Level
CO-1	Describe issues of water scarcity, stress, and conflict on global population and India	K1
CO-2	Summarize multiple approaches against water scarcity and various government schemes for water conservation.	K2
CO-3	Present the connection between water quality and public health and the quality of surface, flowing and impound water	K3
CO-4	Analyze and execute standard strategy for successful HWTS implementation.	K4
CO-5	Defend emerging water treatment technique	K5

SEMESTER III			
Discipline Specific Elective V Water Conservation and Water Treatment			
Course Code: 23PMIE32	Hrs/Week:3	Hrs/Sem:45	Credits:3

Unit I **(9 Hrs)**

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

Unit II **(9 Hrs)**

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 and Atal Bhujal Yojana

Unit III **(9 Hrs)**

Water Quality and Pollution; Impurities in the water, 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,

Unit IV **(9 Hrs)**

Water Treatment Technologies; Sedimentation, Filtration, Coagulation and flocculation, Water softening and adsorption processes, Membrane filtration, Microfiltration, Water disinfection, Household Water Treatment and Safe Storage (HWTS). Household water treatment and safe storage decision tree, Government policies for HWTS.

Unit V **(9 Hrs)**

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

Books for Reference

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.

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

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	3	2	1	1	1	2	2	1	1
CO-2	3	2	3	3	3	3	3	2	3	3
CO-3	3	3	3	2	2	2	2	3	2	1
CO-4	1	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	3	2	2	3
Ave.	2	2.2	2.2	1.6	1.4	1.8	2.4	2.0	1.6	1.8

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER III			
Skill Enhancement Course II Cosmetic Microbiology			
Course Code: 23PMISE2	**Hrs/Week:3**	**Hrs/Sem:45**	**Credits:2**

Objectives:

- To impart basic level information in the novel subject of Cosmetic microbiology.
- To enhance the knowledge on the applications of Cosmetic microbiology in various fields.

Course Outcome:

CO.No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe the introduction and history of cosmetic microbiology	K1
CO -2	Experimentally prove the sanitany manufacturing in cosmetics	K3
CO-3	Analyze the quality of cosmetics	K4
CO-4	Discuss the cleaning and sanitation of cosmetics	K2
CO-5	Estimate the cosmetic tests in laboratory methods	K5

SEMESTER III			
Skill Enhancement Course II Cosmetic Microbiology			
Course Code: 23PMISE2	**Hrs/Week:3**	**Hrs/Sem:45**	**Credits:2**

Unit I **(9 hrs)**

Introduction to cosmetic microbiology-History of cosmetic microbiology – Biology of microbes-Bacteria, molds and yeast.

Unit II **(9 hrs)**

Sanitary manufacturing in cosmetic manufacturing – Cleaning (Detergent ingredients & properties, Types of surfactants) – Sanitization (Physical &chemical sanitizers)-Cleaning & sanitizing equipments-Cleaning and sanitization procedures.

Unit III **(9 hrs)**

Hazard Analysis and Critical Control Point (HACCP) protocols in Cosmetic Microbiology - Apply HACCP to cosmetics-Waste water removal and CIP system-Selecting Critical Control Points – Parameters of an effective HACCP program.

Unit IV **(9 hrs)**

Cosmetic microbiology test methods- preservative efficacy methods-CFTA methods- ASTM methods-Test for factors affecting preservative efficacy-Neutralizer evaluation-Rapid methods used in preservative testing-Microbial content testing.

Unit V **(9 hrs)**

Validation methods – Model for validation-Validation of equipment cleaning & sanitization - Validation in microbiology laboratory- Preservation strategies-Scope and microbiological targets of preservation.

Textbooks:

1. Philip A. Geis (2010). Cosmetic Microbiology – A practical approach. Taylor and Francis group, New York.
2. Janet C. Curry, Daniel K. Brannan, Philip A. Geis., (2006). Cosmetic Microbiology.,CRC Press., 2nd Edition. ISBN 9780429128943.
3. Daniel. K. Brannan. (2006). Cosmetic Microbiology. A Practical Hand book. CRC press.

Books for Reference:

1. Halleck F.E., (2010). Thermal solution sterilization, Pharm.Technol.,

3. Pflug I.J.,and G.M.Smith. (2006). “The Use of Biological Indicators for Monitoring Wet- Heat Sterilization Processes.”. In Sterlization of Medical products.(EDS. E.R.L. Gaughran and K.Kereluk), New Brunswick, N.J.,Johnson and Johnson.

4. Gardner J.F., and M.M.Peel. (2000).Introduction to Sterilization, Disinfection, and Infection Control. Second Edition. Churchill Livingstone, Melbourne.

Web Resources

1. https://ifscc.org/wp-content/uploads/2018/05/5-Intro-to-Cosmetics-Microbiology.pdf
2. https://abu.edu.iq/sites/default/files/library/20061_1.pdf
3. https://www.chemie-brunschwig.ch/documents/suppliers-information/condalab/Microbiological-Analysis-Cosmetics_EN_2020.pdf
4. https://link.springer.com/protocol/10.1385/1-59259-766-1:293

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	2	1	2	2	2	3	2
CO-2	1	3	2	1	2	2	1	2	2	3
CO-3	3	2	3	3	2	1	2	1	1	3
CO-4	2	1	3	2	3	1	3	1	2	1
CO-5	1	3	2	1	3	3	2	3	3	1
Ave.	1.8	2.2	2.2	1.8	2.2	1.8	2.0	1.8	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER III	
Self Study (Optional) Sea Food Processing and Preservation	
Course Code : 23PMISS1	**Credits: +2**

Objectives:

- Explain various microbiological quality standards for sea food, water and air regulatory practices and policies.
- Discuss collection, processing and preservation of sea food samples from industries in different areas.
- Enumeration and isolation of microorganism from the sea food and water samples.
- Enumeration and isolation of microorganism from the air samples.

Course Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Apply knowledge in quality analysis techniques suitable for industries.	K3
CO2	Analyze water managements, treat sewage, water pollutions and remedies.	K4
CO3	Evaluate sea food quality.	K5
CO4	Explain bioaerosols, impact and prevention	K2
CO5	Describe quality control techniques for sea food industrial products	K1

SEMESTER III	
Self Study (Optional) Sea Food Processing and Preservation	
Course Code : 23PMISS1	**Credits: +2**

Unit I

Plant design: Fundamentals of processing plant design: Site selection, design and preparation of layout of processing plants

Unit II

Preservation in sea food industries: Block freezing, Canning

Unit III

Effluent treatment: Legislation and standards of effluent discharge, water pollution control measures in the food industry.

Unit IV

Hazard Analysis Critical Control Point (HACCP) system, Good Manufacturing Practices (GMP)

Unit V

Quality Assurance in Sea food industry –Standard Sanitary Operating Procedures (SSOP), Sanitary Control Procedures (SCP), ISO

Text Books:

1. Dr. G.Jeyasekaran. Dr. R.Jeya Shakila, Dr. P.Velayutham. (2002).Quality control of fish and fishery products

2. Fish Processing Plant-Guidelines for the application of HACCP program –prepared by Food Protection Services, BC centre for disease control-Revised January 2011.

3. Gopakumar K., (2002) Text Book of Fish Processing Technology. 3rd Edition., Indian Council of Agricultural Research

Books for Reference:

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -Taylor &Francis.

2. Sundararaj T. (2003). Microbiology Laboratory Manual. (2nd Edition). Published by A. Sundararaj

3. Amitava Mitra. (2013). Fundamentals of Quality control and Improvement. (3rd Edition). Wiley Publications

Web links:

1. https://www.niftem.ac.in/site/pmfme/processingnew/frozenfishprocessing.pdf
2. https://www.bluecoldref.com/frequently-asked-questions/food-industry
3. https://www.epcbboiler.com/2023-food-industry-boiler-selection-guide.html

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO – 1	3	2	1	2	2	3	3	3	3	2
CO – 2	2	1	2	2	2	3	2	3	2	2
CO – 3	2	1	2	1	2	3	3	3	3	2
CO – 4	2	1	2	2	2	3	2	3	2	2
CO – 5	3	1	1	2	3	3	2	3	2	2
Ave.	2.4	1.2	1.6	1.8	2.2	3	2.4	3	2.4	2

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER IV			
Core VIII Food and Dairy Microbiology			
Course Code : 23PMIC41	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Objectives:

To impart the advanced level knowledge in the subject of food microbiology

Course Outcome

CO. No	Upon completion of this course, students will be able to	Cognitive Level
CO- 1	Recall the techniques in food microbiology.	K1
CO- 2	Explain the about microorganisms important in food and the techniques in food preservation andfermented foods	K2
CO -3	Compile the beneficial and harmful aspects of microbes in dairy products	K3
CO -4	Analyze the recent techniques on good Manufacturing practice.	K4
CO-5	Evaluate the quality and safety assurance in food industry and the hazard analysis and critical control point	K5

SEMESTER IV			
Core VIII Food and Dairy Microbiology			
Course Code : 23PMIC41	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I: Introduction to Food Microbiology (12 hrs)

Food as a substrate for microorganisms – Microorganisms important in food microbiology – Molds, yeasts and bacteria –General characteristics, classification and importance –Factors influencing microbial growth in food – Extrinsic and intrinsic factors(Nutrient content, pH, redox potential, relative humidity, temperature, gaseous atmosphere).

Unit II: Microbial contamination of foods (12 hrs)

Microbial contamination of foods - spoilage of food by microbes in cereals and cereal products- fruits, vegetables and its dried products- Eggs and poultry – meat- fish –canned foods.

Unit III: Food Preservation (12 hrs)

Principles of food preservation: Methods of food preservation – Aseptic handling, pasteurization of milk, refrigeration and freezing, dehydration, Radiation - UV, Smoking chemicals – organic acids, nitrates, nitrites, sulphur di oxide and sulphites. Food fermentation: Bread, Tempeh, Fermented dairy products (Kefir, Koumiss, Acidophilus milk).

Unit IV: Dairy Microbiology (12 hrs)

Dairy Introduction – Sources of microorganisms in milk – Classification of microbes – Biochemical types, characteristics and pathology. Milk borne diseases –bacterial (Mastitis, Anthrax, Brucellosis, Diphtheria, Tetanus) and viral diseases (Foot and mouth disease, Rinderpest, Cowpox, and Virus diarrhoea) in cattle's – Control measures.

Unit V: Microbiological examination of foods (12 hrs)

Microbiological examination of foods – Estimation and examination of specific microorganisms, Bacteriological examination of milk – microbial standard and milk grading- MBRT and Resazurin method. Good manufacturing practice, hazard analysis critical control point (HACCP) concept. BIS Laboratory service.

Textbook:

1. Frazier W.C., Westhoff. D. C. and Vanitha K.N. (2013). Food Microbiology. (6th Edition). McGraw Hill Education.

2. Ray B. and Bhunia A. (2013). Fundamentals of Food Microbiology. (5th Edition). CRC Press.

Books for Reference:

1. Adams M.R., and Moss M.O., (2005). *Food Microbiology*. Cambridge: The Royal Society ofchemistry.
2. Banwarst. G.J. (2003). Basic Food Microbiology 2nd edn, CBS Publishers and distributors.
3. Robinson R. K. (2000). Dairy Microbiology3rdedn, Elsevier Applied Science, London.
4. Vijaya R K, (2004). Food Microbiology 1st 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

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	2	1	3	3	3	3	2	1	1	3
CO-2	1	3	1	2	1	3	1	2	2	3
CO-3	3	3	2	1	1	2	3	3	2	2
CO-4	2	2	2	2	1	2	2	3	2	2
CO-5	2	2	2	2	3	3	3	2	2	3
Ave.	2	2.2	2	2	1.8	2.6	2.2	2.2	1.8	2.6

Mapping	**<40%**	**≥ 40% and <70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

SEMESTER IV			
Core IX Research Methodology and Biostatistics			
Course Code: 23PMIC42	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Objectives:

- To describe the process and importance of research.
- Explain sampling methods, write research reports and articles.
- Summarize the collection and types of data
- Discuss the basic concepts of Biostatistics.
- Explain the tests of significance.

Course Outcomes:

C O No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe the research process, literature survey and thesis.	K1
CO -2	Write research manuscripts and articles for journals.	K2
CO-3	Differentiate primary and secondary data.	K4
CO-4	Analyze the utilization of biostatistics tools for analysis of biological data.	K5
CO-5	Apply software tools for interpretation of biological data.	K3

SEMESTER IV			
Core IX Research Methodology and Biostatistics			
Course Code: 23PMIC42	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits:4**

Unit I **(12 hrs)**

Introduction to Research Methodology - Meaning and importance. Research methods in biological sciences - Research process- Literature survey – sources –scientific databases Review of literature - Review and synopsis presentation. Research report writing – Parts of Thesis and Dissertation – Presentation in seminars and conferences.

Unit II **(12 hrs)**

Writing scientific paper – Organization of scientific paper – Importance of title – Publication in research journals – Standards of Research journals- Peer – review – impact factor – citation index – Preparation of manuscript – Proof correction – proof correction marks - Writing chapters in books – Preparation of Research proposal and funding agencies – Research fellowships. Ethical issues related to publishing, Plagiarism and Self-Plagiarism

Unit III **(12hrs)**

Introduction to Biostatistics – Definition, Basic concepts, Measurement and measurement scales, Data presentation. 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 IV **(12 hrs)**

Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range, mean deviation and coefficient of variation. Sampling and sampling distributions. Sampling frame, importance of probability sampling, sampling - simple random, systematic, stratified random and cluster. Variables - nominal, ordinal, discontinuous, continuous and derived.

Unit V **(12hrs)**

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. Tests of significance: Small sample test (Chi-square, t test & F test), large sample test (Z test).

Text Books

1. Gurumani N. Research methodology for Biological sciences. (2009). MJP Publishers, Chennai.
2. Sharma K. R. (2002) Research methodology. National Publishing House, New Delhi.
3. Daniel W.W. (2005). Biostatistics; A foundation for analysis in the health sciences. (7th Edition). Jhon Wiley & sons Inc, New York.
4. Rao P. S. S. and Richard J. (2006). Introduction to Biostatistics & Research methods. Prentice-Hall, New Delhi.

Books for Reference:

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	2	2	1	1	2	2	3	2
CO-2	2	3	1	1	2	2	1	2	2	3
CO-3	3	2	1	3	2	3	2	1	1	3
CO-4	2	1	2	2	3	3	3	1	2	1
CO-5	2	3	1	1	3	2	2	3	3	1
Ave.	2.4	2.2	1.4	1.8	2.2	2.2	2.0	1.8	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER IV			
Core X Marine Microbiology			
Course Code : 23PMIC43	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 3**

Objectives:

- To impart advanced level information in the subject of Marine Microbiology

Course Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Analyze the marine ecosystem and classification of marine organisms and different ecosystems	K4
CO-2	Define marine microorganisms	K1
CO-3	Interpret marine food chain, degradation of naural and xenobiotics	K2
CO-4	Evaluate Extremophiles and marine microbial interaction	K5
CO-5	Relate biofouling, bioleaching and metal corrosion	K3

SEMESTER IV			
Core X Marine Microbiology			
Course Code - 23PMIC43	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 3**

Unit I: **(12 Hrs)**

Classification of marine organisms- Marine ecosystem: Intertidal zones, inhabitants- Ecology of estuaries, salt marshes, mangroves, swamps, coral reefs and deep sea- Conventional and modern methods of studying microorganisms- Archae bacteria and other special groups- Methanogens.

Unit II: **(12 Hrs)**

Methods of studying marine microorganisms- Collection, enumeration, isolation and identification based on morphological, physiological and biochemical characteristics- Microbial nutrition- Influence of environmental factors on microbial growth and activity.

Unit III: **(12 Hrs)**

Marine food chain- primary production- Eutrophication-Effect of global warming in marine ecosystem- Role of marine microbes in oil degradation - Microbial processes- biodegradation of natural and xenobiotics; biotransformation - bioaccumulation - bioremediation - biomineralization.

Unit IV: **(12 Hrs)**

Extremophiles - thermophiles - halophiles - acidophiles - alkaliphiles - barophiles – baro psychrophiles - psychrophiles.- Marine microbial interactions - bacterial invertebrates - symbiosis - Coral diseases and microbial associates. Deep-Sea microbes - bioluminescence.

Unit V: **(12 Hrs)**

Bio fouling and prevention- Biofilms and Microbial mats- Bioactive compounds from marine microbes. Primary and secondary metabolites Microbial leaching of ore and metal corrosion. Microbial indicator organism of marine pollution.

Text books:

1. Atlas, R.M., and Bartha.M. (2003). Microbial ecology- Fundamentals and Applications. Benjamin- Cummings, Menlo Park, California.
2. Brock, T.D., and Madigan, M.T. (2011). Biology of Microorganisms. (8th edition). Prentice Hall, Inc, New York.
3. Vijaya Ramesh, K. (2004). Environmental Microbiology. MJP Publishers Chennai.
4. C.B. Munn (2003) Marine Microbiology: Ecology and applications.

Books for Reference:

1. Maier R. M., Pepper I. L. and Gerba C. P. (2006). Environmental Microbiology. (2nd Edition). Academic Press. ISBN:978-0-12-370519-8
2. Talaro, K.P., and Talaro. A. (1999). Foundations in Microbiology. WCB Mc Graw Hill, New York.
3. Gasol J. M. and Kirchman D. L. (Eds.). (2018). Microbial Ecology of the Oceans. (3rd Edition). Wiley-Blackwell. ISBN:978-1-119-10718-7.

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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	2	1	3	2	2	1	1
CO-2	1	2	1	3	2	3	2	2	1	2
CO-3	2	3	2	2	3	2	2	3	1	2
CO-4	2	2	2	2	3	3	2	2	2	2
CO-5	2	2	2	3	2	3	2	2	1	1
Ave.	1.8	2.2	1.6	2.4	2.2	2.8	2	2.2	1.2	1.6

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER IV			
Core Practical V Practical in Food and Dairy Microbiology			
Course Code: 23PMICR5	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:2**

Objectives:

- To impart advanced level practical training in Food and Dairy Microbiology.
- To make the students skilled in the field of Food and Dairy Microbiology.

C**ourse outcome:**

CO NO	**Upon completion of this course, students will be able to**	**Cognitive Level**
CO- 1	Recall the microbial examination of milk test	K1
CO- 2	Explain isolation, detection and determination of coliforms in food & beverages.	K2
CO -3	Experiments on isolation, detection and determination of *E.coli* , *Salmonella ,Shigella*, and V*ibrio* species in food & beverages.	K3
CO -4	Analyze mycotoxin in fungal contaminated food materials	K4
CO -5	Evaluate water by most probable number technique	K5

SEMESTER IV			
Core Practical V Practical in Food and Dairy Microbiology			
Course Code: 23PMICR5	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:2**

1. Viable count of bacteria in milk.
2. Phosphatase test in milk sample.
3. Microbial examination of milk by Methylene blue Reduction test
4. Microbial examination of milk by Resazurin test
5. Quantitative analysis of milk by standard plate count method.
6. Detection of mastitis and isolation of microorganisms through the infected milk.
7. Isolation of lipolytic organism from butter.
8. Detection and determination of coliforms in food &beverages.
9. Detection and determination of *E.coli* in food &beverages.
10. Detection & confirmation of *Salmonella* species in food.
11. Detection & confirmation of *Shigella* species in food.
12. Detection & confirmation of pathogenic *Vibrio* species in food.
13. Estimation of molds & yeast from fruit juice.
14. Microbial examination of canned foods.
15. Wine production using grape juice. (Demonstration)
16. Analysis of mycotoxin in fungal contaminated food materials
17. Water analysis by most probable number technique.
18. Visit to food and dairy industry.

Books for Reference:

1. J.G. Cappuccino and N. Sherman. (2006). *Microbiology* – A lab manual. NewYork: Benjamin Cummins.
2. Kannan, N. (2006). *Laboratory Manual in General Microbiology*. Palani: Palani Paramount Publication.
3. Jayaraman, J. (2005) *Laboratory Manual in Biochemistry.* New Delhi: Wiley Eastern Ltd.,
4. Plummer, D.T. (2005). *An Introduction to Practical Biochemistry.* Tata McGraw-Hill.,

New Delhi.

5. Harley Precott. (2002). *Laboratory Exercises in Microbiology.*, The MacGraw Hill companies.5 thedition.

Web Resources:

1. https://www.journalofdairyscience.org/article/S0022-0302(67)87450-2/pdf.
2. https://www.researchgate.net/publication/287189499_Isolation_and_estimation_Biochemical_analysis_of_lipolytic_bacteria_from_unsalted_butter
3. https://www.wikihow.com/Make-Wine-out-of-Grape-Juice
4. https://www.onlinebiologynotes.com/wine-production-process/

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	3	3	3	3	2	1	1	3
CO-2	1	3	1	2	1	3	1	2	2	3
CO-3	3	3	2	1	1	2	3	3	2	2
CO-4	2	2	2	2	1	2	2	3	2	2
CO-5	2	2	2	2	3	3	3	2	2	3
Ave.	2	2.2	2	2	1.8	2.6	2.2	2.2	1.8	2.6

Mapping	<40%	≥ 40% and <70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER IV			
Core Practical VI Practical in Research Methodology, Biostatistics and Marine Microbiology			
Course Code : 23PMICR6	**Hrs/Week: 4**	**Hrs/Sem:60**	**Credits:2**

Objectives:

- Representation of statistical data by various methods.
- Determination of statistical averages.
- Understand the techniques in marine microbiology

Course Outcomes:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Diagrammatic representation of statistical data	K4
CO-2	Estimate statistical averages by various methods	K2
CO-3	Demonstrate the determination of BOD, COD and DO	K3
CO-4	Isolate microbes associated with marine environment	K1
CO-5	Evaluate the marine resources	K5

SEMESTER IV			
Core Practical VI Practical in Research Methodology, Biostatistics and Marine Microbiology			
Course Code: 23PMICR6	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits: 2**

1. Graphical representation of data analysis.
2. Calculation of Mean using Excel spreadsheet.
3. Calculation of Median using Excel spreadsheet.
4. Calculation of Mode using Excel spreadsheet.
5. Calculation of Standard Deviation.
6. Calculation of Karl-Pearson's coefficient.
7. Testing of hypothesis based on exact sampling distributions-Chi Square, t & F test.
8. Selection of simple random sampling
9. Determination of Dissolved Oxygen using marine water sample
10. Determination of Biological Oxygen Demand using marine water sample
11. Determination of Chemical Oxygen Demand using marine water sample
12. Isolation of microbes associated with marine sponges.
13. Isolation of fungi from mangroves.
14. Isolation of antibiotic producing microorganism from marine water.
15. Isolation of crude oil degrading marine bacteria.
16. Determination of salinity of seawater.
17. Extraction of alginate from seaweed (Demonstration)

Books for Reference:

1. Goon A. M, Gupta M.K. & B. Dasgupta. (2017). An Outline of Statistical Theory. Vol. I. The World Press.
2. Dr. Sharma H.L.. (2011). Experimental Designs and Survey Sampling: Methods and Applications, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur.
3. Dr. Chandel S. R. S. (2014). A handbook of Agricultural Statistics. Achal Prakashan Mandir Publications.
4. Kushwaha K. S. and Rajesh Kumar. (2009). The Theory of Sample surveys and Statistical Decisions. New India Publishing Agency, India.
5. Amy Sauter Marine Hill. (2002). Marine Biology Lab Manual–An introduction to ocean ecosystem, Walch publishing.
6. Peter Castro and Michael E. Huber (2019). Marine science Laboratory manual., Eighth edition. Mc Graw Hill.

7. George *Karleskint*, Richard *Turner*, James *Small (2012)*. Introduction to Marine biology ., 4th edition- Cengage Learning

Web Resources

1. https://ijrti.org/papers/IJRTI2112001.pdf
2. https://www.calculator.net/standard-deviation-calculator.html
3. https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704_hypothesistesting-chisquare/bs704_hypothesistesting-chisquare_print.html

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	2	1	2	1	3	2	2	1	1
CO-2	1	2	1	3	2	3	2	2	1	2
CO-3	2	3	2	2	3	2	2	3	1	2
CO-4	2	2	2	2	3	3	2	2	2	2
CO-5	2	2	2	3	2	3	2	2	1	1
Ave.	1.8	2.2	1.6	2.4	2.2	2.8	2	2.2	1.2	1.6

Mapping	<40%	≥40%and <70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER IV			
Discipline Specific Elective VI Bioenergy			
Course Code: 23PMIE41	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Objectives:

- To acquire knowledge on bioenergy utilizing organic wastes and exploiting microbes for the production technology of biodiesel.
- To explain possibility of using microbes for the production of bio-hydrogen as a source of future fuel
- To understand strategies of biogas bottling technology
- To describe resources and techniques for the production and estimation of microbial fuel

Course outcome

CO No	**Upon completion of this course,students will be able to**	**Cognitive Level**
CO-1	Explain the various aspects of biomass production and their implementation	K2
CO-2	Describe a biodiesel plant.	K1
CO-3	Produce the role of enzymes in ethanol production	K3
CO-4	Defend the nature of biogas as a biofuel and their technologies and applications.	K5
CO-5	Analyze the Design, execute and extract biohydrogen from algae	K4

SEMESTER IV			
Discipline Specific Elective VI Bioenergy			
Course Code: 23PMIE41	**Hrs/Week:4**	**Hrs/Sem:60**	**Credits:3**

Unit I **(12 Hrs)**

Bioenergy – Biomass Energy Resources. Biomass conversion methods. Microbes as bioresources for bioenergy products (Bacteria, fungi, yeast and microalgae) - Bioprospecting of microbial strains for biofuel production

Unit II **(12 Hrs)**

Biodiesel − Microbes and Biodiesel. Production and feed stock. Biodiesel quality and its assessment. Strategies of genetic engineering of organisms for biodiesel production. Biodiesel production from single cell organisms (*Cryptococcus, Cunninghamella, Mortierella*).

Unit III **(12 Hrs)**

Alcoholic Fuels from microorganisms: Biochemical conversion to ethanol: starch to sucrose conversion and sucrose to ethanol fermentation. Role of enzymes and their applications in ethanol production. Distillation and quantification of ethanol. Production and estimation of biobutanol and biomethanol

Unit IV **(12 Hrs)**

Biogas - Microbes and Biogas production, Biogas plants – types – design – construction– Biogas Bottling Technology and Development in India, Biogas appliances – burner, luminaries and power generation – effect on engine performance.

Unit V **(12 Hrs)**

Biohydrogen– Production from bacteria and algae. Commercialized microalgae (*Spirulina, Dunaliella, Hematococcus* and *Chlorella*) and their production. Economics of microalgae production. Cultivation of seaweeds. Microbial fuel cells.

Text Books

1. Dahiya A. (2014). Bioenergy- Biomass to Biofuel. (1st Edition). Academic Press Editor.
2. Brown R. C. (2003). Biorenewable Resources: Engineering New Products from Agriculture. (1st Edition). Wiley Blackwell Publishing

Books for Reference

1. Konur O. (2018). Bioenergy and Biofuels. (1st Edition). CRC Press.
2. *Lee* J. W.(2012). Advanced Biofuels and Bioproducts. (13th Edition), Springer
3. Khanal S. (2008). Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. (8th Edition). Wiley-Blackwell Publishing

4. Pradeep Chaturvedi.(1995). Bioenergy Resources. Concept Publishing Company.

Web Resources

1. https://www.elsevier.com Biofuels and Bioenergy
2. https://www.sciencedirect.com › book › bioenergy
3. https://www.un.org/en/climatechange/what-is-renewable-energy?gclid=EAIaIQobChMIqriN2Nao-wIV2HwrCh2pfA5mEAAYASAAEgI-p_D_BwE
4. https://www.energy.gov/eere/bioenergy/bioenergy-basics
5. https://www.iea.org/fuels-and-technologies/bioenergy

Mapping of Course Outcomes with Pos and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	2	1	2	2	2	2	1
CO-2	1	3	3	3	3	3	3	3	3	2
CO-3	2	3	3	3	3	2	3	2	3	2
CO-4	3	2	2	2	1	2	3	3	3	2
CO-5	3	2	3	3	2	3	2	3	1	2
Ave.	2.4	2.6	2.8	2.6	2.0	2.4	2.6	2.6	2.4	1.8

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER IV			
Discipline Specific Elective VI Microbial Quality Control and Testing			
Course Code : 23PMIE42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 3**

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 Outcome:

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO1	Apply knowledge in quality analysis techniques suitable for industries.	K3
CO2	Analyze water managements, water harvesting and treat sewage, water pollutions and remedies.	K4
CO3	Evaluate portability of water. Test water quality.	K5
CO4	Explain bioaerosols, impact and prevention	K2
CO5	Describe quality control techniques for food and pharma products	K1

SEMESTER IV			
Discipline Specific Elective VI Microbial Quality Control and Testing			
Course Code : 23PMIE42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credits: 3**

Unit I **(12 Hrs)**

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 **(12 Hrs)**

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, Textile, Food Industry, Domestic waste. Waste water treatment plant types and quality control. Water pollution causes and remedies.

Unit III **(12 Hrs)**

Microflora of water. 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 **(12 Hrs)**

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 **(12 Hrs)**

Quality control in food - Food X ray inspection, 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. (2nd Edition). Royal Society of Chemistry.
3. Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4. Cappuccimo, J. and Sherman, N. (2002). Microbiology: A Laboratory Manual, (6th 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.

Books for Reference:

1. Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -Taylor &Francis.
2. Sundararaj T. (2003). Microbiology Laboratory Manual. (2nd 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 Pharmaceutcals, cosmetics & Toiletries. by Sally F. Bloomfield
4. Amitava Mitra. Fundamentals of Quality control and Improvement. (3rd 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

Mapping of Course Outcomes with POs and PSOs

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO – 1	3	2	1	2	2	3	3	3	3	2
CO – 2	2	1	2	2	2	3	2	3	2	2
CO – 3	2	1	2	1	2	3	3	3	3	2
CO – 4	2	1	2	2	2	3	2	3	2	2
CO – 5	3	1	1	2	3	3	2	3	2	2
Ave.	2.4	1.2	1.6	1.8	2.2	3	2.4	3	2.4	2

Mapping	<40%	≥40% and < 70%	≥ 70%
Relation	Low level	Medium level	High level
Scale	1	2	3

SEMESTER IV			
Core XI Project and Viva Voce			
Course Code:23PMIP41	**Hrs/ Week: 6**	**Hrs/Sem:90**	**Credits:4**

Objectives:

- To impart advanced practical knowledge to conduct a research project.
- To plan and design statistically, retrieve relevant literature, organize and conduct, process the data, photograph relevant observations, evaluate by statistical programmes.
- To assist students to choose a research design, solve real life problems and benefit the society at large.

Course outcome

CO No	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Find the significance of data analysis in research	K1
CO-2	Explain scientific concept and research theme	K2
CO-3	Demonstrate different hypothesis invented by the researcher to the concerned title	K3
CO-4	Examine outcome of the research to the society and scientific community	K4
CO-5	Defend the research gap and challenges to adopt for the improvement	K5

Guidelines:

- A research problem need to be selected based on creative ability and scientific thought.
- A brief description of the problem needs to be given.
- Hypothesis statement should be framed.
- Objectives by which the project work is to be carried out should be clearly stated.
- Methodology has to be designed to test the hypothesis.
- Results obtained need to be replicable.
- Documented report has to be submitted on completion of the project.

PRESENTATION OF SCIENTIFIC FINDINGS:

Each student will have to present their scientific finding so individual work in any State / Regional / National International Seminar or Symposia. Alternatively, they can attend any workshops conducted by the State / National Organizations of Scientific Recognition. Abstracts/Papers presented along with certificates will have to be produced during examination.

Scientific papers published in Journals / Proceedings during his /her Master Program will be given special weightage.

GENERAL VIVA- VOCE

The examiners shall conduct a General Viva-Voce pertaining to the core course papers as an overall component.