

SENGUNTHAR ARTS AND SCIENCE COLLEGE

(Autonomous)

(Affiliated to Periyar University, Salem and Approved by AICTE, New Delhi)
An ISO 9001:2015 Certified Institution. Recognized under section 2(f) and 12(B) of the UGC Act, 1956 and
Accredited by NAAC with A⁺

TIRUCHENGODE-637205, NAMAKKAL DT., TAMIL NADU

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SYLLABUS

M.Sc., MICROBIOLOGY (CBCS –LOCF)

(With effect from the Academic Year 2024- 2025 onwards)

CHAIRMAN

CDC

PRINCIPAL

CORRESPONDENT

INTRODUCTION

The programme M.Sc. in Microbiology is a promising branch in the field of Life Sciences. Microbiology is the branch of Science that deals with microorganisms and their behaviour in different environments such as aquatic, terrestrial, and atmosphere and their associations with other living organisms. This programme includes Clinical, Food & Dairy Microbiology, Industrial and Fermentation Technology, Environmental Microbiology, Microbial Biotechnology, and Agricultural Microbiology. There is a continuous demand for microbiologists as workforce in education, industry, and research. Hence, microbiological tools and techniques are used in almost all fields which are indispensable for people working in field ,Food Industry, Medical Sciences, Environmental Science, Pharmaceutical Science etc. The syllabi for the two-year M.Sc. degree course in Microbiology are framed in such a way that the students at the end of the course developed specialists who would provide high quality health care and advance the cause of science through research& training, can also apply Microbiological methods judiciously to the variety of industrial needs.

AIM

The syllabus of this programme is aimed at preparing the students with the latest developments and put them on the right track to fulfill the present requirements.

ELIGIBILITY

Candidates for admission to the first year of the Degree of Master of Science in Microbiology (PG) Course shall be required to have passed the B.Sc. degree in any Life Sciences[Microbiology / Applied Microbiology/Industrial Microbiology/ Botany/Plant Sciences and Plant biotechnology/Zoology/Animal Science/Applied Animal Science and Animal Biotechnology/Biochemistry/Bioinformatics/Biology/Food Science & Nutrition/ /B.Sc Medical Lab Technology/BSMS/BAMS/BUMS/BHMS/Chemistry with Botany/Zoology]as Allied Subjects of this University or an Examination of any other University accepted by other examinations accepted by the Guidelines of Periyar University, as equivalent there to shall be eligible for admission to M.Sc. Degree Course in Microbiology.

REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	M.Sc., Microbiology
Programme Code	24PMI
Duration	PG –2YEARS
Programme Outcomes(POs)	PO1:Problem Solving Skill Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. PO2:Decision Making Skill Foster analytical and critical thinking abilities for data-based decision-making. PO3: Ethical Value Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. PO4: Communication Skill Ability to develop communication, managerial and interpersonal skills. PO5: Individual and Team Leadership Skill Capability to lead themselves and the team to achieve organizational goals. PO6: Employability Skill Inculcate contemporary business practices to enhance employability skills in the competitive environment. PO7:Entrepreneurial Skill Equip with skills and competencies to become an entrepreneur PO8: Contribution to Society Succeed in career endeavors and contribute significantly to society. PO9: Multicultural competence Possess knowledge of the values and beliefs of multiple cultures and a global perspective. PO 10: Moral and ethical awareness/reasoning Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	PSO1 – Placement To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, and beliefs and apply diverse frames of reference to decisions and actions. PSO 2 - Entrepreneur To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

	PSO3 – Research and Development Design and implement HR systems and practices grounded in research that complies with employment laws, leading the organization towards growth and development. PSO4 – Contribution to Business World To produce employable, ethical and innovative professionals to sustain in the dynamic business world. PSO 5 – Contribution to the Society To contribute to the development of the society by collaborating with stakeholders for mutual benefit.
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	Pos										PSOs				
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	PS01	PS02	PS03	PS04	PS05
CLO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CLO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Correlation between POs and PSOs (*Suggested by UGC as per Six Sigma Tool– Cause and Effect Matrix*); 1–Low, 2–Medium, 3–High, 0–No Correlation

**I YEAR
SEMESTER –I**

S. No	Course Category	Course code	Title of the course	Hrs/ Week			Credit Points	Max Marks		
				L	T	P		CIA	ESE	Total
1	Part - I Core - I	24S1PMI01	Introductory Microbiology and Microbial Diversity	6	-		5	25	75	100
2	Part - I Core II	24S1PMI02	Immunology, Immunomics and Microbial Genetics	6	-		5	25	75	100
3	Part - I Core III	24S1PMIP01	Practical-I	-		6	4	40	60	100
4	Part - I Elective I	24S1PMIE01	Forensic Science	5	-		3	25	75	100
		24S1PMIE02	Health and Hygiene							
		24S1PMIE03	Micro Algal Technology							
5	Part - I Elective II	24S1PMIE04	Bioresearch Instrumentation	5	-		3	25	75	100
		24S1PMIE05	Herbal Technology and Cosmetic Microbiology							
		24S1PMIE06	Essentials of Laboratory Management and Biosafety							
				22		06	20			500

SEMESTER –II

1	Part – I Core IV	24S2PMI03	Medical Bacteriology and Mycology	6	-		5	25	75	100
2	Part – I Core V	24S2PMI04	Medical Virology and Parasitology	6	-		5	25	75	100
3	Part – I Core VI	24S2PMIP02	Practical-II	-		6	5	40	60	100
4	Part – I Elective III	24S2PMIE07	Epidemiology	4	-		3	25	75	100
		24S2PMIE08	Clinical and Diagnostic Microbiology							
		24S2PMIE09	Bioremediation							
5	Part – I Elective IV	24S2PMIE10	Bioinformatics	4	-		3	25	75	100
		24S2PMIE11	Nanobiotechnology							
		24S2PMIE12	Clinical Research and Clinical Trials							
6	Part – II Skill Enhancement Course: I	24S2PMIN01	Vermitechnology	2	-		2	25	75	100
7	Common Paper	24S2PHR01	Fundamentals of Human Rights	2			1			100
				24		06	24			700

**SECOND YEAR
SEMESTER-III**

S.No	Course Category	Course code	Title of the course	Hrs/ Week			Credit Points	Max Marks		
				L	T	P		CI A	ES E	Total
1	Part - I Core VII	24S3PMI05	Soil and Environmental Microbiology	6	-	-	5	25	75	100
2	Part -I Core VIII	24S3PMI06	Molecular Biology and Recombinant DNA Technology	6	-	-	5	25	75	100
3	Part - I Core IX	24S3PMIP03	Practical-III		-	6	5	40	60	100
4	Part - I Core X Industry	24S3PMI07	Fermentation Technology and Pharmaceutical Microbiology	6	-	-	4	25	75	100
5	Part - I Elective V	24S3PMIE13	Biosafety, Bioethics and IPR	5	-	-	3	25	75	100
		24S3PMIE14	Molecular modeling and drug designing							
		24S3PMIE15	Water Conservation and Water Treatment Technologies							
6	Part - I Core	24S3PIT01	Internship / Industrial Activity	-	-	-	2	-	-	-
7	Part –III Skill Enhancement Course II	24S3PMIN02	Organic Farming and Biofertilizer Technology	3	-	-	2	25	75	100
Total				24		06	26			600
SEMESTER –IV										
1	Part – I Core X	24S4PMI08	Food and Dairy Microbiology	6	-	-	5	25	75	100
2	Part – I Core XI	24S4PMI09	Research Methodology and Biostatistics	6	-	-	5	25	75	100
3	Part – I Core XII	24S4PMIPR01	Project With Viva voce	-	-	10	7	40	60	100
4	Part – II Elective - VI	24S4PMIE16	Bioenergy	4	-	-	3	25	75	100
		24S4PMIE17	Essentials of Bio-Entrepreneurship							
		24S4PMIE18	Life Science For Competitive Examinations							
5	Part – III Skill Enhancement Course II	24S4PMIS01	Microbial Quality Control and Testing	4	-	-	2	25	75	100
		24S4PEX01	Extension Activity		-	-	1	-	-	-
Total				20	0	10	23			500

SEMESTER -I

FIRST YEAR SEMESTER –I**CORE I– INTRODUCTORY MICROBIOLOGY AND MICROBIAL DIVERSITY**

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI01	Core –I	Theory	Y	Y	-	6	5

Learning Objectives

- ❖ To acquire knowledge on the principles of different types of microscope applications.
- ❖ To compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
- ❖ To exemplify, isolate and cultivate microalgae from diverse environmental sources.
- ❖ To explain various pure culture techniques and discuss sterilization methods.
- ❖ To discuss the importance and conservation of microbial diversity.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	PO1, PO4, PO10
CO2	Differentiate and appreciate the anatomy of various microbes. Plan the growth of microbes for different environmental conditions.	PO1, PO4
CO3	Identify and cultivate the algae understanding their habitat. Analyze the morphology, classify and propagate depending on its economic importance.	PO7, PO8, PO9
CO4	Create aseptic conditions by following good laboratory practices.	PO3, PO4, PO7
CO5	Categorize and cultivate a variety of extremophiles following standard protocols for industrial applications.	PO5, PO7, PO8, PO9

CORE I –INTRODUCTORY MICROBIOLOGY AND MICROBIAL DIVERSITY

Unit	Details	No. of Hours
I	Historical Foundations and Scope of Microbiology: Contributions of Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Role of microorganisms in Medical microbiology and immunology, Industrial Microbiology, Agricultural microbiology.	18
II	Microscopy- Bright field and dark field microscopy, Fluorescence Phase contrast Microscopy, Electron Microscopy (SEM &TEM), Confocal microscopy and Micrometry. Staining methods – Simple, Differential and Special staining.	18
III	Cell organization: Bacterial Structure, properties and biosynthesis of cellular components – Cell wall and. Sporulation. Growth and nutrition – Nutritional requirements, Growth curve, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth. Fungi -Distribution, morphology, classification, reproduction and economic importance, Algae - Distribution, morphology, classification, reproduction and economic importance Poster Preparation-Bacteria/ Fungi	18
IV	Laboratory techniques: Sterilization, Disinfection and its validation. Pure cultures techniques – Cultivation of Anaerobic organisms. Automated Microbial identification systems. Maintenance and preservation of pure cultures. Culture collection centres –National and International (NRM, IMTECH, ATCC & PCCC).	18
V	Extremophiles: Thermophiles - Classification, Thermophilic archaeobacteria and its applications. Methanogens - Classification, Habitats, applications. Alkaliphiles and Acidophiles - Classification, discovery basin, its cell wall and membrane. Barophiles- Classification and its applications. Halophiles - Classification, Osmoadaptation / halotolerance - Applications of halophiles. Self Study- Economic importance of extremophiles	18
	Total	90
• Poster preparation – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
- ❖ Chan E.C.S., Michael Pelczar. J. (2023-2024). Microbiology. (5th Edition). Mc.Graw Hill. Inc, New York.
- ❖ Prescott L. M., Dorothy Wood.,(2023). Microbiology. (12th Edition). McGraw - Hill company, New York.
- ❖ White D. Drummond J. and Fuqua C. (2011). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.
- ❖ Dubey R.C. and Maheshwari D. K. (2022). Textbook of Microbiology. S. Chand, Limited.

References Books

- ❖ Tortora G. J., Funke B. R. and Case C. L. (2015). Microbiology: An Introduction (12th Edition). Pearson, London, United Kingdom
- ❖ Webster J. and Weber R.W.S. (2007). Introduction to Fungi. (3rd Edition). Cambridge University Press, Cambridge.
- ❖ Schaechter M. and Leaderberg J. (2004). The Desk encyclopedia of Microbiology. Elsevier Academic Press, California.
- ❖ Ingraham, J.L. and Ingraham, C.A. (2000) Introduction to Microbiology. (2nd Edition). Books / Cole Thomson Learning, UK.
- ❖ Madigan M. T., Bender K.S., Buckley D. H. Sattley W. M. and Stahl (2018) Brock Biology of Microorganisms. (15th Edition). Pearson.

Web Resources

- ❖ <http://sciencenetlinks.com/tools/microbeworld>
- ❖ <https://www.microbes.info/>
- ❖ <https://www.asmscience.org/VisualLibrary>
- ❖ <https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404>
- ❖ https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	3	0	0	0	0	0	3
CO2	2	0	0	3	0	0	0	0	0	0
CO3	0	0	0	0	0	3	3	3	0	0
CO4	0	0	3	3	0	3	0	0	0	0
CO5	0	0	0	0	3	3	3	3	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

CORE II - IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI02	Core –II	Theory	Y	Y	-	6	5

Learning Objectives

- ❖ To discuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties
- ❖ To describe immunoglobulin and its types. Categorize MHC and understand its significance.
- ❖ To elucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
- ❖ To acquire knowledge the structure DNA in prokaryotes and eukaryotes.
- ❖ To explain out gene transfer studies in microbes.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity.	PO1, PO4, PO10
CO2	Justify the significance of MHC molecules in immune response and antibody production.	PO1, PO4
CO3	Design antibodies and evaluate immunological assays in patient samples.	PO7, PO8, PO9
CO4	Analyze genomic DNA of prokaryotes and eukaryotes.	PO3, PO4, PO7
CO5	Summarize gene transfer mechanisms for experimental study.	PO5, PO7, PO8, PO9

CORE II - IMMUNOLOGY, IMMUNOMICS AND MICROBIAL GENETICS

Unit	Details	No. of Hours
I	Physiology of 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.	18
II	Immunoglobulins: Theories of antibody production. 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, Humoral Immunity, CMI – Cell mediated cytotoxicity, DTH response. Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies.	15
III	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. Immunomics - Introduction and Applications. Report writing on Clinical Laboratory Visit	21
IV	Genomic Structure of prokaryotic and eukaryotic: 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. Power point presentation on Replication	18
V	Gene Transfer Mechanisms: Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of <i>E. coli</i> , Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.	18
	Total	90
• Power point preparation & Clinical Laboratory Visit – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.
- ❖ Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.
- ❖ Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10th Edition). Elsevier.
- ❖ Malacinski G.M. (2015). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi. Gardner E. J. Simmons M. J. and Snusted

References Books

- ❖ Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.
- ❖ Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell.
- ❖ Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4th Edition). Wiley-Blackwell.
- ❖ Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.
- ❖ Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition

Web Resources

- ❖ <https://www.ncbi.nlm.nih.gov/books/NBK279395/>
- ❖ <https://med.stanford.edu/immunol/phd-program/ebook.html>
- ❖ <https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/>
- ❖ [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download – Study Materialz.in
- ❖ <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications>.

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	2	0	2	0	0	3	0
CO2	3	0	0	3	2	3	3	0	3	0
CO3	0	0	0	3	0	3	3	3	3	2
CO4	0	0	0	3	3	3	2	0	3	2
CO5	0	0	0	3	3	3	2	0	3	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

CORE III - PRACTICAL - I

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMIP01	Core –III	Practical -I	-	-	Y	6	4

Learning Objectives

- ❖ To gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.
- ❖ To prepare media for bacterial growth. Discuss plating and growth measurement techniques.
- ❖ To acquire adequate skills to perform blood grouping and serological reactions.
- ❖ To provide fundamental skills in preparation, separation and purification of immunoglobulin.
- ❖ To apply the knowledge of molecular biology skills in clinical diagnosis.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Apply microscopic techniques and staining methods in the identification and differentiation of microbes	PO1,PO6, PO7, PO8,
CO2	Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	PO1, PO6, PO7, PO8,
CO3	Perform and evaluate immunological reactions to aid diagnosis	PO5, PO7, PO8, PO9,
CO4	Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	PO6, PO7, PO8, PO9,
CO5	Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	PO6, PO7, PO8, PO9

CORE III - PRACTICAL - I

Unit	Details	No. of Hours
I	Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Sterilization methods: moist heat, dry heat, and filtrations - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.	18
II	Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities. Microbial Physiology: Purification and maintenance of microbes. Streak plates, pour plate, and slide culture technique. Aseptic transfer. Direct counts –Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.	20
III	Blood Grouping, 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 Rocket immuno electrophoresis and Counter current immuno electrophoresis.	18
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.	15
V	Western Blotting – Demonstration. Isolation of genomic DNA from <i>E. coli</i> 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 <i>E.coli</i> . RNA isolation from yeast. RNA estimation by Orcinol method.	19
	Total	90

Text Books

- ❖ Dubey R.C. and Maheshwari D. K. (2023). Practical Microbiology. S. Chand. (4th Edition)
- ❖ Cappuccino, J. and Sherman, N. (2014). Microbiology: A Laboratory Manual, (10th Edition). Pearson Education, Publication, New Delhi.
- ❖ Cullimore D. R. (2010). Practical Atlas for Bacterial Identification. (2nd Edition). -Taylor & Francis.
- ❖ Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
- ❖ 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.
- ❖ Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.

References Books

- ❖ Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
- ❖ Gupta P. S. (2003). Clinical Immunology. Oxford University Press.
- ❖ 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.
- ❖ Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt Ltd.

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	0	3	2	3	3	0
CO2	2	0	0	0	0	3	2	3	3	0
CO3	0	0	0	0	3	0	3	3	3	0
CO4	0	0	0	0	0	3	3	3	3	0
CO5	0	0	0	0	0	3	3	3	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE I - FORENSIC SCIENCE

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMIE01	Elective I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To understand the Scope, need and learn the tools and techniques in forensic science.
- ❖ To comprehend organizational setup of a forensic science laboratory.
- ❖ To Identify and Examine body fluids for identification.
- ❖ To extract DNA from blood samples for investigation.
- ❖ To recognize medico legal post mortem procedures and their importance.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Identify the scope and need of forensic science in the present scenario.	PO1,PO6, PO7, PO8,
CO2	Plan for the organizational setup and functioning of forensic science laboratories.	PO1, PO6, PO7, PO8,
CO3	Analyze the biological samples found at the crime scene.	PO5, PO7, PO8,
CO4	Perform extraction and identification of DNA obtained from body fluids.	PO6, PO7, PO8, PO9,
CO5	Discuss the concept of forensic toxicology	PO6, PO7, PO8,

ELECTIVE I - FORENSIC SCIENCE

Unit	Details	No. of Hours
I	History of Development of Forensic Science in India- 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.	15
II	Forensic Science Laboratories in India- 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.	15
III	Forensic serology: Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.	15
IV	Forensic DNA Typing: 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. Power point Presentation- DNA testing in disputed paternity.	15
V	Forensic toxicology: Introduction and concept of forensic toxicology. Medico legal post mortem and their examination. Poisons - Types of poisons and their mode of action. Self study-Testing of chemical nature of poisonous material.	15
	Total	75
• Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3rd Edition). CRC Press, New York. ISBN-10:1498720196.
- ❖ 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.
- ❖ Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
- ❖ Val Mc Dermid (2014). Forensics. (2nd Edition). ISBN 9780802125156.

- ❖ Sharma B.R (2020) Forensic science in criminal investigation and trials. (6thEdition)Universal Press.
- ❖ Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12thEdition).Pearson Press.

References Books

- ❖ Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, New York. ISBN:0-8493-8122-3.
- ❖ 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.
- ❖ Lincoln, P.J. and Thomson, J. (1998). (2ndEdition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
- ❖ Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2ndEdition). CRC Press.

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	0	3	2	2	3	0
CO2	3	0	0	0	0	3	2	2	3	0
CO3	2	0	0	0	3	0	3	2	3	0
CO4	3	0	0	0	0	3	3	2	3	0
CO5	3	0	0	0	0	3	3	2	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE I - HEALTH AND HYGIENE

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI E02	Elective I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To acquire knowledge on hygiene and live healthy.
- ❖ To provide insights on health laws for food safety and hygiene.
- ❖ To explain health, physical exercises and their importance.
- ❖ To illustrate mental hygiene and involved in mental hygiene.
- ❖ To describe the various health and health education programmes by the government.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Identify factors affecting health and health habits.	PO1, PO5, PO10
CO2	Execute the knowledge of ventilation and lighting. Justify Health laws for food safety and hygiene.	PO5, PO10
CO3	Follow personal hygiene to avoid diseases and Prevent people from health-destroying habits and addictions.	PO5, PO10
CO4	Explore Mental hygiene and maintain emotional stability.	PO5, PO10
CO5	Participate in health education programmes.	PO1, PO5, PO10

ELECTIVE I - HEALTH AND HYGIENE

Unit	Details	No. of Hours
I	Importance of Hygiene: Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.	15
II	Nutrition and Health: Balanced diet, Food surveillance, food Fortification, adulteration and preventive measures. Health laws for food safety. Environmental and housing hygiene, Ventilation and lighting.	15
III	Personal hygiene and Physical Practices: physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief, Sun bathing, Colon Hygiene. Health destroying habits and addictions-Pan, Supari, ganja, drinking, smoking, tea and coffee. International control of health, WHO. PowerPoint Presentation: My Physical Practices	15
IV	Mental hygiene and health: factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adult hood and oldage. Mental health occupational hazards.	15
V	Health programme and Health Policy: Determinants of health, Key Health Indicators, Health Education, Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive And Child health programmes (RCH). National Health Policy of Govt. of India. Poster Presentation-RDA and Malnutrition.	15
	Total	75
• Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Bamji M. S., Krishnaswamy K. and Brahman G. N. V. (2019). Textbook of Human Nutrition. (4th Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
- ❖ Swaminathan (1995) Food & Nutrition (Vol I) (2nd Edition). The Bangalore Printing & Publishing Co Ltd., Bangalore.
- ❖ Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd
- ❖ Lindsay Dingwall (2010). Personal Hygiene Care
- ❖ Walter C. C. Pakes (1900). The Science of Hygiene: a Text-book of Laboratory Practice. (London: Methuen and Co.,). and Health, Kalyan Publishers, New Delhi.
- ❖ Srilakshmi, B. (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi.
- ❖ Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.

References Books

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

Web Resources

- ❖ Health and Hygiene - Personal Hygiene, Community Hygiene and Diseases (vedantu.com)
- ❖ Chapter-32.pdf (nios.ac.in)
- ❖ Menstrual Health and Hygiene Guide | Student Health and Counseling Services (ucdavis.edu)
- ❖ <https://nap.nationalacademies.org/read/11756/chapter/13>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	3	0	0	0	0	2
CO2	0	0	0	0	3	0	0	0	0	2
CO3	0	0	0	0	3	0	0	0	0	1
CO4	0	0	0	0	3	0	0	0	0	2
CO5	2	0	0	0	3	0	0	0	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE I- MICRO ALGAL TECHNOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMIE03	Elective I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To characterize the different groups of algae.
- ❖ To describe the cultivation and harvesting of algae.
- ❖ To identify the commercial applications of various algal products.
- ❖ To apply microalgae for environmental applications.
- ❖ To employ microalgae as alternate fuels.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Acquire knowledge in the field of microalgal technology and their characteristics.	PO1
CO2	Identify the methods of algal cultivation and harvesting.	PO1, PO6
CO3	Recognize and recommend the use of microalgae as food, feed and fodder.	PO7, PO8, PO9
CO4	Promote microalgae in phycoremediation.	PO7, PO9,
CO5	Compare and critically evaluate recent applied research in these micro algal applications.	PO7, PO8, PO9

ELECTIVE I- MICRO ALGAL TECHNOLOGY

Unit	Details	No. of Hours
I	Introduction to Phycology: General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Identification methods. Economically important microalgae.	15
II	Isolation and culturing of Algae: Growth media. Isolation and enumeration of microalgae. Laboratory cultivation and maintenance. Outdoor cultivation - Photobioreactors - construction, types and operation; raceway ponds - Heterotrophic and mixotrophic cultivation - Harvesting of microalgae biomass.	15
III	Commercial values of Microalgae: Algal single cell proteins (<i>Spirulina</i> and <i>Dunaliella</i>). Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - microalgal carotenoids and Phycobiliproteins their commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications. Power point presentation on Spirulina and Azolla cultivation	15
IV	Phycoremediation: Domestic and industrial waste water treatment. High-rate algal ponds and surface-immobilized systems - Treatment of gaseous wastes by microalgae. Sequestration of carbon dioxide. Scavenging of heavy metals by microalgae. Negative effects of algae. Algal blooms, algicides for algal control.	15
V	Microalgae as feed stock for production of biofuels: Carbon-neutral fuels. Lipid-rich algal strains - <i>Botryococcus braunii</i> . Drop-in fuels from algae -hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas from microalgae biomass. Biocrude synthesis from microalgae. Analysis of algae biofuels. Self study – Preparing of Algal biofuels.	15
	Total	75
Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Lee R.E. (2008). Phycology. Cambridge University Press.
- ❖ Sharma O.P. (2011). Algae. Tata McGraw-Hill Education.
- ❖ Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.
- ❖ Lele. S.S., Jyothi Kishen Kumar (2008). Algal bio process technology. New Age International P(Ltd) .
- ❖ Das., Mihirkumar. Algal Biotechnology. Daya Publishing House, New Delhi.

References Books

- ❖ Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.
- ❖ Bux F. (2013). Biotechnological Applications of Microalgae: Biodiesel and Value-added Products. CRC Press.
- ❖ Singh B., Baudh K., Bux, F. (2015). Algae and Environmental Sustainability. Springer.
- ❖ Das D. (2015). An algal biorefinery: An integrated approach. Springer.
- ❖ Bux F. and Chisti Y. (2016). Algae Biotechnology: Products and Processes. Springer.

Web Resources

- ❖ <https://www.classcentral.com/course/algae-10442>
- ❖ https://onlinecourses.nptel.ac.in/noc19_bt16/preview
- ❖ <https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46>
- ❖ <https://nptel.ac.in/courses/103103207>
- ❖ <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	2	0	0	0	0
CO3	0	0	0	0	0	0	3	3	3	0
CO4	0	0	0	0	0	0	3	0	3	0
CO5	0	0	0	0	0	0	2	3	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE II - BIORESEARCH INSTRUMENTATION

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI E04	Elective II	Theory	Y	Y		5	3

Learning Objectives

- ❖ To explain the principles and working mechanisms of laboratory instruments.
- ❖ To discuss chromatography techniques and molecular biology techniques.
- ❖ To illustrate molecular techniques in biological applications.
- ❖ To acquire knowledge on spectroscopic techniques
- ❖ To demonstrate the use of radio isotopes in various techniques.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Make use of the laboratory instruments- laminar air flow, pH meter, centrifugation methods, biosafety cabinets following SOP.	PO4, PO6, PO7, PO8, P10
CO2	Apply chromatography techniques in the separation of biomolecules.	PO4, PO6, PO7, PO8, P10
CO3	Perform molecular techniques like mutagenesis and their detection.	PO4, PO6, PO7,
CO4	Estimate molecules in biological samples by adopting UV spectroscopic techniques.	PO4, PO6, PO7, PO8, P10
CO5	Cultivate organisms anaerobically.	PO4, PO6, PO7, PO8, P10

ELECTIVE II - BIORESEARCH INSTRUMENTATION

Unit	Details	No. of Hours
I	Basic laboratory Instruments: Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation co-efficient; Principles, methodology and applications of differential, rate, zonal and density gradient centrifugation- Applications In determination of molecular weight.	15
II	Biomolecules separation Techniques: Chromatographic 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).	15
III	Separation of Biomolecules by Electrophoresis: General principles - 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, Immunoelectrophoresis. Blotting techniques-Southern, northern and western blotting.	15
IV	Spectroscopic techniques: Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH. Power point presentation on GC-MS	15
V	Radioisotopic techniques: Principle and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, auto radiography and its applications. Commonly use di-isotopes in biology, labeling procedures and safety aspects. Self study- Standard Operating Procedures.	15
	Total	75
Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	0	0	0	3	0	2	2	3	0	3
CO2	0	0	0	3	0	2	2	3	0	3
CO3	0	0	0	3	0	3	3	3	0	3
CO4	0	0	0	3	0	2	3	3	0	3
CO5	0	0	0	3	0	2	3	3	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE II- HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI E05	Elective II	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To impart knowledge of Indian Medicinal Plants and their applications in microbiology.
- ❖ To promote the technical skills involved in preparation of different types of plant extracts.
- ❖ To explain methods to analyze the antimicrobial activity of medicinal plants.
- ❖ To acquire knowledge on cosmetic microbiology and role of microorganisms in cosmetics.
- ❖ To gain insight into pharmacopeial microbial assays and biosafety.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Identify the applications of Indian medicinal plants in treating diseases.	PO1, PO5
CO2	Identify and authenticate herbal plants.	PO6, PO7
CO3	Evaluate the antimicrobial activity of medicinal plants.	PO4, PO6,
CO4	Describe the role of microorganisms and their metabolites in the preparation of cosmetics.	PO1, PO5, PO7
CO5	Validate procedures and biosafety measures in the mass production	PO6, PO7

ELECTIVE II- HERBAL TECHNOLOGY AND COSMETIC MICROBIOLOGY

Unit	Details	No. of Hours
I	Concepts of Herbal medicine: Indian medicinal plants: Scope and Applications of Indian medicinal plants in treating bacterial, fungal and viral diseases. Basic principles involved in Ayurvedha, Sidha, Unani and Homeopathy.	15
II	Collection and authentication of selected Indian medicinal plants: <i>Emblica officinalis</i> , <i>Withania somnifera</i> , <i>Phyllanthus amarus</i> , <i>Tinospora cordifolia</i> , <i>Andrographis paniculata</i> , <i>Piper longum</i> , <i>Ocimum sanctum</i> , <i>Azardirchata indica</i> , <i>Terminalia chebula</i> , <i>Allium sativum</i> . Preparation of extracts- Hot and cold methods. Preparation of stock solutions.	15
III	Antimicrobial activity of selected Indian medicinal Plants: In vitro determination of antibacterial and fungal activity of selected whole medicinal plants/ parts – well-diffusion methods. MIC - Macro and micro dilution techniques. Antiviral activity- cell lines- cytotoxicity, cytopathic and non-cytopathic effect.	15
IV	Cosmetic Microbiology: Need for cosmetic microbiology, Scope of cosmetic microbiology- Role of microbes in cosmetic preparation. Preservation of cosmetics. Antimicrobial properties of natural cosmetic products – Garlic, neem, turmeric, aloe vera and tulsi. Sanitary practices in cosmetic manufacturing - HACCP protocols in cosmetic microbiology.	15
V	Microbiological test for Cosmetics: Antimicrobial preservative efficacy, microbial content testing and biological toxicological testing. Validation methods -bioburden and Pharmacopeial microbial assays. Preservatives of cosmetics - Global regulatory and toxicological aspect of cosmetic preservatives. Report making on -Making herbal Antirepellents product / mosquito coil.	15
	Total	75
• Report making – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.
- ❖ Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN: 8178330911.
- ❖ Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.
- ❖ Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3rd Edition). CRC Press. ISBN: 9780429113697.
- ❖ Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press. ISBN-10:0849337135.

References Books

- ❖ Indian Herbal Pharmacopoeia (2002). Vol. I & II Indian Drug Manufacturers Association, Mumbai.
- ❖ British Herbal Pharmacopoeia.(1990).Vol.I. British Herbal Medicine Association.ISBN: 0903032090.
- ❖ Verpoorte R. and Mukherjee, P. K. (2010). GMP for Botanicals: Regulatory and Quality issues on Phytomedicines. In GMP for botanicals: regulatory and quality issues on phytomedicines. (2nd edition). Saujanya Books, Delhi.ISBN-10:81-900788-5-2/8190078852. ISBN-13:978-81-900788-5-6/9788190078856.
- ❖ Turner R. (2013). Screening methods in Pharmacology. Elsevier. ISBN:9781483264233.
- ❖ Cupp M. J. (2010). Toxicology and Clinical Pharmacology of Herbal Products (pp. 85-93). M. J. Cupp. Humana Press.Totowa, NJ, USA. ISBN-10:1617371904.

Web Resources

- ❖ https://www.academia.edu/50236711/Modern_Extraction_Methods_for_Preparation_of_Bioactive_Plant_Extracts
- ❖ https://www.nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl
- ❖ <https://pubmed.ncbi.nlm.nih.gov/17004305/>
- ❖ <https://pubmed.ncbi.nlm.nih.gov/15156038/>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	3	0	0	0	0	0
CO2	0	0	0	0	0	3	2	0	0	0
CO3	0	0	0	3	0	3	0	0	3	0
CO4	2	0	0	0	3	0	3	0	0	0
CO5	0	0	0	0	0	2	3	0	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE II- ESSENTIALS OF LABORATORY MANAGEMENT AND BIOSAFETY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S1PMI E06	Elective II	Theory	Y	Y	-	5	3

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Employ skills on laboratory safety and avoid laboratory accidents.	PO1, PO2, PO3, PO7,
CO2	Prevent laboratory hazards by practicing safety strategies.	PO2, PO5, PO7, PO10
CO3	Practice various first aid procedures during common laboratory accidents.	PO1, PO2, PO3, PO5, PO10, PO11
CO4	Ensure biosafety strategies in laboratory.	PO2, PO3, PO4, PO7,
CO5	Recognize the importance of biosafety guidelines.	PO3, PO4, PO5,

ELECTIVE II- ESSENTIALS OF LABORATORY MANAGEMENT AND BIOSAFETY

Unit	Details	No. of Hours
I	Principles of Laboratory Management: General laboratory facilities, Occupational safety- Lab accidents - Fires, chemical burns, slips and falls, Animal bites. Cuts from broken glass. Toxic fume inhalation. General laboratory rules, Good laboratory practice (GLP). Laboratory plan.	15
II	Laboratory hazards: Chemical hazards- Safe handling of chemicals and gases, hazard labels and symbols. Material safety datasheet (MSDS), Chemical handling - Fume hood, Storage of chemicals. Chemical Waste Disposal Guideline. Physical hazards - Physical agent data sheets (PADS), Electric hazards- Electrical shock, Electrical explosions, Electrical burns. Safe work practices. Potential ignition sources in the lab. Stages of Fire. Fire Extinguishers. Fire Response.	15
III	Safety precautions & First aid for laboratory accidents: Personal protective equipment (PPE), Proper attire (Eye/Face Protection, laboratory coats, gloves, respirators. Disposal/Removal of PPE. Emergency equipment safety - Showers/ Eye Washes. Laboratory security and emergency response. First aid for - Injuries caused by broken glass, Acid/Alkali splashes on the skin, swallowing acid/alkali, burns caused by heat, electric shock.	15
IV	Introduction to Biosafety: Biological safety cabinets. Primary containment for biohazards. Biosafety levels of specific microorganisms recommended biosafety. Risk groups with examples - Risk assessment. Packing, sending, transport, import and export of biological agents. Hygiene, disinfection, decontamination, sterilization. Power point Presentation - Safe working, hand hygiene	15
V	Biosafety regulations and guidelines: Centers for disease control and prevention and the National institutes of health. Recombinant DNA advisory committee (RDAC), Institutional biosafety committee (IBSC), Review committee on genetic manipulation (RCGM), Genetic engineering approval committee (GEAC). Implementation of biosafety guidelines. Self Study-Members of various Committees	15
	Total	75
• Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Ayurvedic Formulary of India. (2011). Part 1, 2 & 3. Pharmacopoeia Commission for Indian Medicine and Homeopathy. ISBN-10:8190648977.
- ❖ Panda H. (2004). Handbook on herbal medicines. Asia Pacific Business Press Inc. ISBN:8178330911.
- ❖ Mehra P. S. (2019). A Textbook of Pharmaceutical Microbiology. Dreamtech Press. ISBN 13:9789389307344.
- ❖ Geis P. A. (2020). Cosmetic microbiology: A Practical Approach. (3rd Edition). CRC Press. ISBN:9780429113697.
- ❖ Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press. ISBN-10:0849337135.

References Books

- ❖ World Health Organization, Biosafety programme management. (2010). (4th Edition). WHO Publications.
- ❖ Rashid N. (2013). Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides) (1st Edition).
- ❖ Dayuan X. (2015). Biosafety and Regulation for Genetically Modified Organisms, Alpha Science International Ltd, ISBN-10 : 1842657917
- ❖ Ochei J. Kolhatkar(2000). A. (Medical Laboratory Science – Theory and Practice. ISBN; 13:978-0074632239.
- ❖ Brannan D. K. (1997). Cosmetic microbiology: A Practical Handbook. CRC Press. ISBN-10:0849337135.

Web Resources

- ❖ <https://www.cdc.gov/labs/pdf/CDC-Biosafety%20regulation.pdf>
- ❖ <https://consteril.com/biosafety-levels-difference/>
- ❖ <https://www.cdc.gov/labs/pdf/CDC-BiosafetymicrobiologicalBiomedicalLaboratories-2009-P.pdf>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	0	0	0	0	3	0	0	0
CO2	0	3	0	0	3	0	3	0	0	0
CO3	3	3	3	0	3	0	0	0	0	3
CO4	0	3	3	2	0	0	3	0	0	3
CO5	0	0	3	3	3	0	3	0	0	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

SEMESTER -II

CORE IV-MEDICAL BACTERIOLOGY AND MYCOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMI03	Core – IV	Theory	Y	Y	-	6	5

Learning Objectives

- ❖ To acquire knowledge on collection, transportation and processing of various kinds of clinical specimens.
- ❖ To explain morphology, characteristics and pathogenesis of bacteria.
- ❖ To discuss various factors leading to pathogenesis of bacteria.
- ❖ To acquire knowledge on antifungal agents and their importance.
- ❖ To describe various diagnostic methods available for fungal disease diagnosis.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Collect, transport and process of various kinds of clinical specimens.	PO1,PO5,PO9
CO2	Analyze various bacteria based on morphology and pathogenesis.	PO1,PO5,PO9
CO3	Discuss various treatment methods for bacterial disease.	PO1,PO5,PO9
CO4	Employ various methods detect fungi in clinical samples and apply knowledge on antifungal agents.	PO5,PO9
CO5	Apply various immunodiagnostic method to detect fungal infections.	PO5,PO9

CORE IV - MEDICAL BACTERIOLOGY AND MYCOLOGY

Unit	Details	No. of Hours
I	Pathogenesis of Bacterial Infection: Normal flora of human body, Bacterial virulence factors, Regulation of bacterial virulence factors. Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice. laboratory animals– Rabbits, guinea pigs and mice.	18
II	Pathogenesis of G+ve Bacteria: Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of <i>Staphylococci</i> , <i>Streptococci</i> , <i>Pneumococci</i> , <i>Neisseriae.</i> , <i>Bacillus</i> , <i>Corynebacteria</i> , <i>Mycobacteria</i> and <i>Clostridium</i> .	18
III	Pathogenesis of G-ve Bacteria: Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, <i>Yersinia</i> , <i>Pseudomonas</i> , <i>Vibrio</i> , <i>Mycoplasma</i> , <i>Helicobacter</i> , <i>Rickettsiae</i> , <i>Chlamydiae</i> , <i>Bordetella</i> , <i>Francisella</i> , <i>Spirochaetes- Leptospira</i> , <i>Treponema</i> and <i>Borrelia</i> . Nosocomial, zoonotic and opportunistic infections -prevention and control. Field Visit- Report Preparation (Clinical Lab- Processing of sample)	18
IV	Superficial Mycoses: Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. <i>Trichophyton</i> , <i>Epidermophyton</i> & <i>Microsporum</i> . Yeasts of medical importance – <i>Candida</i> , <i>Cryptococcus</i> . Mycotoxins. Antifungal agents, testing methods and quality control.	18
V	Systemic mycoses: <i>Histoplasma</i> , <i>Coccidioides</i> , <i>Sporothrix</i> , <i>Blastomyces</i> . Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immune compromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents. Self study – Development of multidrug resistance	18
	Total	90
• Field Visit& Report Preparation – related to the above topic are to be considered for Internal Exam only		

Text Books

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

References Books

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

Web Resources

- ❖ <https://www.cdc.gov/labs/pdf/CDC->
- ❖ <https://microbiologysociety.org/members-outreach-resources/links.html>
- ❖ <https://www.pathelective.com/micro-resources>
- ❖ <http://mycology.cornell.edu/fteach.html>
- ❖ <https://www.adelaide.edu.au/mycology>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	3	0	0	0	2	0
CO2	2	0	0	0	3	0	0	0	2	0
CO3	2	0	0	0	3	0	0	0	2	0
CO4	0	0	0	0	3	0	0	0	2	0
CO5	0	0	0	0	3	0	0	0	2	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

CORE V - MEDICAL VIROLOGY AND PARASITOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMI04	Core –V	Theory	Y	Y	-	6	5

Learning Objectives

- ❖ To describe the replication strategy and cultivation methods of viruses.
- ❖ To acquire knowledge about oncogenic virus and human viral infections.
- ❖ To develop diagnostic skills, in the identification of virus infections.
- ❖ To impart knowledge about parasitic infections.
- ❖ To develop diagnostic skills, in the identification of parasitic infections.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Cultivate viruses by different methods and aid in diagnosis. Perform purification and viral assay.	PO5, PO7, PO8, PO10
CO2	Investigate the symptoms of viral infections and presumptively identify the viral disease.	PO5, PO7, PO8, PO10
CO3	Diagnose various viral diseases by different methods.(serological, conventional and molecular)	PO5, PO7, PO8, PO10
CO4	Educate public about the spread, control and prevention of parasitic diseases.	PO5, PO7, PO8, PO10
CO5	Identify the protozoans and helminthes present in stool and blood specimens. Perform serological and molecular diagnosis of parasitic infections.	PO5, PO7, PO8, PO10

CORE V – MEDICAL VIROLOGY AND PARASITOLOGY

Unit	Details	No. of Hours
I	General features of viruses: Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic Acids studies). Infectivity Assays.	18
II	Mode of infection, Pathogenesis, diagnosis and Prevention and Control of viral infection: DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and re-emerging viral infections.	18
III	Bacteriophages: Φ X 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics.	18
IV	Medical Parasitology: Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – <i>Entamoeba</i> , Aerobic and Anaerobic amoebae, <i>Giardia</i> , <i>Trichomonas</i> , <i>Balantidium</i> . <i>Toxoplasma</i> , <i>Cryptosporidium</i> , <i>Leishmania</i> , and <i>Trypanasoma</i> .	18
V	Medical Helminthology: Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for Cestodes – <i>Taenia Solium</i> , <i>T. Saginata</i> , <i>T. echinococcus</i> . Trematodes – <i>Fasciola hepatica</i> , <i>Fasciolopsis Buski</i> , <i>Paragonimus</i> , <i>Schistosomes</i> . Nematodes - <i>Ascaris</i> , <i>Ankylostoma</i> , <i>Trichuris</i> , <i>Trichinella</i> , <i>Enterobius</i> , <i>Strongyloides</i> and <i>Wuchereria</i> . Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Anti-protozoan drugs. Power point Presentation Antiparasitic Agents	18
	Total	90
Power point Presentation – related to the above topic are to be considered for Internal Exam only		

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	0	0	0	0	3	0	3	2	0	3
CO2	0	0	0	0	3	0	3	2	0	3
CO3	0	0	0	0	3	0	3	2	0	3
CO4	0	0	0	0	3	0	3	2	0	3
CO5	0	0	0	0	3	0	3	2	0	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

CORE IV - PRACTICAL –II

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIP02	Practical	Practical	-	-	Y	6	4

Learning Objectives

- ❖ To develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
- ❖ To impart knowledge on fungal infections and its diagnosis.
- ❖ To diagnose parasitic diseases.
- ❖ To gain knowledge about industrially important microbes.
- ❖ To screen and utilize microorganisms for effective industrial production of metabolites.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Collection of different clinical samples, transport, culture and examination.	PO7, PO8, PO9
CO2	Identify medically important bacteria, fungus and parasites from the clinical samples by staining and biochemical tests.	PO7, PO8, PO9
CO3	Promote diagnostic skills; interpret laboratory tests in the diagnosis of infectious diseases.	PO7, PO8, PO9, PO10
CO4	Perform antibiotic sensitivity tests and compare with the standard tests.	PO7, PO8, PO9, PO10
CO5	Screening of industrially important microbes for metabolite production.	PO7, PO8, PO9

CORE IV - PRACTICAL –II

Unit	Details	No. of Hours
I	Staining of clinical specimens - Wet mount, Differential and Special staining methods. Isolation and identification of bacterial pathogens from clinical specimens - Biochemical identification tests. Enumeration of bacteria in urine to detect significant bacteriuria.	18
II	Examination of different fungi by Lactophenol cotton blue staining and KOH staining. Cultivation of fungi and their identification - <i>Mucor</i> , <i>Rhizopus</i> , <i>Aspergillus</i> , <i>Penicillium</i> . Identification of Dermatophytes. Isolation and characterization of bacteriophage from natural sources by phage titration. Cultivation of viruses –Egg Inoculation methods. Diagnosis of Viral Infections –ELISA –HIA. Spotters of viral inclusions and CPE-stained smears	18
III	Examination of parasites in clinical specimens - Ova/cysts in faeces . Floatation methods-simple Saturated salt solution method – Zinc sulphate methods, Sedimentation methods- Formal ether method. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. Identification of common arthropods of medical importance - spotters of <i>Anopheles</i> , <i>Glossina</i> , <i>Phlebotomus</i> , <i>Aedes</i> , Ticks and mites	18
IV	Screening for Enzyme producers (amylase /protease). Optimization of parameters for Amylase production. Screening for Organic acid producers (acetic acid/lactic acid). Screening for Antibiotic producers. Immobilization of microbial cells and enzyme and its assessment.	18
V	Immobilization of microbial cells and enzyme and its assessment. Microbiological assay of antibiotics by cup plate method, Antimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.	18
	Total	90

Text Books

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

References Books

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

Web Resources

- ❖ <http://textbookofbacteriology.net/>
- ❖ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/>
- ❖ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/>
- ❖ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	0	0	0	0	0	0	3	3	3	0
CO2	0	0	0	0	0	0	3	3	3	0
CO3	0	0	0	0	0	0	3	3	3	2
CO4	0	0	0	0	0	0	3	3	3	2
CO5	0	0	0	0	0	0	3	3	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE III - EPIDEMIOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE07	Elective –III	Theory	Y	Y	-	4	3

Learning objectives

- ❖ To describe the role of epidemiology in public health.
- ❖ To explain about epidemiology tools and disease surveillance methods.
- ❖ To analyze various communicable and non-communicable diseases in India.
- ❖ To discuss on mechanism of antimicrobial resistance.
- ❖ To outline on National health programmes that have been designed to address the issues.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Apply the knowledge acquired on concepts of epidemiology to clinical and public health environment.	PO1
CO2	Plan various strategies to trace the epidemiology.	PO4, PO5, PO6
CO3	Plan the control of communicable and non-communicable diseases.	PO1, PO5,
CO4	Analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management.	PO5,
CO5	Employ National control programs related to Communicable and Non-Communicable diseases with the public.	PO4, PO5,

ELECTIVE III - EPIDEMIOLOGY

Unit	Details	No. ofHours
I	Fundamentals of epidemiology: Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission -. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis.	12
II	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.	12
III	Epidemiological aspects of diseases of national importance: Vector borne diseases in India. Diarrhoeal diseases. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome. Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Malignancy, diabetes mellitus, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.	12
IV	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 <i>Pseudomonas</i> , <i>Acinetobacter</i> , <i>Clostridium difficile</i> , HBV, HCV, Rotavirus, <i>Cryptosporidium</i> and <i>Aspergillus</i> in Nosocomial infections. Prevention and management of nosocomial infections.	12
V	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), Protein profiling. Self study - Curie Point PyMS (Pyrolysis Mass spectrometry) Molecular typing method.	12
	Total	60

Text Books

- ❖ Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of Epidemiology in Public Health Practice., (3rd Edition). CDC.
- ❖ Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.
- ❖ Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
- ❖ Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
- ❖ Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology. 5th edn. Blackwell Scientific Publishers.

References Books

- ❖ Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
- ❖ Celentano D. D. and Szklo M. (2018). Gordis Epidemiology. (6th Edition). Elseiver, USA.
- ❖ Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press.
- ❖ Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
- ❖ Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London

Web Resources

- ❖ <https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en>
- ❖ <https://hal.archives-ouvertes.fr/hal-00902711/document>
- ❖ <https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf>
- ❖ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/>
- ❖ https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_outbreaks.pdf

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	0	0	0	0	0	0	0
CO2	0	0	0	2	2	3	0	0	0	0
CO3	2	0	0	0	3	0	0	0	0	0
CO4	0	0	0	0	3	0	0	0	0	0
CO5	0	0	0	3	3	0	0	0	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE III - CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE08	Elective -III	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.
- ❖ To develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.
- ❖ To elucidate various diagnostic procedures in microbiology.
- ❖ To acquire knowledge on different methods employed to check antibiotic sensitivity.
- ❖ To gain knowledge on hospital acquired infections and their control measures.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Apply the knowledge acquired on concepts of epidemiology to clinical and public health environment.	PO1
CO2	Plan various strategies to trace the epidemiology.	PO4, PO5, PO6
CO3	Plan the control of communicable and non-communicable diseases.	PO1, PO5,
CO4	Analyze the implications of drug resistance in the society and design the control of antimicrobial resistance and its management.	PO5,
CO5	Employ National control programs related to Communicable and Non-Communicable diseases with the public.	PO4, PO5,

ELECTIVE III - CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Unit	Details	No. of Hours
I	Applied Anatomy & Physiology: Study of the structure of a cell.– Normal anatomical structure, Histology & Functions (Physiology) of the following systems. The circulatory system (Heart– & Blood Vessels) The Respiratory system The Digestive system, Lymphatic system, Urinary system ,Central nervous system .	12
II	Microbiology Laboratory Safety Practices: General Safety Guidelines, Handling of Biological Hazards, Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.	12
III	Diagnosis of microbial diseases: Clinical, differential, Microbiological, immunological and molecular diagnosis of microbial diseases. Modern and novel microbial diagnostic methods. Automation in Microbial diagnosis.	12
IV	Antibiotic sensitivity tests: Disc diffusion - Stokes and Kirby Bauer methods, E test - Dilution - Agar dilution & broth dilution - MBC/MIC - Quality control for antibiotics and standard strains.	12
V	Nosocomial Infections: Common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Emerging and Re-emerging infections. Hospital Infection Control Committee (HICC) – Functions. Infectious health care waste disposal - Biomedical waste management	12
	Total	60

Text Books

- ❖ Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of Epidemiology in Public Health Practice., (3rd Edition). CDC.
- ❖ Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.
- ❖ Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
- ❖ Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
- ❖ Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology. 5th edn. Blackwell Scientific Publishers.

References Books

- ❖ Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
- ❖ Celentano D. D. and Szklo M. (2018). Gordis Epidemiology. (6th Edition). Elsevier, USA.
- ❖ Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press.
- ❖ Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
- ❖ Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London.

Web Resources

- ❖ <https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en>
- ❖ <https://hal.archives-ouvertes.fr/hal-00902711/document>
- ❖ <https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	0	0	0	0	3	2	2	0	0	0
CO2	0	0	0	0	0	2	3	0	0	0
CO3	0	0	0	0	0	2	3	0	2	0
CO4	0	0	0	0	0	0	3	0	2	0
CO5	0	0	0	0	3	0	2	0	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE III - BIOREMEDIATION

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE09	Elective –III	Theory	Y	Y		4	3

Learning Objectives

- ❖ To describe the nature and importance of bioremediation and use in real world applications.
- ❖ To describe the typical composition of waste water and application of efficient technologies for water treatment.
- ❖ To explain the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.
- ❖ To explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
- ❖ To familiarize the role of plants and their associated microbes in remediation and management of environmental pollution.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Differentiate Ex-situ bioremediation and In-situ bioremediation. Assess the roles of organisms in bioremediation.	PO1, PO2, PO4, PO5
CO2	Distinguish microbial processes necessary for the design and optimization of biological processing unit operations.	PO1, PO4, PO5,
CO3	Identify, formulate and design engineered solutions to environmental problems.	PO5, PO7, PO8,
CO4	Explore microbes in degradation of toxic wastes and playing role on biological mechanisms.	PO5, PO6, PO7, PO8, PO9
CO5	Establish the mechanisms of Arbuscular mycorrhizal fungi and Plant growth promoting <i>Rhizobacteria</i> in phytoremediation.	PO1, PO5, PO6, PO7, PO8

ELECTIVE –III BIOREMEDIATION

Unit	Details	No. of Hours
I	Bioremediation: Bioaugmentation - Ex-situ and in-situ processes; Intrinsic and engineered bioremediation. Major pollutants and associated risks; organic pollutant degradation. Microbial aspects and metabolic aspects. Factors affecting the process. Recent developments and significance.	12
II	Microbes involved in Waste Water treatment: BOD, COD, dissolved gases, removal of heavy metals, total organic carbon removal. Secondary waste water treatments - use of membrane bioreactor. Aquaculture effluent treatment. Aerobic sludge and landfill leachate process. Aerobic digestion.	12
III	Microbes involved in solid wastes: Composting of solid wastes, anaerobic digestion - methane production and important factors involved, Pros and cons of anaerobic process, sulphur, iron and nitrate reduction, hydrocarbon degradation, degradation of nitroaromatic compounds. Bioremediation of dyes, bioremediation in paper and pulp industries. Aerobic and anaerobic digesters – design. Various types of digester for bioremediation of industrial effluents. Poster Preparation on Compost using solid Waste	12
IV	Microbial leaching of ores: Bioleaching of copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.	12
V	Phytoremediation of heavy metals in soil: Basic principles of phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Rhizodegradation. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation. Power point Presentation- Phytoremedial Plants	12
	Total	60
• Power point Presentation & Poster Preparation – related to the above topic are to be considered for internal exam only		

Text Books

- ❖ Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications.
- ❖ Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.
- ❖ Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2nd edition, CRC Press.
- ❖ Liu, D.H.F and Liptak, B.G (2005). Hazardous Wastes and Solid Wastes, Lewis Publishers.
- ❖ Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJP Publishers

References Books

- ❖ 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.
- ❖ Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.
- ❖ Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.
- ❖ Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
- ❖ Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London.

Web Resources

- ❖ Bioremediation- Objective, Principle, Categories, Types, Methods, Applications (microbenotes.com)
- ❖ <https://agris.fao.org/agris-search>
- ❖ <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation>
- ❖ <https://www.intechopen.com/chapters/70661>
- ❖ <https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	0	2	3	0	0	0	0	0
CO2	3	0	0	2	3	0	0	0	0	0
CO3	0	0	0	0	3	0	3	3	0	0
CO4	0	0	0	0	3	3	3	3	3	0
CO5	2	0	0	0	3	2	3	3	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE IV - BIOINFORMATICS

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE10	Elective –IV	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To discuss about various biological data mining concepts, tools.
- ❖ To elucidate the principles and applications of sequence alignment methods and tools.
- ❖ To demonstrate different phylogenetic tree construction methods and its uses in phylogenetic analysis.
- ❖ To acquaint with various approaches in predicting 3D and 2D structure of proteins.
- ❖ To describe various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Access to databases that provides information on nucleic acids and proteins.	PO1, PO4, PO6, PO7, PO9, PO10,
CO2	Invent algorithms for sequence alignment.	PO7, PO9, PO10,
CO3	Construct phylogenetic tree.	PO6, PO9, PO10
CO4	Predict the structure of proteins.	PO4, PO6, PO7,
CO5	Design drugs by predicting drug ligand interactions and molecular docking.	PO4, PO5, PO6, PO7, PO9, PO10,

ELECTIVE IV - BIOINFORMATICS

Unit	Details	No. ofHours
I	Biological Data Mining: Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).	12
II	Phylogenetic Tree Construction: Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.	12
III	Computational Protein Structure prediction: Secondary structure – Homology modelling- Fold recognition and ab initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements-Molecular graphics – Molecular file formats- Molecular visualization tools. Power point presentation: Computational Protein Structure prediction	12
IV	Prediction of Properties of Ligand Compounds: 3D Autocorrelation -3D Morse Code-Conformation Dependent and Independent Chirality Codes –Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships – Prediction of the Toxicity of Compounds.	12
V	Molecular Docking: Flexible - Rigid docking- Target- Ligand preparation- Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.	12
	Total	60
Power point presentation - related to the above topic are to be considered for internal exam only		

Text Books

- ❖ Lengauer T. (2008). Bioinformatics- from Genomes to Therapies (Vol-1).Wiley- VCH.
- ❖ Rastogi S. C., Mendiratta N. and Rastogi P. (2014). Bioinformatics - Methods and Applications (Genomics, Proteomics and Drug Discovery) (4thEdition). Prentice-Hall of India Pvt.Ltd.
- ❖ Attwood, T.K. and Parry-Smith, D.J. (1999). Introduction to Bioinformatics. Addison Wesley Longman Limited, England.
- ❖ Mount D.W., (2013).Bioinformatics sequence and genome analysis, 2ndedn.CBS Publishers, New Delhi.
- ❖ Lengauer T. (2008). Bioinformatics- from Genomes

References Books

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

Web Resources

- ❖ <https://www.hsls.pitt.edu/obrc/>
- ❖ <https://www.hsls.pitt.edu/obrc/index.php?page=dna>
- ❖ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/>
- ❖ <https://www.ebi.ac.uk/>
- ❖ <https://www.kegg.jp/kegg/kegg2.html>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	0	0	2	0	2	0	0	2	2
CO2	0	0	0	0	0	0	3	0	3	3
CO3	0	0	0	0	0	3	0	0	3	3
CO4	0	0	0	3	0	3	3	0	3	0
CO5	0	0	0	3	3	3	3	0	3	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE IV - NANOBIO TECHNOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE11	Elective -IV	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To analyze nanomaterials based on the understanding of nanobiotechnology.
- ❖ To discuss the methods of fabrication of nanomaterials.
- ❖ To gain Knowledge on characterization of nanomaterials.
- ❖ To discover nanomaterials for targeted drug delivery.
- ❖ To explain nanomaterials in nanomedicine and environmental pollution.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Employ knowledge in the field of nanobiotechnology for development.	PO1, PO9
CO2	Identify various applications of nanomaterials in the field of medicine and environment.	PO1, PO9
CO3	Examine the prospects and significance of nanobiotechnology.	PO1, PO6
CO4	Identify recent advances in this area and create a career or pursue research in the field.	PO1, PO5, PO7, PO9
CO5	Design non-toxic nanoparticles for targeted drug delivery.	PO1, PO5, PO7, PO9

ELECTIVE –IV NANOBIO TECHNOLOGY

Unit	Details	No. ofHours
I	Nanobiotechnology: general features of nanoparticles, Classification of nanomaterials based on their dimensions (0D, 1D, 2D and 3D materials), based on realization (The First, second, third and fourth generation materials) of their applications, Need for nanomaterials and the risks associated with the materials.	12
II	Fabrication of Nanomaterials: Top-down and Bottom-up approaches, Solid phase synthesis-milling, Liquid phase synthesis-Sol-gel synthesis, colloidal synthesis, micro emulsion method, hydrothermal synthesis and solvo thermal synthesis, Vapour/Gas phase synthesis-Inert gas condensation, flame pyrolysis, Laser ablation and plasma synthesis techniques. Microbial synthesis of nanoparticles.	12
III	Characterization of nanoparticles: Based on particle size/morphology- Dynamic light scattering (DLS), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Based on surface charge-zeta potential, Based on structure –X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Energy dispersive X-ray analysis (EDX), Based on optical properties- UV – Spectrophotometer, Based on magnetic properties-Vibrating sample magnetometer (VSM).	12
IV	Nano-medicines: Surface modified nano particles, MEMS/NEMS based devices, peptide/DNA coupled nanoparticles, lipid and inorganic nano particles for drug delivery, Metal/metaloxyde nano particles as antibacterial, antifungal and antiviral agents. Toxicity of nanoparticles and Toxicity Evaluation.	12
V	Nanomaterials in diagnosis: Imaging, nanosensors in detection of pathogens. Treatment of surface water, ground water and waste water contaminated by toxic metal ions, organic and inorganic solutes and microorganisms.	12
	Total	60
• Report Writing - related to the above topic are to be considered for internal exam only		

Text Books

- ❖ Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
- ❖ Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd.
- ❖ Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House.
- ❖ Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc.

References Books

- ❖ Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
- ❖ Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd.
- ❖ Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience.
- ❖ Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press

Web Resources

- ❖ <https://www.gale.com/nanotechnology>
- ❖ <https://www.understandingnano.com/resources.html>
- ❖ <http://dbtnanobiotech.com/index2.php>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	2	0	0	0	0	2	0
CO2	3	0	0	0	0	0	0	0	3	0
CO3	3	0	0	0	0	2	0	0	0	0
CO4	3	0	0	0	3	0	2	0	3	0
CO5	3	0	0	0	3	0	2	0	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

ELECTIVE IV - CLINICAL RESEARCH AND CLINICAL TRIALS

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIE12	Elective -IV	Theory	Y	Y	-	4	3

Learning objectives

- ❖ To provide an overview of history and methods involved in conducting clinical research.
- ❖ To design the principles involved in ethical, legal, and regulatory issues in clinical research on human subjects.
- ❖ To describe principles and issues involved in monitoring patient-oriented research.
- ❖ To formulate a well- defined quality assurance and quality control plans.
- ❖ To acquires business development skills in the area of clinical research.

Course Outcomes		
Course Outcomes	On completion of this course, students will;	Programme Outcomes
CO1	Apprehend the Drug Development process and different phases of clinical trials.	PO1, PO2, PO3, PO5
CO2	Recognize the ethics and regulatory perspectives on clinical research trials activities.	PO3, PO5, PO6, PO9
CO3	Accentuate about clinical trials management concepts and documentation process.	PO2, PO4, PO6, PO9
CO4	Accomplish quality assurance and quality control to ensure the protection of human subjects and the reliability of clinical trial results.	PO2, PO4, PO6, PO7, PO9
CO5	To nurture skills recitation to commercial start up and industriousness.	PO4, PO8, PO9

ELECTIVE –IV CLINICAL RESEARCH AND CLINICAL TRIALS

Unit	Details	No. of Hours
I	Introduction to Clinical Research: An Overview, Different types of Clinical Research. Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Pharmacoepidemiology, Bioavailability, Bioequivalence, Terminologies and definition in Clinical Research. Drug Development Process: Drug Discovery Pipeline, Drug Discovery Process. Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV).	12
II	Ethical Considerations and Guideline in Clinical Research: Historical guidelines in Clinical Research-Nuremberg code, Declaration of Helsinki, Belmont report. International Conference on Harmonization (ICH)-Brief history of ICH, Structure of ICH & ICH Harmonization Process, Guidelines for Good Clinical Practice. Regulation in Clinical Research-Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities. Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.	12
III	Clinical Trial Management: Key Stakeholders in Clinical Research, Ethics Committees and Institutional Review Board, Responsibilities of Sponsor. Responsibilities of Investigator, Protocol in Clinical Research Clinical Trial Design, Project Planning Project Managements - Informed Consent, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding. Essential Documents in clinical research -IB, ICF, PIS, TME, ISF, CDA & CTA.	12
IV	Quality Assurance, Quality Control & Clinical Monitoring: Defining the terminology-Quality, Quality system, Quality Assurance & Quality Control-QA audit plan. 21 CRF Part 11, Site Auditing, Sponsor Compliance and Auditing, SOP For Clinical Research-CRF Review & Source Data Verification, Drug Safety Reporting Corrective and preventative action process.	12
V	Business Development in the Clinical Research Industry: Introduction & Stages of Business Development-Start-up Phase, Growth Phase, Maturity Phase, Decline Phase. Outsourcing in Clinical Research, Reasons for outsourcing to contract research organizations, The India Advantage, Scope and Future of CRO, List of Clinical Research Organizations in India. Role of business development manager. Self study – Role of IT companies in Clinical Research Organizations.	12
	Total	60

Text Books

- ❖ Gallin J. I., Ognibene F. P. and Johnson L. L. (2007). Principles and Practice of Clinical Research. (4th Edition). Elsevier, 2007. ISBN-10: 0128499052
- ❖ Friedman L. M., Furberg C. D. and Demets D. (1998). Fundamentals of Clinical Trials, Vol: XVIII. (3rd Edition). Springer Science & Business Media.
- ❖ Hulley S. B., Cummings S. R., Browner W. S., Grady D. G. and Newman T. B. (2013). Designing Clinical Research. (4th Edition). Jaypee Medical. ISBN-13: 978-1608318049.
- ❖ Reed, G. (2004). Prescott and Dunn's Industrial Microbiology, 4th edn, CBS publication and distributors.

References Books

- ❖ Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley.
- ❖ Browner W. S., (2012). Publishing and Presenting Clinical Research. (3rd Edition). Lippincott Williams and Wilkins.
- ❖ Rondel R. K., Varley S. A. and Webb C. F. (2008). Clinical Data Management. (2nd Edition). Wiley.
- ❖ Peppler, H.J. and Pearl Man, D. (1979). Fermentation Technology, Vol 1 & 2, 2nd Edition
- ❖ Academic Press, London.
- ❖ E1-Mansi, E.M.T., Bryce, C.F.A., Demain, A.L. and Allman, A.R. (2007). Fermentation Microbiology and Biotechnology. 2nd Edition, CRC press, Taylor and Francis Group.

Web Resources

- ❖ [https://www.hzu.edu.in/uploads/2020/10/Textbook-of-Clinical-Trials-Wiley-\(2004\).pdf](https://www.hzu.edu.in/uploads/2020/10/Textbook-of-Clinical-Trials-Wiley-(2004).pdf)
- ❖ <https://www.routledge.com/A-Practical-Guide-to-Managing-Clinical-Trials/Pfeiffer-Wells/p/book/9780367497828>
- ❖ <https://www.auctoresonline.org/journals/clinical-research-and-clinical-trials>
- ❖ https://www.who.int/health-topics/clinical-trials#tab=tab_1
- ❖ <https://www.cancerresearchuk.org/about-cancer/find-a-clinical-trial/what-clinical-trials-are/types-of-clinical-trials>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	0	3	0	0	0	0	0
CO2	0	0	3	0	3	3	0	0	3	0
CO3	0	3	0	3	0	3	0	0	3	0
CO4	0	3	0	3	0	3	3	0	3	0
CO5	0	0	0	3	0	0	0	3	3	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator

BOS Chairman

SKILL ENHANCEMENT COURSE I - VERMITECHNOLOGY

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PMIN01	Skill Enhancement Course - I	Theory	Y	Y	-	2	2

Learning Objectives

- ❖ To introduce the concepts of vermicomposting.
- ❖ To explain the physiology, anatomy and biology of earthworms.
- ❖ To acquire the knowledge of the vermicomposting process.
- ❖ To explain the trouble shooting, harvesting and packaging of vermin composts.
- ❖ To gain knowledge on applications of vermin composts and their value added products

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Compare and contrast the uses of vermicompost to the soil.	PO1, PO4, PO5, PO9,
CO2	Recommend different species of earthworms after acquiring knowledge on its biology.	PO1, PO4, PO6, PO9
CO3	Design the vermicomposting process.	PO1, PO4, PO6, PO7,
CO4	Assess the Best Practices of Vermicomposting	PO6,PO7, PO8,PO9,
CO5	Recommend the applications of vermicompost to different soils and for different crops.	PO1, PO4, PO5,PO6, PO7

SKILL ENHANCEMENT COURSE- I: VERMITECHNOLOGY

Unit	Details	No. of Hours
I	Introduction to Vermitechnology: Definition, history, growth and development in India and other countries, significance. Vermiculture –scope and importance; common species for culture; Environmental parameters; culture methods – wormery – breeding techniques; indoor and outdoor cultures - monoculture and polyculture – merits and demerits, factors affecting distribution of earthworms in soil.	6
II	Earthworm Biology and Rearing: Key to identify the species of earthworms. Taxonomy Anatomy, physiology, reproduction and Vital cycle, (alimentation, fecundity, annual reproducer potential) and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors) for <i>Eisenia fetida</i> and <i>Eudrilus eugeniae</i> . Power point Presentation - Identify the <i>Eisenia fetida</i> and <i>Eudrilus eugeniae</i>	6
III	Vermicomposting Process: Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. a)Basic process- Initial pre-composting phase b) Mesophilic phase- Maturing phase c)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.	6
IV	Trouble Shooting of Vermicompost: 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.	6
V	Applications of Vermiculture: 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. Report writing on Field Visit to Vermicomposting Unit	6
	Total	30
• Power point Presentation & Report writing – related to the above topic are to be considered for Internal Exam only		

Text Books

- ❖ Ismail S. A. (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
- ❖ Rathoure A. K., Bharati P. K. and Ray J. (2020). Vermitechnology, Farm and Fertilizer. Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
- ❖ Christy M. V. 2008. Vermitechnology, (1stEdition), MJP Publishers.
- ❖ The complete technology book on Vermiculture and Vermicompost with manufacturing Process, machinery equipment details and Plant Layout. AB Press.

References Books

- ❖ Roy D. (2018). Handbook of Vermitechnology. Lambert Academic Publishing.
- ❖ Kumar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New delhi
- ❖ Lekshmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.
- ❖ Edwards CA, Arancon NQ ShermanRL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1stedn.CRC Press.
- ❖ Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1stedn. Orient longman.

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	2	3	0	0	0	3	0
CO2	3	0	0	2	0	3	0	0	3	0
CO3	3	0	0	3	0	3	3	3	0	0
CO4	0	0	0	0	0	2	3	3	3	0
CO5	3	0	0	2	3	2	3	0	0	0

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to Pos	3.0	3.0	3.0	3.0	3.0

Course Coordinator**BOS Chairman**

COMMON PAPER - FUNDAMENTALS OF HUMAN RIGHTS

Subject code	Subject	Category	L	T	P	Hours	Credits
24S2PHR01	Fundamentals of Human Rights	Theory	Y	Y	-	2	1

24S2PHR01 - FUNDAMENTALS OF HUMAN RIGHTS

Unit	Details	No. of Hours
I	Introduction: Meaning and Definitions of Human Rights – Characteristics and Importance of Human Rights – Evolution of Human Rights – Formation, Structure and Functions of the UNO - Universal Declaration of Human Rights – International Covenants – Violations of Human Rights in the Contemporary Era.	6
II	Human Rights in India: Development of Human Rights in India – Constituent Assembly and Indian Constitution – Fundamental Rights and its Classification – Directive Principles of State Policy – Fundamental Duties.	6
III	Rights of Marginalized and other Disadvantaged People: Rights of Women – Rights of Children – Rights of Differently Abled – Rights of Elderly - Rights of Scheduled Castes – Rights of Scheduled Tribes – Rights of Minorities – – Rights of Prisoners – Rights of Persons Living with HIVAIDS – Rights of LGBT.	6
IV	Redressal Mechanisms: Protection of Human Rights Act, 1993 (Amendment 2019) – Structure and Functions of National and State Human Rights Commissions - National Commission for SCs – National Commission for STs – National Commission for Minorities – Characteristics and Objectives of Human Rights Education.	6
V	ADVANCED TECHNIQUES: JAR file format creation – Internationalization – Swing Programming – Advanced java-Techniques. Self Study: National Commission for Women	6
	Total	30

Reference books

- ❖ Sudarshanam Gankidi, Human Rights in India: Prospective and Retrospective, Rawat Publications, Jaipur, 2019.
- ❖ SatvinderJuss, Human Rights in India, Routledge, New Delhi, 2020.
- ❖ Namita Gupta, Social Justice and Human Rights in India, Rawat Publications, Jaipur, 2021.
- ❖ Mark Frezo, The Sociology of Human Rights, John Willy & Sons, U.K. 2014. 36
- ❖ Chiranjivi J. Nirmal, Human Rights in India: Historical, Social and Political Perspectives, Oxford University Press, New York, 2000.
- ❖ Dr. S. Mehartaj Begum, Human Rights in India: Issues and perspectives, APH Publishing Corporation, New Delhi, 2010.
- ❖ Asha Kiran, The History of Human Rights, Mangalam Publications, Delhi, 2011.
- ❖ Bani Borgohain, Human Rights, Kanishka Publishers & Distributors, New Delhi-2, 2007.
- ❖ Jayant Chudhary, A Textbook of Human Rights, Wisdom Press, New Delhi, 2011.

Course Coordinator

BOS Chairman

SEMESTER - III

THIRD SEMESTER

CORE VII - SOIL AND ENVIRONMENTAL MICROBIOLOGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMI05	Core-VII	Theory	Y	Y	-	6	5

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Depict diversity and significance of soil microbes and predict the role of microbes in biological nitrogen fixation.	PO1
CO2	Utilize the knowledge of microbial interactions, with beneficial application of bio fertilizers for sustainable agriculture and benefits of bio pesticides.	PO1, PO7, PO8
CO3	Explain the different types of microorganisms in water. Identify the causes of water pollution and the methods for quality assessment of water and control of water borne diseases.	PO1, PO5, PO6, PO7, PO8
CO4	Apply knowledge about waste treatments and microbial decomposition and bio-remediation process in environmental Cleanup.	PO1, PO5
CO5	Plan a clear approach on environmental issues. Control pollution and explain protection laws to public.	PO1, PO5

CORE VII - SOIL AND ENVIRONMENTAL MICROBIOLOGY

Unit	Details	No. of Hours
I	Soil Microbiology– Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major group of microorganisms in soil. Factors effecting soil microflora Quantification of soil microflora, role of microorganism in soil fertility. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation- Chemistry and Genetics of BNF. Phytopathology and Disease cycle of Plant pathogens - Tikka and Citrus canker, Types of disease symptoms, Structural and Inducible biochemical defences - Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Plantibodies, Phenolics, Phytoalexins.	18
II	Microbial Interactions - Mutualism, Commensalism, mensalism, Synergism, Competition, Rhizosphere- Mycorrhizae–Types,Endophytes,PGPR-bacteria–symbiotic(Rhizobium,rankia),Non-Symbiotic (Azotobacter, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. Biofertilizers and Biocontrol agents – Types, benefits and application.Advantages, social and environmental aspects - Bt crops, goldenrice.	18
III	Microbial ecology- definition and types Energy flow in the ecosystem-Carbon, Nitrogen, Sulfur and Phosphorous cycles. Physical factors affecting distribution of microorganisms in various environments. Predisposing factors for Environmental diseases – infectious (water and air borne) and pollution related spread and control of these diseases. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Poster Preparation: Quality assurance of drinking water in Mineral water Industries.	18
IV	Waste management – Solid waste - Types - management- Factors affecting solid waste generation rates. Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process. Quality assessment of decontaminated matters and other biological effluents. Biological reference standards. Utilization of Solid Waste as Food, Feed and Fuel-Composting, Vermicomposting, Bio manure and Biogas production. E waste management. Saccharification, palieo microbiology-fossil microbes in sediments, Space microbiology - Microbiological research in space environment.	18
V	Degradation of organic matter - cellulose, Starch. Common pesticides-herbicides (2,4-D) and pesticides(DDT), heavy metals. Biodegradation of Xenobiotics, Recalcitrant Halocarbons, and Synthetic polymers. Biodegradation of Hydrocarbons. 0 Biodeterioration of Textiles and Leather. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, CPCB, EIA guidelines, US Environment protection Agency norms. Self Study: GMO in removal of Oil Pollution	18
	Total	90

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	2	3	1	2
CO2	3	3	2	2	2	3	3	3	1	2
CO3	3	3	3	2	2	3	2	3	1	3
CO4	3	3	3	3	2	3	3	3	1	3
CO5	3	3	3	3	3	3	2	3	2	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3
CO2	3	3	2	3	3
CO3	3	2	3	2	3
CO4	3	3	3	3	3
CO5	3	2	2	3	3
Weightage	15	12	13	13	15
Weighted percentage of Course Contribution to Pos	3	2.4	2.6	2.6	3

Course Coordinator**BOS Chairman**

CORE VIII - MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMI06	Core-VIII	Theory	Y	Y	-	6	5

Learning Objectives

- ❖ Provide knowledge on the structure, replication and repair mechanisms of DNA. Illustrate the structure, functions and significance of RNA.
- ❖ Discuss the gene regulatory mechanisms in prokaryotes and eukaryotes and importance of mutations.
- ❖ Provide in depth knowledge about artificial gene transfer mechanisms and selection of Recombinants.
- ❖ Impart knowledge on various molecular techniques and their importance in biotechnology.
- ❖ Develop knowledge about organic matter degradation, bioremediation, and the environment risk assessment.

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Analyze, demonstrate and appreciate DNA replication and protein synthesis.	PO4, PO6, PO9
CO2	Investigate the types of mutation and its impact on microbes. Illustrate various strategies on gene cloning.	PO4, PO6, PO9
CO3	Analyze, modify and characterize DNA modifying enzymes.	PO4, PO6, PO9
CO4	Illustratively assess the molecular techniques for DNA and protein analysis.	PO4, PO6, PO9
CO5	Adopt the applications of Genetic Engineering in the field of agriculture and medicine towards scientific research.	PO1, PO3, PO4, PO5, PO6, PO7, PO8, PO9

CORE VIII - MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Unit	Details	No. of Hours
I	DNA replication – modes and enzymes involved. Detailed mechanism of semi-conservative replication. Prokaryotic and eukaryotic transcription. Structure and processing of m-RNA, r- RNA and t-RNA. Ribosomes. Genetic Code and Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications.	18
II	Gene regulation and expression – Lac operon, arabinose and tryptophan operons. Gene regulation in eukaryotic systems -repetitive DNA, gene rearrangement, promoters, enhancer elements. Molecular basis of gene mutation - Types of mutations - base substitutions, frame shift, deletion insertion, duplication, inversion. Silent, conditional and lethal mutation. Chemical mutagenesis. Selection of Mutants. Repair of DNA damage. Photoreactivation. SOS Repair mechanism. Base excision repair. Nucleotide excision repair.	18
III	Tools and methods used 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. Cloning vector properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors, Reporter genes. Poster Preparation: Cloning strategies	18
IV	Genomic DNA and cDNA library - Construction and Screening. Substrative hybridization for tissue specific DNA libraries. Techniques in genetic engineering, Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) – Polymerase chain reaction (PCR) – Principles, types and their applications. DNA sequencing - Primer walking, Forward, Reverse primer Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array.	18
V	Plant biotechnology - constituents and concepts of sterilization -preparation, isolation and selection of explants. Animal biotechnology– equipment and media used for animal cell culture technology. Applications of animal cell cultures. Serum protein media viability and cytotoxicity - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Transgenic Plants. Self Study: Applications of Genetic Engineering.	18
	Total	90

Text Books

- ❖ Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.
- ❖ Snusted D.P. and Simmons M. J. (2019). Principles of Genetics. (7th Edition). John Wiley and Soms, Inc.
- ❖ 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.
- ❖ Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing.
- ❖ Maloy S. R. Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing House Pvt. Ltd.

References Books

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

- ❖ <https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/>
- ❖ <https://geneticeducation.co.in/what-is-transcriptomics>
- ❖ <https://www.molbiotools.com/usefullinks.html>
- ❖ <https://geneticeducation.co.in/what-is-transcriptomics>
- ❖ <https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	0	3	0	2	0	2
CO2	3	3	2	2	2	3	2	2	0	2
CO3	3	3	2	2	0	3	2	2	0	2
CO4	3	3	2	3	2	3	2	2	0	2
CO5	3	3	3	3	2	3	2	3	0	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	1
CO2	2	3	2	3	2
CO3	1	2	2	3	1
CO4	2	2	3	3	2
CO5	3	3	2	3	3
Weightage	10	11	10	14	9
Weighted percentage of Course Contribution to Pos	2	2.2	2	2.8	1.8

Course Coordinator**BOS Chairman**

CORE IX - PRACTICAL III

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMIP03	Core-IX	Practical	-	-	Y	6	5

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Utilize various molecular techniques for gene manipulation and detection of mutants	PO4, PO6, PO7, PO9
CO2	Undertake novel research with techniques like PCR and blotting analysis.	PO4, PO6, PO7, PO9, PO10
CO3	Assess the microbial quality of water and air and relate the results to standards.	PO1, PO4, PO5 PO7, PO8
CO4	Synthesize biofertilizers and vermicompost. Cultivate mushrooms using solid waste.	PO1, PO4, PO5 PO7, PO8
CO5	Identify various plant pathogens	PO5, PO10

CORE IX - PRACTICAL III

Unit	Details	No. of Hours
I	Transformation by CaCl treatment, Detection of Antibiotic resistant mutants Identification of mutants by replica plating method	18
II	Amplification of 16s RNA, DNA by PCR, Western blotting - Demonstration Southern blotting – Demonstration	18
III	Detection of Water hardness A) Microbiological analysis of water 1.Total Heterotrophic Count 2.Test for indicative organisms a) MPN b) Membrane Filtration B) Physical, chemical, assessment of water TS, TDS, TSS, DO, BOD, COD Enumeration of bacteria and fungi from air – Air sampler Isolation of free-living nitrogen fixers from soil and <i>Rhizobium</i> from root nodules of leguminous plants. Isolation and enumeration of phosphate-solubilizing bacteria from soil	18
IV	R:S ratio of soil microbes Study of phylloplane microflora by leaf impression method Isolation of Starch and cellulose degrading bacteria Preparation of a vermicompost Isolation of VAM fungi from soil Isolation of plant pathogen – <i>Alternaria</i> & <i>Curvularia</i> spp., Cultivation of edible mushroom from solid waste Cultivation of <i>Azolla</i> .	18
V	Visual examination, observation, and identification of some common plant infections. Collection of 5 herbarium specimens of infected leaves.	18
	Total	90

Text Books

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

References Books

- ❖ Sambrook J. and Russell D.W. (2001). Molecular Cloning: A Laboratory Manual. (7th Edition). Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
- ❖ Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
- ❖ 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.
- ❖ Pepper I., Gerba C. and Brendecke J. (2004). Environmental Microbiology - A Laboratory Manual. (2nd Edition). Academic Press, Elsevier.
- ❖ Yates M.V., Nakatsu C.H., Miller R.V. and Pillai, S.D. (2016). Manual of Environmental Microbiology. (4th Edition). Wiley.

Web Resources

- ❖ <https://geneticgenie.org3>.
- ❖ <https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5>
- ❖ <https://vlab.amrita.edu/index.php?sub=3&brch=272>
- ❖ <https://nptel.ac.in/courses/102105087>



Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	0	3	2	2	0	2
CO2	3	3	2	2	2	3	2	2	0	2
CO3	3	3	3	2	2	3	0	3	0	3
CO4	3	3	2	2	2	3	2	3	0	2
CO5	3	3	2	2	2	3	0	3	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	3	2	3	2
CO3	2	2	1	3	3
CO4	1	3	2	3	3
CO5	2	2	2	3	2
Weightage	9	13	9	15	12
Weighted percentage of Course Contribution to Pos	1.8	2.6	1.8	3	2.4

Course Coordinator

BOS Chairman

CORE X - FERMENTATION TECHNOLOGY AND PHARMACEUTICAL MICROBIOLOGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMI07	Core-X	Theory- Industry Module	Y	Y	-	6	4

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Develop microbial strains, carry out fermentation and recover the products of the process.	PO6, PO7, PO8, PO9
CO2	Design fermenters according to needs for various products.	PO6, PO7, PO8, PO9
CO3	Recover the end products of the fermentation process Economically.	PO4, PO6 PO7, PO8, PO9
CO4	Utilize the knowledge on pharmaceutical microbiology for	PO1, PO4, PO5 PO7, PO8, PO9
CO5	Produce therapeutic products from microbes employing technology and analyze the quality the products.	PO5, PO10

CORE X - FERMENTATION TECHNOLOGY AND PHARMACEUTICAL MICROBIOLOGY

Unit	Details	No. of Hours
I	Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculums for fermentation process- Bacteria , Fungus. Media for industrial fermentation- Formulation, optimization. Sterilization. Stages of upstream - Growth of inoculums, fermenter pre-culture and production fermentation. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.	18
II	Fermenter – Design, types and construction, Instrumentation and control. Productivity. Yield coefficients. Heat production. Aeration and agitation. Gas exchange and mass transfer. Computer Applications in RSM fermentation technology.	18
III	Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, Filtration, flocculation and other recent developments. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid dextraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization. Poster Preparation: Downstream Processing for Penicillin	18
IV	Overview of pharmaceutical microbiology - Ecology of microorganisms- Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building, equipment and their control measures. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, ophthalmologic preparation implants.	18
V	Production of pharmaceutical recombinant products and quality assurance – Vaccines, Insulin, Growth hormone, immunodiagnostics, immuno-sera, immunoglobulin. Antibiotics- Penicillin, Griseofulvin, Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification. .Self Study: Antivenom/antisera for venom.	18
	Total	90

Text Books

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

References Books

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

Web Resources

- ❖ <https://ib.bioninja.com.au/options/untitled/b1-microbiologyorganisms/fermenters.html>
- ❖ <https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html>
- ❖ <https://www.sciencedirect.com/topics/biochemistry-genetics-andmolecular-biology/ethanol-fermentation>
- ❖ https://www.usp.org/sites/default/files/usp/document/harmonization/genmethod/q05b_pf_ira_34_6_2008.pdf
- ❖ <http://www.simbhq.org/>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	1	2	3	2	2	1	2
CO2	3	3	2	2	3	3	3	2	1	2
CO3	3	3	2	1	2	3	3	3	1	3
CO4	3	2	3	2	2	3	2	3	2	3
CO5	3	3	3	2	2	3	3	3	2	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	1	3	2	3	2
CO3	2	3	2	3	3
CO4	2	2	2	3	2
CO5	2	3	2	3	3
Weightage	9	14	10	15	12
Weighted percentage of Course Contribution to Pos	1.8	2.8	2	3	2.4

Course Coordinator**BOS Chairman**

ELECTIVE V - BIOSAFETY, BIOETHICS AND IPR

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMIE13	Elective- V	Theory	Y	Y	-	5	3

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Execute the role of IPR, Patent, Trademarks and its importance.	PO1, PO2, PO3, PO5, PO6
CO2	Develop patent procedure, patent filling and its mapping.	PO3, PO4, PO13
CO3	Become Patent attorneys and Patent officers.	PO2, PO3, PO4, PO7, PO9
CO4	Apply bioethics in GMO, food crops and its biodiversity.	PO2, PO3, PO5, PO9
CO5	Analyze the importance of bioethics in research associated with HGP, clinical research, stem cell therapy.	PO1, PO3, PO5, PO6, PO9, PO10

ELECTIVE V - BIOSAFETY, BIOETHICS AND IPR

Unit	Details	No. of Hours
I	Intellectual Property Rights: Different forms of Intellectual Property Rights – their relevance, importance to industry, Academia. Role of IPR's in Biotechnology, Intellectual Property Rights in the Cyber World. Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. Patentable Invention– Inventions, Not Patentable. International organizations and IPR – Overview of WTO, GEO Tag, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.	15
II	Process involved in patenting. Patent Search – Procedural steps in patenting, process of filing, PCT application, pre-grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc.), patent mapping.	13
III	Patentability of biotechnology inventions - Patentability of biotechnology inventions in India, statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Biotechnological inventions as patentable subject matter, territorial nature of patents - from territorial to global patent regime, interpreting trips in the light of biotechnology inventions, feasibility of a uniform global patent system, merits and demerits of uniform patent law, relevance of the existing international patent, tentative harmonisation efforts, implications of setting up a uniform world patent system. Poster Preparation: Indian patented products	17
IV	Introduction to bioethics - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods and food crops, organisms and their possible health implications and mixing up with the gene- pool.	15
V	Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: stem cell research, human genome project, use of animals in research, human volunteers for clinical research, studies on ethnic races. He Nuremberg code. Self Study: Bioethics in organ transplantation	15
	Total	75

Text Books

- ❖ Usharani B., Anbazhagi S. and Vidya C. K. (2019). Biosafety in Microbiological Laboratories. (1st Edition). Notion Press. ISBN-101645878856
- ❖ Satheesh M. K. (2009). Bioethics and Biosafety. (1st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN:9788190675703
- ❖ Raj Mohan Joshi. Biosafety and Bioethics. Wiley Publications.
- ❖ Goel D. and Parashar S. (2013). IPR, Biosafety and Bioethics. (1st Edition). Pearson Education: Chennai. ISBN-13: 978-8131774700
- ❖ Sibi. GIntellectual, Property Rights, Bioethics, Biosafety and Entrepreneurship in biotechnology. (2021). Wiley Publications.

References Books

- ❖ Nithyananda K. V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited.
- ❖ Neeraj, P. and Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI Learning Private Limited,
- ❖ Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis.
- ❖ Tony Hope (2004). Medical Ethics: A very Short introduction,. Oxford Publication.
- ❖ Goel Parashar. IPR, Biosafety and Bioethics (2013). Pearson Publications.

Web Resources

- ❖ <http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf>.
- ❖ https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.
- ❖ <https://www.cdc.gov/training/quicklearns/biosafety/>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	2	2	2	2
CO2	3	3	2	3	2	3	3	2	2	2
CO3	3	3	2	3	3	3	3	2	2	2
CO4	2	2	3	2	2	2	2	3	2	3
CO5	2	2	3	2	2	2	2	3	2	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	3	2
CO2	2	3	2	3	3
CO3	2	3	3	3	2
CO4	2	2	2	3	3
CO5	2	2	2	3	3
Weightage	10	12	12	15	13
Weighted percentage of Course Contribution to Pos	2	2.4	2.4	3	2.6

Course Coordinator

BOS Chairman

ELECTIVE V - MOLECULAR MODELING AND DRUG DESIGNING

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMIE14	Elective- V	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To impart comprehensive overview of the scientific and technical aspects of Molecular modelling and Drug Designing.
- ❖ To workout in databases, sequence analysis and drug designing
- ❖ To demonstrate several packages and software's available in Molecular Modelling and Drug Designing.
- ❖ Understand the structural organization and of drug able targets
- ❖ Learn the drug discovery process and role of computational techniques

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	The students gained the knowledge on the molecular modelling and field effects as a part of drug discovery.	PO1, PO2, PO3, PO5, PO6
CO2	Students have understood on the various stages and various targets of drug discovery	PO3, PO4, PO13
CO3	Learned the importance of the pharmacophores in drug discovery	PO2, PO3, PO4, PO7, PO9
CO4	Learned the importance of genomics and proteomics in drug designing	PO2, PO3, PO5, PO9
CO5	They have learned the importance of the role of computer aided drug design in drug discovery.	PO1, PO3, PO5, PO6, PO9, PO10

ELECTIVE V- MOLECULAR MODELING AND DRUG DESIGNING

Unit	Details	No. of Hours
I	Protein: Structure of protein; Hierarchical organization of protein structure – primary, secondary, tertiary and quaternary structure.	15
II	Ramachandran map. Introduction to enzymes as drug targets; enzymatic activity and its inhibition Transcription factors as drug target, membrane proteins as drug targets..	15
III	DNA: Structure of DNA, types of base pairing – Watson-Crick and Hoogsteen; Structural properties of A-, B- and Z- DNA. DNA as drug target. Poster Preparation: Types of DNA	15
IV	Targeting Bimolecular Interactions: protein – protein interactions and DNA – protein interactions. Introduction to receptors; Drug – receptor interaction; Forces involved in drug receptor interaction.	15
V	Drug discovery and design: Structure based drug discovery process. Methods and Tools in Computer-aided drug design. Modelling drug - target interaction; molecular docking, and virtual screening. Auto Dock: , Swiss Dock: Schrödinger Suite and PyRx, Self Study: Big Data in Drug Discovery	15
	Total	75

Text Books

- ❖ Berg J.M., Tymoczko J.L. & Stryer, L. (2006) Biochemistry (6th Ed.); W.H. Freeman and Co New York.
- ❖ Leach A.R. (2001) Molecular Modeling: Principles and Applications (2nd Ed.). Prentice Hall, USA.
- ❖ Gervasio F. L. & Spiwok V. (Ed.) (2019) Biomolecular Simulations in Structure-Based Drug Discovery. Wiley-VCH Verlag GmbH & Co.
- ❖ Riccardo, B. (Ed) (2012) Computational Drug Discovery and Design Humana Press. Online resources

Web resources

- ❖ <https://www.britannica.com>
- ❖ <https://encyclopedia.thefreedictionary.com>
- ❖ <http://www.free-ebooks.net/>
- ❖ <https://www.scribd.com>
- ❖ <https://www.wikipedia.org>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	0	3	2	2	0	2
CO2	3	3	2	2	2	3	2	2	0	2
CO3	3	3	2	2	2	3	2	2	0	2
CO4	3	3	2	2	2	3	2	3	0	2
CO5	3	3	2	2	2	3	3	3	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	3	2	3	2
CO3	2	3	2	3	2
CO4	2	3	2	3	2
CO5	2	3	2	3	2
Weightage	10	15	10	15	10
Weighted percentage of Course Contribution to Pos	2	3	2	3	2

Course Coordinator**BOS Chairman**

ELECTIVE V - WATER CONSERVATION AND WATER TREATMENT TECHNOLOGIES

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMIE15	Elective- V	Theory	Y	Y	-	5	3

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Appraise issues of water scarcity, stress, and conflict on global population	PO1, PO2, PO4, PO5, PO10
CO2	Apprehend the multiple approaches against water scarcity and to understand various government schemes for water conservation.	PO1, PO2, PO5, PO10, PO14
CO3	Acquire knowledge to identify the quality of water by standard method	PO4, PO6, PO10
CO4	Design and execute standard strategy for successful HWTs implementation.	PO4, PO5, PO6, PO9
CO5	Describe the application and uses of various emerging water treatment technologies	PO4, PO5, PO6, PO9, PO10

ELECTIVE V - WATER CONSERVATION AND WATER TREATMENT TECHNOLOGIES

Unit	Details	No. of Hours
I	Water Scarcity; Major Causes of Water Scarcity, Types of Water Scarcity, Water Footprint- Effects of Water Scarcity Across the Globe-, Water Scarcity in India; Effects of Water Scarcity in India - Social and Political Effects and Economic Risks of Water Scarcity in India.	15
II	Multi-pronged approach to Prevent Water Scarcity; Aquifer Recharging, Water reuse and Zero-Liquid Discharge Technology, Coastal Reservoir, Desalination Plants- Measures for Preventing Water Scarcity in India - Jal Shakti Abhiyan Campaign, Atal Bhujal Yojana, Adoption of Composite Water Management Index (CWMI), Water conservation resource management, Rain Water Harvesting.	15
III	Water Quality and Pollution; Impurities in the water, Characteristics of different water sources Vulnerability of the water sources to contamination, Water quality criteria - Quality of surface waters, flowing waters, impounded waters, Groundwater, Water quality standards, Microbiological quality of drinking Water, Chemical quality of drinking water.	15
IV	Water Treatment Technologies; Sedimentation, Filtration, Coagulation and flocculation, Water softening and adsorption processes, Membrane filtration, Microfiltration, Ultrafiltration and Nanofiltration, Water disinfection, Activated carbon filtration, Household Water Treatment and Safe Storage (HWTS). Methods for household water treatment Safe water storage, Household water treatment and safe storage decision tree, Assessing the impact of HWTS, Government policies for HWTS.	15
V	New and Emerging Drinking Water Treatment Technologies; Nanotechnology, Acoustic nanotube technology, Photocatalytic water purification technology, Aquaporin Inside™ technology, Automatic Variable Filtration (AVF) technology, Sun Spring System, Desalination.	15
	Total	75

Texts Books

- ❖ 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.
- ❖ Pannirselvam M., ShuLi.,Griffin G., Philip L., Natarajan A. and Hussain S. (2019). Water Scarcity and Ways to Reduce the Impact. ISBN: 978-3-319-75199-3.
- ❖ Tiwari A., Kumar A., Singh A., Singh T.N., Suozzi E., Matta G. and Russo S. (2022). Water Scarcity, Contamination and Management. Elsevier. ISBN: 9780323853781.
- ❖ Daniel, C.J. (1996). Environmental Aspects of Microbiology, 1stedn. Bright Sun Publications.
- ❖ Maier RM, Pepper IL, Gerba CP (2008). Environmental Microbiology, 2ndedn. Academic Press.

References Books

- ❖ Fujita K. and Mizushima T. (2021). Sustainable Development in India -Groundwater Irrigation, Energy Use, and Food Production. ISBN 9780367460976.
- ❖ Gupta R. (2008). Water Crisis in India. Atlantic Publishers. ISBN: 9788126909582, 9788126909582.
- ❖ SaeidEslamian ., FaezehEslamian ., (2021) Water harvesting and conservation – Basic Concepts and fundamentals, Wiley Publications.
- ❖ Buckley RG. (2016) Environmental Microbiology 1stedn. CBS Publishing.

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	0	3	2	2
CO2	3	3	2	2	2	3	2	03	2	2
CO3	3	3	2	2	2	3	0	3	0	2
CO4	3	3	2	3	3	3	2	3	0	2
CO5	3	3	2	3	2	3	2	3	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	3
CO2	2	3	1	3	3
CO3	2	2	1	3	2
CO4	2	3	2	3	3
CO5	2	3	2	3	3
Weightage	11	13	7	15	14
Weighted percentage of Course Contribution to Pos	2.2	2.6	1.4	3	2.8

Course Coordinator

BOS Chairman

NME II - ORGANIC FARMING AND BIOFERTILIZER TECHNOLOGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S3PMIN02	NME II	Theory	Y	Y	-	3	2

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Produce bio fertilizers and distinguish between organic and conventional farming.	PO1
CO2	Plan a Complete Farm Business including marketing, operation and financial outline.	PO1, PO7, PO8
CO3	Practice the application of microbial bio-fertilizers in large Scales, thereby increasing soil fertility.	PO1, PO5, PO6, PO7, PO8
CO4	Develop integrated farming for sustainable agriculture.	PO1, PO5
CO5	Promote the quality of packaging, storage, increase shelflife, accelerate the bio efficacy of bio fertilizers as per BIS standards	PO1, PO5

NME- II ORGANIC FARMING AND BIOFERTILIZER TECHNOLOGY

S. No	Details	No. of Hours
I	Organic farming – Definition, relevance. Biological nutrient management - Organic manures, vermicompost, greenmanure, organic residue, Biofertilizer soil amendments. Integrated pest and weed management - Use of biocontrol agents, bio pesticides etc. Organic and Conventional farming. Organic and Chemical farming – Comparison.	9
II	Certification and Schemes - Certification and Schemes. Organic certification in brief. Integrated farming system-definition, goal, components. Factors affecting ecological balance. Land degradation. Soil health management. Models of IFS for rainfed and irrigated conditions and different categories of farmers. Government schemes -NPOF, NHM, HMNEH, NPMSH&F and RKVY.	9
III	Biofertilizers - Introduction, types, advantages and future perspective. Introduction, status and scope. Structure and characteristic features of bacterial biofertilizers- <i>Azospirillum</i> , <i>Azotobacter</i> , <i>Bacillus</i> , <i>Pseudomonas</i> , <i>Rhizobium</i> and Actinobacteria- <i>Frankia</i> . Nitrogen fixation-Free Living and symbiotic. Mechanism of phosphate solubilization and phosphate mobilization, potassium Silicate solubilization.	9
IV	Cyanobacterial biofertilizers- <i>Anabaena</i> - <i>Azolla</i> , <i>Nostoc</i> , <i>Hapalosiphon</i> -fungal biofertilizers-AM mycorrhiza and ectomycorrhiza.	9
V	Production technology -Strain, selection, sterilization, growth and fermentation, mass production of carrier based and liquid bio-fertilizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers. Biofertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.	9
	Total	45

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	2	2	2	3	3	3	2	3	3
CO2	3	3	2	3	3	3	3	2	2	2	3
CO3	3	3	2	2	2	3	2	3	0	2	3
CO4	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	2	2	2	3	3	3	0	3	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	3
CO2	2	3	3	3	3
CO3	2	3	2	3	3
CO4	2	3	2	3	3
CO5	2	3	2	3	3
Weightage	10	15	11	15	15
Weighted percentage of Course Contribution to Pos	2	3	2.2	3	3

Course Coordinator

BOS Chairman

SEMESTER - IV

FOURTH SEMESTER
CORE X - FOOD AND DAIRY MICROBIOLOGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMI08	Core X	Theory	Y	Y	-	6	5

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Utilize the knowledge on process of food contamination and spoilage to preserve food.	PO1
CO2	Use the knowledge on food borne disease to protect public health.	PO1, PO7, PO8
CO3	Familiarize various national and international aspects of food safety and quality assurance.	PO1, PO5, PO6, PO7, PO8
CO4	Prepare dairy products and perform quality checks.	PO1, PO5
CO5	Apply microbiological standards to milk and milk products.	PO1, PO5

CORE X - FOOD AND DAIRY MICROBIOLOGY

S. No	Details	No. of Hours
I	Microorganisms of food- Scope of food Microbiology. Contamination and spoilage of food –vegetables, fruits, poultry, fish, eggs, meat, meat products and canned foods. Food Preservation - Temperature (low and high), drying, radiation and chemicals.	18
II	Food microbiology and public health. Food hazards. Food infections – <i>Bacillus cereus</i> , <i>Vibrio parahaemolyticus</i> , <i>Escherichia coli</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Yersinia enterocolitica</i> , <i>Listeria monocytogenes</i> and <i>Campylobacter jejuni</i> . Nonbacterial food borne illness - Helminthes, nematodes, protozoa, toxigenic fungi and food borne virus.	18
III	Quality assurance of food - International aspects of Quality and safety assessment of foods. Microbiological quality standards for food. Government regulatory practices and policies - FDA, HACCP, BIS (IS), FSSAI-2014. Food adulteration and common food additives. Food sampling for quality analysis, Hyphernated Technique in food analysis. Poster Preparation: Food adulteration testing	18
IV	Introduction to Dairy microbiology – Milk production and hygiene. Microorganisms associated with milk. Microbial metabolites and their role in spoilages. Antimicrobial systems in raw milk. Microbiological grading of raw milk. Milk borne diseases and their control. Bacteriological aspects of milk processing – Thermization, pasteurization, boiling, sterilization, UHT, bactofugation, and membrane filtration.	18
V	Composition and chemistry of cream, butter, ghee, ice- cream, cheese, kefir, koumiss, rennin, condensed and dried milks, infant food. Chemistry of milk fermentation. Chemistry of rennin coagulation of milk and changes occurring during ripening of cheese, Physico-chemical changes in the manufacture and storage of milk powder, lactose, crystallization and its significance. Dairy plant hygiene and sanitation. Disposal of dairy waste. Microbiological standards for Milk and Milk products- PFA BIS, Codex/ ISO standards. Self study Microbiological standards Jam/Fruit juices	18
	Total	90

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	2	2	2	3	2	3	0	3	3
CO2	3	3	3	2	2	3	2	3	2	3	3
CO3	3	3	3	2	2	3	2	3	2	3	3
CO4	3	3	2	2	2	3	3	3	0	2	3
CO5	3	3	3	2	2	3	2	3	0	3	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	2	2	3	3
CO3	2	3	2	3	3
CO4	2	3	2	3	2
CO5	2	3	2	3	3
Weightage	10	14	10	15	13
Weighted percentage of Course Contribution to Pos	2	2.8	2	3	2.6

Course Coordinator

BOS Chairman

CORE XI - RESEARCH METHODOLOGY AND BIOSTATISTICS

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMI09	Core-XI	Theory	Y	Y	-	6	5

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Collect and present data suitable to the research design.	PO1, PO4, PO9, PO10
CO2	Write research manuscripts and articles for journals.	PO1, PO2, PO3, PO4, PO5, PO6, PO9, PO10
CO3	Recommend the utilization of biostatistics tools for analysis of biological data.	PO5, PO6, PO9, PO10
CO4	Prove and justify hypothesis for a particular research.	PO3, PO4, PO9, PO10
CO5	Apply software tools for interpretation of biological data.	PO4, PO9, PO10,

CORE XI - RESEARCH METHODOLOGY AND BIOSTATISTICS

S. No	Details	No. of Hours
I	Introduction to Research Methodology - Meaning and importance. Statement, Constraints. Review of literature - Review and synopsis presentation. Types of research, Qualitative and Quantitative Research, Research tools. Methods and techniques of data collection - types of data, methods of primary data collection (observation/experimentation/ questionnaire/ interviewing/ case/pilot study, methods), methods of secondary data collection.	18
II	Sampling and sampling distributions. Sampling frame, importance of probability sampling, sampling - simple random, systematic, stratified random and cluster. Variables - nominal, ordinal, discontinuous, continuous, derived. Code of Ethics in Research – Ethics and Research Process – Importance of Ethics in Research, Research process, designs and Report writing - types of research reports, guidelines for writing an article and report, report format, appendices, Ethical issues related to publishing, Plagiarism and Self- Plagiarism. iThenticate, Drill Bit	18
III	Introduction to Biostatistics - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation. Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range, mean deviation and coefficient of variation. Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, t test, correlation coefficient. Poster Preparation: Data presentation in diagram	18
IV	Correlation and regression - Positive, negative, calculation of Karl-Pearsons co-efficient of correlation. Linear regression and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. Tests of significance - Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error.	18
V	Probability and distributions - Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. RSM: methods for process optimization set up CCD, Box Behnken, optimal RSM design, regression models FDS curves, surface contours, multi linear constraints. SPSS, PCA using PROMETHEE. Self study Numerical data analysis and result presentation	18
	Total	90

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	2	3	2	3	2	2	0	2
CO2	3	3	3	3	2	3	2	3	0	3
CO3	3	3	2	2	2	3	2	2	0	2
CO4	3	3	2	2	2	3	2	2	0	2
CO5	3	3	2	2	2	3	2	2	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	3	2
CO2	2	2	3	3	2
CO3	2	3	3	3	2
CO4	2	3	3	3	2
CO5	2	3	3	3	2
Weightage	10	13	15	15	10
Weighted percentage of Course Contribution to Pos	2	2.6	3	3	2

Course Coordinator**BOS Chairman**

ELECTIVE VI - BIOENERGY

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMIE16	Elective - VI	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ Acquire knowledge on bioenergy utilizing organic wastes for energy recovery.
- ❖ Discuss methods and strategies of exploiting microbes for the production technology of biodiesel.
- ❖ Describe resources and techniques for the production and estimation of eco-friendly biofuels and the extent of their use potentially.
Gain knowledge for executing biogas plant in communities.
- ❖ Explain possibility of using microbes for the production of bio-hydrogen as a Source of future fuel.

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Evaluate the various aspects of biomass production and their implementation.	PO1, PO5, PO6
CO2	Design and construct a biodiesel plant.	PO5, PO7, PO8,
CO3	Carry out the process of fermentation for bio – alcoholfuels.	PO1, PO4, PO5, PO7
CO4	Identify the nature of biogas as a biofuel and their technologies and applications.	PO5, PO7, PO8,
CO5	Design, execute and extract biohydrogen from algae.	PO4, PO5, PO7,

ELECTIVE VI - BIOENERGY

S. No	Details	No. of Hours
I	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.	12
II	Biodiesel – Microbes and Biodiesel. Production and feed stock. Techniques of lipid extraction and conversion to biodiesel. Biodiesel quality and its assessment. Strategies of genetic engineering of organisms for biodiesel production. Biodiesel production from single cell organisms (<i>Cryptococcus</i> , <i>Cunninghamella</i> , <i>Mortierella</i>).	12
III	Alcoholic Fuels from microorganisms: Biochemical conversion to ethanol: Biomass pre-treatment, 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, biomethanol, biopropanol and bioglycerol. Poster Preparation: Biodiesel production	12
IV	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. Application of Biogas slurry in agriculture.	12
V	Biohydrogen– Production from bacteria and algae. Commercialized microalgae (<i>Spirulina</i> , <i>Dunaliella</i> , <i>Hematococcus</i> and <i>Chlorella</i>) and their production. Economics of microalgae production. Cultivation of Seaweeds. Microbial fuel cells. Self study: Carbon sequestration	12
	Total	60

Text Books

- ❖ Dahiya A. (2014). Bioenergy- Biomass to Biofuel. (1st Edition). Academic Press Editor.
- ❖ Brown R. C. (2003). Biorenewable Resources: Engineering New Products from Agriculture. (1st Edition). Wiley Blackwell Publishing.
- ❖ Jawaid M., Hakeem K. R. and Rashid U. (2014). Biomass and Bioenergy: Processing and Properties. (1st Edition). Springer Cham.
- ❖ Caye M. Drapcho, Tery H. Walker (Biofuels Engineering Process Technology. McGraw Hill.
- ❖ Teri. Bio energy powering the Future. Pearson Longman Publications.

References Books

- ❖ Konur O. (2018). Bioenergy and Biofuels. (1st Edition). CRC Press.
- ❖ Lee J. W.(2012). Advanced Biofuels and Bioproducts. (13th Edition), Springer.
- ❖ Khanal S. (2008). Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. (8th Edition). Wiley-Blackwell Publishing.
- ❖ Pradeep Chaturvedi.(1995). Bioenergy Resources. Concept Publishing Company.
- ❖ Lee S. (2018). Biofuel and Bioenergy. Taylor and Francis

Web Resources

- ❖ <https://www.elsevier.com> Biofuels and Bioenergy
- ❖ <https://www.sciencedirect.com> › book › bioenergy
- ❖ <https://www.energy.gov/eere/bioenergy/bioenergy-basics>
- ❖ <https://www.iea.org/fuels-and-technologies/bioenergy>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	2	2	2	3	2	3	0	2
CO2	3	3	2	2	3	3	3	3	0	2
CO3	3	3	2	2	2	3	3	3	0	2
CO4	3	3	2	2	2	3	2	3	0	2
CO5	3	3	2	2	2	3	3	3	0	2

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	3	2	3	2
CO3	2	3	2	3	2
CO4	2	3	2	3	2
CO5	2	3	2	3	2
Weightage	10	15	10	15	10
Weighted percentage of Course Contribution to Pos	2	3	2	3	2

Course Coordinator**BOS Chairman**

ELECTIVE VI - ESSENTIALS OF BIO-ENTREPRENEURSHIP

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMIE17	Elective - VI	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ Understand entrepreneurship concepts as a whole.
- ❖ Understands the basic concepts about the Entrepreneurship
- ❖ To develop the skills of entrepreneurship & to encourage the students to become an entrepreneur.
- ❖ Understand the Business proposal for starting a company.
- ❖ Acquire knowledge on marketing and requirement for bioentrepreneurship.

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Students will be able to identify the Biotech based companies, products, services and IPR	PO1
CO2	Will understand the Business proposal for starting a company	PO1, PO7, PO8
CO3	Will know the funding of biotech business	PO1, PO5, PO6, PO7, PO8
CO4	Will aspire to set up Biotech enterprises	PO1, PO5
CO5	Will analyse the Financial requirement for bio-entrepreneurship	PO1, PO5

ELECTIVE VI - ESSENTIALS OF BIO-ENTREPRENEURSHIP

S. No	Details	No. of Hours
I	Innovation and bio-entrepreneurship: Innovation as strategy in Biotech Companies – Biotechnology based products and services – license and protection – IPR issues in bioentrepreneurships – biosafety.	12
II	Major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited), MSME., NABARD, Pm-Kmy.	12
III	Funding of biotech business - funding for biotech in India - support mechanisms for entrepreneurship - Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, biotech policy initiatives. Poster Preparation: Bioproducts	12
IV	Biotech enterprises: Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities.	12
V	Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process. Self study: Support Entrepreneurs like, NSIC, SIDO, SSIB and SSIDC.	12
	Total	60

Text Books

- ❖ The Business of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
- ❖ Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross Mann, 2003
- ❖ Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne& John 58 Kapeleris, 2006

References Books

- ❖ Dynamics of Entrepreneurial Development and Management by Vasant Desai, Himalaya Publishing House, 2005.
- ❖ Projects Planning Analysis, Selection, Implementation & Review by Prasannan.
- ❖ Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008.

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	2	2	2	3	2	2	0	2	3
CO2	3	3	2	3	2	3	3	2	0	2	3
CO3	3	3	2	2	2	3	3	2	0	2	3
CO4	3	3	2	2	3	3	3	3	0	2	3
CO5	3	3	2	2	2	3	3	2	0	2	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	2
CO2	2	3	2	3	2
CO3	2	3	2	3	2
CO4	2	3	2	3	2
CO5	2	3	2	3	2
Weightage	10	15	10	15	10
Weighted percentage of Course Contribution to Pos	2	3	2	3	2

Course Coordinator

BOS Chairman

ELECTIVE VI - LIFE SCIENCES FOR COMPETITIVE EXAMINATIONS

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMIE18	Elective - VI	Theory	Y	Y	-	4	3

Learning objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Define, classify and assess the structure, biological functions and interactions of Biomolecules.	PO4, PO6, PO9
CO2	Validate the knowledge of collective and progressive notions of cellular organization.	PO4, PO6, PO9
CO3	Assess and describe the importance of inheritance biology.	PO4, PO6, PO9
CO4	Establish acquaintance and understanding of ecology & Biodiversity in a broader sense.	PO4, PO6, PO9
CO5	Understand the processes of evolution, relate with natural selection, adaptation and speciation.	PO4, PO6, PO9

ELECTIVE VI - LIFE SCIENCES FOR COMPETITIVE EXAMINATIONS

S. No	Details	No. of Hours
I	Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins. Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics.	12
II	Cellular Organisation, Cell division and cell cycle, Membrane structure and function, Organization of genes and chromosomes, Structural organization and function of intracellular organelles, DNA replication, repair and recombination, Protein synthesis and processing.	12
III	Inheritance Biology, Mendelian principles- Dominance, segregation, independent assortment, Linkage and Gene mapping, Karyotyping, Extra chromosomal inheritance - Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics-Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.	12
IV	Ecology- Habitat and Niche, biotic and abiotic interactions, Biome-biogeographical zones of India. Ecological Succession, Population Ecology- Characteristics of a population; population growth curves, Environmental pollution-global environmental change, Biodiversity: status, monitoring and documentation; major drivers of biodiversity Change; biodiversity management approaches. Biodiversity Management approaches. Indian case studies on conservation/Management strategy (Project Tiger, Biosphere Reserves).	12
V	Evolution and Behaviour- Evolution - Theories- Darwin's, Lamarck's, Oparin Haldane. Paleontological, Embryological and Molecular evidences. Hardy Weinberg's Law. Speciation; Allopatricity and Sympatricity. Adaptive radiation and Convergent evolution; Sexual selection; Co-evolution. Altruism, Biological clocks, Migration and Parental care. Molecular Evolution-Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny.	12
	Total	60

Text Books

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	2	2	2	1	3	0	2	0	2
CO2	3	3	2	2	2	3	0	2	0	2
CO3	3	3	2	2	1	3	0	2	0	2
CO4	3	2	2	2	2	3	2	3	2	3
CO5	3	3	3	2	2	3	2	3	3	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	2	2	2	3	2
CO3	2	2	2	3	2
CO4	2	2	2	3	3
CO5	2	2	2	3	3
Weightage	10	10	10	15	12
Weighted percentage of Course Contribution to Pos	2	2	2	3	2.4

Course Coordinator**BOS Chairman**

SEC II - MICROBIAL QUALITY CONTROL AND TESTING

Subject Code	Major	Category	L	T	P	Hours	Credit
24S4PMIS01	SEC – II	Theory	Y	Y	-	4	2

Learning Objectives

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

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Apply knowledge in quality analysis techniques suitable for industries.	PO4, PO5,PO7, PO8
CO2	Perform water managements, water harvesting and treat sewage, water pollutions and remedies.	PO4, PO5,PO7, PO8
CO3	Detect portability of water. Test water quality.	PO4, PO5,PO7, PO8
CO4	Impart knowledge on bioaerosols, impact and prevention	PO4, PO5,PO7, PO8
CO5	Apply quality control techniques for food and pharma Products	PO4, PO5,PO7, PO8

SEC II - MICROBIAL QUALITY CONTROL AND TESTING

S. No	Details	No. of Hours
I	Concepts of quality control techniques - quality assurance, Total Quality Management (TQM) Continuous Quality Improvement (CQI) Quality Assurance (QA) pre analytical and post analytical techniques, ATCC, MTCC, microbial based assay.	12
II	Water management, water harvesting, water recycling. Characteristics of waste water from industries - Sugarfactory, Pulp & Paper mill, Distillery, Textile, Engineering, Food Industry, Domestic waste. Water pollution causes and remedies.	12
III	Microflora of water. Microbiological analysis of water sample. Microbiological analysis of water sample collection, drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: MPN tests, (b) Membrane filter technique and (c) presence/absence tests Control of microbes in water: borne pathogens - Precipitation, chemical disinfection, filtration, high temperature, UV light.	12
IV	Microflora of air - Bioaerosols, Air borne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres. collection of air samples and analysis. Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, isolation and Identification. Control Measures of Bioaerosols - UV light, HEPA filters, desiccation, Incineration.	12
V	Quality control in food - Food X ray inspection, PPE Equipment, IoT sensors, preventive quality control and reality quality control. Quality control of pharma products. Quality assurance framework, assessment of pharmaceutical quality, determinants of pharmaceutical quality, practical approaches to quality assurance.	12
	Total	60

Text Books

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

References Books

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

Web Resources

- ❖ <https://www.researchgate.net/publication/320730681>
- ❖ <https://www.fssai.gov.in>
- ❖ <https://mofpi.nic.in/Schemes/implementation-haccp-iso-22000-iso-9000-ghp-gmp-etc>
- ❖ <https://www.who.int/news-room/fact-sheets/detail/food-safety>
- ❖ <https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp->

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 - Low

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO
CO1	3	3	2	2	2	3	2	2	1	2
CO2	2	3	3	2	2	3	2	3	1	3
CO3	3	2	3	1	1	3	1	3	1	3
CO4	2	2	3	3	2	2	1	3	2	3
CO5	3	3	3	2	2	3	2	2	1	3

Mapping with Programme: Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	2	3	2	3	2
CO3	2	2	2	3	2
CO4	2	2	2	3	2
CO5	2	3	2	3	3
Weightage	10	12	10	15	11
Weighted percentage of Course Contribution to Pos	2	2.4	2	3	2.2

Course Coordinator**BOS Chairman**