MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL-624 101

DEPARTMENT OF BIOTECHNOLOGY

M.SC MICROBIOLOGY
Curriculum Framework, Syllabus, and Regulations
(Based on TANSCHE Syllabus under choice Based Credit System – CBCS)

(For the candidates to be admitted from the Academic Year 2023-2024)

M.Sc. MICROBIOLOGY

About the Programme

About the Programme: M.Sc. in Microbiology is a two years postgraduate programme offered in 4 semesters. The program combines the concepts of biology and chemistry to understand living things and their relationship with the ecosystem. The course covers the study of microorganisms and their effect on human life. Microbiologists are needed to do the research required for the future battle against infectious diseases worldwide, understanding the environmental importance of microbes and to exploit them for food production, biotechnological and industrial applications. This advanced course can help students in taking a career in Research as well as getting employed in companies like pharma, healthcare, agri-based and many other life

Programme:	**M.Sc. MICROBIOLOGY**
Programme code:	**P23MB**
Duration:	**2 Years [PG]**
Programme Outcomes:	**PO1: Disciplinary Knowledge** Capable of demonstrating detailed knowledge and expertise in all the disciplines of the subject. **PO2: Communication Skills** Able to express thoughts, ideas, concepts, scientific information, experiments and its significance effectively in writing and verbal, communicate with confidence to different groups, using appropriate media. **PO3: Moral and Ethical Awareness** Ability to employ values in conducting one's life, use ethical practice at work, avoiding fabrication, misinterpretation and plagiarism, adhering to intellectual property rights and appreciate ethical solutions for environmental sustainability. **PO4: Analytical Reasoning** Ability to evaluate the reliability and relevance of evidence, identify flaws, analyze and synthesize data from different sources. **PO5: Contribution to Society** Solve public issues concerned with public health and safety for the welfare

	of the society. **PO6: Scientific Reasoning** Ability to identify, analyze, interpret and draw conclusions from qualitative and quantitative data, critically evaluate ideas, evidences and experiences, with an open mind and reasoned perspective. **PO7 : Employability Skill** Equip with skills, based on current trends and future expectations for career development and placements. **PO8: Entrepreneurial Skill** To create efficient entrepreneurs by accelerating critical thinking, problem solving, decision making and leadership qualities to facilitate startups. **PO9: Research Related Skill** A sense of inquiry and capability for questioning, problem arising, synthesizing and articulating. Ability to recognize cause and effect relationships, define problems, formulate and test hypothesis, analyze, interpret and draw conclusions from data, establish hypothesis, predict cause and effect relationships, ability to plan, execute and report the results of an experiment or investigation. **PO10: Lifelong Learning** Identify the need for skills necessary to be successful in future, through self- paced and self - directed learning aiming at personal development, meeting economic, social and cultural objectives, adapting to changing trends and demands of work place. **PO11: Instrumentation Skill** Able to handle conventional and sophisticated instruments thereby acquiring employability skills. **PO12: Leadership Readiness and Qualities** Capability for building a team, identifying the tasks, setting direction, formulating an inspiring vision, employing skills to reach the right destination, smoothly. **PO13: Information/ Digital Literacy**

	Ability to use software for interpretation and analysis of data in a variety of learning situations. **PO14: Cooperation and Team Work** Ability to work effectively with diverse teams, facilitate cooperative or coordinated effort on the part of a group and act together as a group or as a team in the interest of a common cause and work efficiently as a member of a team.

Programme Specific Outcomes	**PSO-1: Placement** Prepare the students in varied disciplines like agriculture, industry - medical, pharma, dairy, hotel, food and food processing, immunological, cosmetics, vermitechnology and water treatment for effective and respectful placement. **PSO-2: Entrepreneurship** To create effective entrepreneur by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO-3: Research and Development** Design and implement HR systems that comply with good laboratory practices, following ethical values, leading the organization towards growth and development. . **PSO-4: Contribution to Society** To contribute to the development of society and produce microbiological products, by collaborating with stake holders, related to the betterment of environment and mankind at the national and global level.

Eligibility:

- Candidate should have passed a UG degree (B.Sc Microbiology/ Biochemistry/ Zoology/ Botany/Immunology/Biotechnology/Applied Microbiology/Integrated Biology/Medical Microbiology) or equivalent life science degree.
- Candidate should have secured at least 50%.

- A relaxation of 5-10% in the total percentage will be given to SC, ST candidates.
- Candidates sponsored by industries/hospitals/Clinical laboratories may be considered for admission.

MethodsofEvaluation		
Internal Evaluation	ContinuousInternalAssessmentTest	25 Marks
	Assignments	
	Seminars	
	AttendanceandClassParticipation	
External Evaluation	EndSemesterExamination	75 Marks
	Total	100 Marks
MethodsofAssessment		
Recall(K1)	Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions	
Understand/Comprehend(K2)	MCQ,True/False,Shortessays,Conceptexplanations,Shortsummaryor Overview	
Application (K3)	Suggestidea/conceptwithexamples,Suggestformulae, Solveproblems, Observe,Explain	
Analyze(K4)	Problem-solvingquestions,Finishaprocedureinmanysteps,Differentiate	
	betweenvariousideas,Mapknowledge	
Evaluate(K5)	Longer essay/Evaluationessay,Critiqueorjustifywithprosandcons	
Create(K6)	Checkknowledgeinspecificoroffbeatsituations,Discussion,Debatingor Presentations	

- **Question paper pattern for External examination for Core and Elective papers:**

WRITTEN EXAMINATION QUESTION PAPER PATTERN

Theory Paper (Bloom's Taxonomy based)

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration: Three Hours**
Memory Recall/Example/ Counter Example / Knowledge about the Concepts/Understanding	**Part–A (10x2=20Marks)** Answer ALL questions **Each Question carries 2 marks**
	Two questions from each Unit
	Question 1 toQuestion10

Descriptions/Application (problems)	**Part–B (5x5=25Marks) Answer ALL questions Each question carries 5 Marks**
	Either - or Type Both parts of each question from the same Unit
	Question 11 (a) or 11(b) to **Question 15(a) or 15(b)**
Analysis/Synthesis / Evaluation	**Part-C (3x 10 = 30 Marks) Answer any THREE questions Each question carries 10 Marks**
	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

***Minimum credits required to pass:91**

Project Report

A student should select a topic for the Project Work at the end of the fifth semester itself and submit the Project Report at the end of the sixth semester. The Project Report shall not exceed 75typed pages in Times New Roman font with 1.5linespace.

Project Evaluation

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25Marks; External (Viva):75 Marks).

Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Grade	Description
90 –100	9.0 –10.0	O	Outstanding
80-89	8.0 –8.9	D+	Excellent
75-79	7.5 –7.9	D	Distinction
70-74	7.0 –7.4	A+	VeryGood
60-69	6.0 –6.9	A	Good

50-59	5.0 –5.9	B	Average

Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the prescribed form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

MOTHER TERESA WOMEN'S UNIVERSITY,KODAIKANAL

M.Sc. MICROBIOLOGY SYLLABUS
2023-2024

SEMESTER-I								
Course Code	**Course Title**	**Hours**			**Credits**	**CIA**	**ESE**	**Total**
		L	**T**	**P**				
P23MBT11	Core-1: **General Microbiology and Microbial Diversity**	4	3		5	25	75	100
P23MBT12	Core-2: **Immunology, Immunomics and Microbial Genetics**	4	3		5	25	75	100
P23MBP11	Core – 3: Practical – I: **General Microbiology and Microbial Diversity & Immunology, Immunomics and Microbial Genetics**			6	4	25	75	100
P23MBE1A / P23MBE1B / P23MBE1C	Discipline Specific Elective -1 A - Forensic Science / B - Health Hygiene / C - Microalgal Technology	3	2		3	25	75	100
P23WSG11	Generic Course – Women Empowerment	3	2		3	25	75	100
	Total	**30**			**20**	**-**	**-**	**500**
SEMESTER-II								
P23MBT23	Core-4: Medical Bacteriology and Mycology	3	3		5	25	75	100
P23MBT24	Core-5: Medical Virology and Parasitology	3	3		5	25	75	100
P23MBP22	Core – 6: Practical – II Medical Bacteriology , Mycology ,Medical Virology and Parasitology			6	4	25	75	100
P23MBE2A / P23MBE2B / P23MBE2C	Discipline Specific Elective-2 A – Epidemiology / B - Clinical Diagnostic Microbiology / C - Bioremediation	2	2		3	25	75	100
P23MBS21	SEC I (NME)- Vermitechnology	2	2		2	25	75	100
P23CSG22	Generic Course – Cyber Security	2	2		3	25	75	100
	Total	**30**			**22**	**-**	**-**	**600**

FIRST YEAR
SEMESTER-I

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**

P23MBT11	**General Microbiology and Microbial Diversity**	**Core Course I**	**4**	**3**	**-**	**-**	**5**	**7**	**25**	**75**	**100**

Course Objectives	
CO1	Acquire knowledge on the principles of different types of microscopes and their applications.
CO2	Compare and contrast the structure of bacteria and fungi. Illustrate nutritional requirements and growth in bacteria.
CO3	xemplify, isolate and cultivate microalgae from diverse environmental sources.
CO4	xplain various pure culture techniques and discuss sterilization methods.
CO5	***Discuss the importance and conservation of microbial diversity.***

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	History and Scope of Microbiology. Microscopy – Principles and applications. Types of Microscopes - Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force, Confocal microscope. Micrometry – Stage, Ocular and its applications.	20	CO1
II	Bacterial Structure, properties and biosynthesis of cellular components – Cell wall. Actinomycetes and Fungi - Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition - Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.	20	CO2
III	Algae - Distribution, morphology, classification, reproduction and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection and large-scale cultivation. Life cycle - *Chlamydomonas, Volvox Spirogyra* (Green algae), *Nostoc* (Cyanobacteria) *Ectocarpus, Sargassum* (Brown algae), *Polysiphonia, Batrachospermum* (Red algae).	15	CO3
IV	Microbial techniques - Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems - Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres - National and International.	15	CO4
V	Biodiversity - Introduction to microbial biodiversity –	20	CO5

	Thermophiles - Classification, Thermophilic Archaebacteria and its applications. Methanogens - Classification, Habitats, applications. Alkaliphiles and Acidophiles - Classification, discovery basin, its cell wall and membrane. Barophiles - Classification and its applications. Halophiles - Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes, Osmoadaptation / halotolerance - Applications of halophiles. Conservation of Biodiversity.		
	Total	90	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Examine various microbes employing the microscopic techniques learnt. Measure and compare the size of microbes.	PO1, PO4, PO11
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

Text Books

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

REFERENCES BOOKS

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

Web Resources

1.	http://sciencenetlinks.com/tools/microbeworld
2.	https://www.microbes.info/
3.	https://www.asmscience.org/VisualLibrary
4.	https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5.	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	M			M							S			
CO2	L			S										
CO3							S	S	M					
CO4			S	S			S							
CO5					S		S	S	S					

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CI	**External**	**Total**

									A	**l**	
P23MBT12	**Immunology, Immunomics and Microbial Genetics**	**Core Course II**	**4**	**3**	**-**	**-**	**5**	**7**	**25**	**75**	**100**

Course Objectives	
CO1	)iscuss immunity, organs and cells involved in immunity. Compare the types of antigens and their properties.
CO2	)escribe immunoglobulin and its types. Categorize MHC and understand its significance.
CO3	lucidate the mechanisms of different hypersensitivity reactions. List out the Vaccines and discuss their development.
CO4	Acquire knowledge the structure DNA in prokaryotes and eukaryotes
CO5	Explain out gene transfer studies in microbes.

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Introduction to biology of the immune system – Cells and organs of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Antigen processing and presentation to T-lymphocytes.	20	CO1
II	Immunoglobulins. Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions. Antigen recognition – TCR, Diversity of TCR, T cell surface alloantigens, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity, DTH response.	20	CO2
III	Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of	25	CO3

	ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D- antigens. Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay- Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry. Immune regulation mechanisms – immuno-induction, immuno- suppression, immuno-tolerance, immuno-potentiation, Immunomodulation. Role of cytokines, lymphokines and chemokines. Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants. Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology.		
IV	Structural of prokaryotic and eukaryotic genome. Introduction to prokaryotic genomic structure, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications-methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, organelle genome.	13	CO4
V	Gene Transfer Mechanisms- Conjugation and its uses. Transduction, Generalized and Specialized, Transformation– Natural Competence and Transformation. Transposition and Types of Transposition reactions. Insertion sequences, complex and compound transposons – T10, T5, and Retroposon. Mechanism – Transposons of *E. coli*, Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.	12	CO5
	Total	60	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Categorize the immune response to a variety of antigens. Identify different immune cells involved in immunity.	PO1, PO4, PO6, PO7, PO9
CO2	Justify the significance of MHC molecules in immune response and antibody production.	PO1, PO4, PO5,PO6, PO9
CO3	Design antibodies and evaluate immunological assays in patient samples.	PO4, PO6, PO7, PO8, PO9, PO10
CO4	Analyze genomic DNA of prokaryotes and eukaryotes.	PO4,PO5, PO6, PO7, PO9, PO10

CO5	Summarize gene transfer mechanisms for experimental study.	PO4,PO5, PO6, PO7, PO9, PO10
Text Books		
1.	Coico R., Sunshine G. and Benjamini E. (2003). Immunology – A Short Course. (5th Edition). Wiley-Blackwell, New York.	
2.	Owen J. A., Punt J., Stranford S. A. and Kuby J. (2013). Immunology, (7th Edition). W. H. Freeman and Company, New York.	
3.	Abbas A. K., Lichtman A. H. and Pillai S. (2021). Cellular and Molecular Immunology. (10th Edition). Elsevier.	
4.	Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. (4th Edition). Narosa Publishing House, New Delhi.	
5.	Gardner E. J. Simmons M. J. and Snusted D.P. (2006). Principles of Genetics. (8th Edition). Wiley India Pvt. Ltd.	
References Books		
1.	Travers J. (1997). Immunobiology - The Immune System in Health and Disease. (3rd Edition). Current Biology Ltd. New York.	
2.	Delves P.J., Martin S., Burton D. R. and Roitt I. M. (2006). Roitt's Essential Immunology. (11th Edition). Wiley-Blackwell.	
3.	Hay F. C. and Westwood O. M. R. (2002). Practical Immunology (4th Edition). Wiley-Blackwell.	
4.	Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. (5th Edition). ASM Press.	
5.	Russell P.J. (2010). Genetics - A Molecular Approach. (3rd Edition). Pearson New International Edition.	
Web Resources		
1.	https://www.ncbi.nlm.nih.gov/books/NBK279395/	
2.	https://med.stanford.edu/immunol/phd-program/ebook.html	
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/	
4.	[PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in	
5.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/	

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	S			M		M	S		S					
CO2	S			S	M	S			S					
CO3				S		S	S	S	S	M				
CO4				S	M	S	M		S	M				
CO5				S	M	S	M		S	S				

Subject Code	Subject Name Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
P23MBP11	Practical I - Core Course III **General Microbiology and Microbial Diversity & Immunology, Immunomics and Microbial Genetics**	**-**	**-**	**6**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives			
CO1	Gain knowledge on the fundamentals, handling and applications of microscopy, sterilization methods. Identify microbes by different staining methods.		
CO2	Prepare media for bacterial growth. Discuss plating and growth measurement techniques.		
CO3	Acquire adequate skills to perform blood grouping and serological reactions.		
CO4	Provide fundamental skills in preparation, separation and purification of immunoglobulin.		
CO5	Apply the knowledge of molecular biology skills in clinical diagnosis.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Microscopic Techniques: Light microscopy: Hay infusion broth. Wet mount to show different types of microbes, hanging drop. Dark field microscopy – Motility of Spirochetes. Washing and cleaning of glass wares: Sterilization methods: moist heat, dry heat, and filtration. Quality control check for each method. Staining techniques - Simple staining, Gram's staining, Acid fast staining, Meta chromatic granule staining, Spore, Capsule, Flagella.	20	CO1
II	Media Preparation: Preparation of liquid, solid and semisolid media. Agar deeps, slants, plates. Preparation of basal, enriched, selective and enrichment media. Preparation of Biochemical test media, media to demonstrate enzymatic activities. Microbial Physiology: Purification and maintenance of microbes. Streak plate, pour plate, and slide culture technique. Aseptic transfer. Direct counts – Total cell count, Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve. Effect of physical and chemical factors on growth. Anaerobic culture methods.	20	CO2
III	Hematological reactions - Blood Grouping – forward and reverse, Rh Typing Identification of various immune cells by morphology – Leishman staining, Giemsa staining. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP. Detection of HBs Ag by ELISA. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID) Immuno-electrophoresis and staining of precipitin lines- Rocket immuno electrophoresis and counter current immuno electrophoresis.	20	CO3
IV	Preparation of lymphocytes from peripheral blood by density gradient centrifugation.	10	CO4

	urification of immunoglobulin– Ammonium Sulphate Precipitation. eparation of IgG by chromatography using DEAE cellulose or Sephadex.		
V	Vestern Blotting – Demonstration. olation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis stimation of DNA using colorimeter (Diphenylamine reagent) eparation of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) V induced mutation and isolation of mutants by replica plating technique. lasmid DNA isolation from *E.coli*. NA isolation from yeast. NA estimation by Orcinol method.	20	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Apply microscopic techniques and staining methods in the identification and differentiation of microbes.	PO1, PO6, PO7, PO8, PO9, PO11
CO2	Apply the knowledge on the sterilization of glass wares and media by different methods and measurement of cell growth.	PO1, PO6, PO7, PO8, PO9, PO11
CO3	Perform and evaluate immunological reactions to aid diagnosis.	PO5, PO7, PO8, PO9, PO11
CO4	Assess the level of lymphocytes in a blood sample and purify immunoglobulin employing appropriate techniques.	PO6, PO7, PO8, PO9, PO11
CO5	Perform DNA extraction and gene transfer mechanisms, analyze and identify by gel electrophoresis	PO6, PO7, PO8, PO9, PO11

Text Books

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

References Books

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
2. Gupta P. S. (2003). Clinical Immunology. Oxford University Press.

3.	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
4.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. (3rd Edition). John Wileys and Sons Ltd. 2012.
5.	Maloy S. R., Cronan J.E. Jr. and Freifelder D. (2011). Microbial Genetics. (2nd Edition). Narosa Publishing Home Pvt Ltd.
Web Resources	
1.	http://textbookofbacteriology.net/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
3.	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4.	[PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
5.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	M					S	M	M	S		M			
CO2	M					S	M	M	S		M			
CO3					S		S	M	S		M			
CO4						S	S	M	S		S			
CO5						S	S	M	S		S			

Subject Code	Subject Name Discipline Specific Elective	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
P23MBE1A	**Forensic Science**	**3**	**2**	**-**	**-**	**3**	**5**	**25**	**75**	**100**

Course Objectives			
CO1	Understand the Scope, need and learn the tools and techniques in forensic science.		
CO2	Comprehend organizational setup of a forensic science laboratory.		
CO3	Identify and Examine body fluids for identification.		
CO4	Extract DNA from blood samples for investigation.		
CO5	Recognize medico legal post mortem procedures and their importance.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.	12	CO1
II	Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.	12	CO2
III	Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.	12	CO3
IV	DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood samples - Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.	12	CO4
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.	12	CO5
	Total	60	

Course Outcomes	On completion of this course, students will;	
CO1	Identify the scope and need of forensic science in the present scenario.	PO1, PO6, PO7, PO8, PO9
CO2	Plan for the organizational setup and functioning of forensic science laboratories.	PO1, PO6, PO7, PO8, PO9
CO3	Analyze the biological samples found at the crime scene.	PO1, PO5, PO7, PO8, PO9

CO4	Perform extraction and identification of DNA obtained from body fluids.	PO1, PO6, PO7, PO8, PO9
CO5	Discuss the concept of forensic toxicology.	PO1, PO6, PO7, PO8, PO9

	Text Books
1.	Nanda B. B. and Tewari R. K. (2001) Forensic Science in India: A Vision for the Twenty First Century. Select Publishers, New Delhi. ISBN-10:8190113526 / ISBN-13:9788190113526.
2.	James S. H. and Nordby, J. J. (2015) Forensic Science: An Introduction to Scientific and Investigative Techniques. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3.	Li R. (2015) Forensic Biology. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4.	Sharma B.R (2020) Forensic science in criminal investigation and trials. (6th Edition)Universal Press.
5.	Richard Saferstein (2017). Criminalistics- An introduction to Forensic Science. (12th Edition).Pearson Press.
	Reference books
1.	Nordby J. J. (2000). Dead Reckoning. The Art of Forensic Detection- CRC Press, New York. ISBN:0-8493-8122-3.
2.	Saferstein R. and Hall A. B. (2020). Forensic Science Hand book, Vol. I, (3rd Edition). CRC Press, New York. ISBN-10:1498720196.
3.	Lincoln, P.J. and Thomson, J. (1998). (2nd Edition). Forensic DNA Profiling Protocols. Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4.	Val McDermid (2014). Forensics. (2nd Edition). ISBN 9780802125156.
5.	Vincent J. DiMaio., Dominick DiMaio. (2001). Forensic Pathology (2nd Edition). CRC Press.
	Web resources
1.	http://clsjournal.ascls.org/content/25/2/114
2.	https://www.ncbi.nlm.nih.gov/books/NBK234877/
3.	https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8
4.	https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics
5.	https://cisac.fsi.stanford.edu/events/microbial forensics

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	L					S	M	M	S					
CO2	M					S	M	M	S					
CO3	L				S		S	M	S					
CO4	M					S	S	M	S					
CO5	M					S	S	M	S					

Subject Code	Subject Name Elective - B	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
P23MBE1B	**Health and Hygiene**	**3**	**2**	**-**	**-**	**3**	**5**	**25**	**75**	**100**

Course Objectives

CO1	Acquire knowledge on hygiene and live healthy.
CO2	Provide insights on health laws for food safety and hygiene.
CO3	Explain health, physical exercises and their importance.
CO4	Illustrate mental hygiene and involved in mental hygiene.
CO5	Describe the various health and health education programmes by the government.

UNIT	Details	No. of Hours	Course Objectives
I	Introduction to hygiene and healthful live. Factors affecting health, health habits and practices. Recognizing positive & negative practices in the community. Scientific principles related to health.	12	CO1
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.	12	CO2
III	Physical health, physical exercises and their importance – Walking, jogging, yoga and meditation, stress relief. International control of health, WHO. Personal hygiene, Sun bathing, Colon Hygiene. Health destroying habits and addictions - Pan, supari, ganja, drinking, smoking, tea and coffee.	12	CO3
IV	Mental hygiene - factors responsible, developmental tasks, basic needs, emotional stability. Mental hygiene and health in infancy, early childhood, adolescence, adulthood and old age. Mental health occupational hazards.	12	CO4
V	Health programme and health education – Malaria control, Tuberculosis control, AIDS control programmes and Immunization Programmes. Family planning, Reproductive and Child health programmes (RCH).	12	CO5
	Total	60	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
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

Text Books	
1.	Bamji M. S., Krishnaswamy K. and Brahmam G. N. V. (2019). Textbook of Human Nutrition. (4th Edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2.	Swaminathan (1995) Food& Nutrition (Vol I) (2nd Edition). The Bangalore Printing &Publishing Co Ltd., Bangalore.
3.	Paniker J. C. K. and Ananthanarayan R. (2017). Textbook of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd
4.	Lindsay Dingwall.(2010). **Personal Hygiene Care** Print ISBN:9781405163071 |Online ISBN:9781444318708 |DOI:10.1002/9781444318708
5.	Walter C. C. Pakes(1900). The Science of Hygiene: a Text-book of Laboratory Practice. (London: Methuen and Co.,).
References Books	
1.	Khader V. (2000) Food, Nutrition and Health, Kalyan Publishers, New Delhi.
2.	Srilakshmi, B. (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi.
3.	Dubey R.C. and Maheshwari D. K. (2010). Practical Microbiology. S. Chand.
4.	Park K. 2007, Park's text book of Preventive and Social Medicine, Banarsidas Bhanot publishers, India.
5.	Srilakshmi, 2002, Dietetics, New Age Publications, India
Web Resources	
1.	Health and Hygiene - Personal Hygiene, Community Hygiene and Diseases (vedantu.com)
2.	Chapter-32.pdf (nios.ac.in)
3.	Menstrual Health and Hygiene Guide | Student Health and Counseling Services (ucdavis.edu)
4.	https://nap.nationalacademies.org/read/11756/chapter/13
5.	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=112325

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14

CO1	L				S					M			
CO2					S					M			
CO3					S					L			
CO4					S					M			
CO5	L				S					M			

Subject Code	Subject Name Category – Elective-1C	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
P23M BE11C	**Microalgal Technology**	**3**	**2**	**-**	**-**	**3**	**5**	**25**	**75**	**100**

Course Objectives

CO1	Characterize the different groups of algae.
CO2	Describe the cultivation and harvesting of algae.
CO3	Identify the commercial applications of various algal products.
CO4	Apply microalgae for environmental applications.
CO5	Employ microalgae as alternate fuels.

UNIT	Details	No. of Hours	Course Objectives
I	Introduction to Algae - General characteristics. Classification of algae according to Fritsch. Salient features of different groups of algae. Distribution - Freshwater, brackish water and marine algae. Identification methods. An overview of applied Phycology. Economically important microalgae.	12	CO1
II	Cultivation of freshwater and marine microalgae - 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.	12	CO2
III	Microalgae in food and nutraceutical applications - Algal single cell proteins. Cultivation of *Spirulina* and *Dunaliella*. Microalgae as aquatic, poultry and cattle feed. Microalgal biofertilizers. Value-added products from microalgae. Pigments - Production of microalgal carotenoids and their uses. Phycobiliproteins - production and commercial applications. Polyunsaturated fatty acids as active nutraceuticals. Microalgal secondary metabolites - Pharmaceutical and cosmetic applications.	12	CO3
IV	Microalgae in environmental applications. 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.	12	CO4
V	Microalgae as feed stock for production of biofuels - Carbon-neutral fuels. Lipid-rich algal strains - *Botryococcus braunii*. Drop-in fuels from algae - hydrocarbons and biodiesel, bioethanol, biomethane, biohydrogen and syngas	12	CO5

	from microalgae biomass. Biocrude synthesis from microalgae. Integrated biorefinery concept. Life cycle analysis of algae biofuels.		
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
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, PO11, PO14
CO5	Compare and critically evaluate recent applied research in these microalgal applications.	PO7, PO8, PO9

Text Books	
1.	Lee R.E. (2008). Phycology. Cambridge University Press.
2.	Sharma O.P. (2011). Algae. Tata McGraw-Hill Education.
3.	Shekh A., Schenk P., Sarada R. (2021). Microalgal Biotechnology. Recent Advances, Market Potential and Sustainability. Royal Society of Chemistry.
4.	Lele. S.S., Jyothi Kishen Kumar (2008). Algal bio process technology. New Age International P(Ltd)
5.	Das., Mihirkumar. Algal Biotechnology. Daya Publishing House, New Delhi.
References Books	
1	Andersen R.A. (2005). Algal culturing techniques. Academic Press, Elsevier.
2	Bux F. (2013). Biotechnological Applications of Microalgae: Biodiesel and Value-added Products. CRC Press.
3	Singh B., Bauddh K., Bux, F. (2015). Algae and Environmental Sustainability. Springer.
4	Das D. (2015). An algal biorefinery: An integrated approach. Springer.
5	Bux F. and Chisti Y. (2016). Algae Biotechnology: Products and Processes. Springer.
Web Resources	
1	https://www.classcentral.com/course/algae-10442
2	https://onlinecourses.nptel.ac.in/noc19_bt16/preview
3	https://freevideolectures.com/course/4678/nptel-industrial-biotechnology/46
4	https://nptel.ac.in/courses/103103207
5.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microalgae

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	S													
CO2	S					M								
CO3							S	S	S					
CO4							S		S		M			M
CO5							M	S	S					

FIRST YEAR
SEMESTER-II

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
P23MBT23	**Medical Bacteriology and Mycology**	**Core Course IV**	**3**	**3**	**-**	**-**	**5**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	Acquire Knowledge on collection, transportation and processing of various kinds of clinical specimens.
CO2	Explain morphology, characteristics and pathogenesis of bacteria.
CO3	Discuss various factors leading to pathogenesis of bacteria.
CO4	Acquire knowledge on antifungal agents and their importance.
CO5	Describe various diagnostic methods available for fungal disease diagnosis.

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.	20	CO1
II	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci, Streptococci, Pneumococci, Neisseriae., Bacillus, Corynebacteria, Mycobacteria* and *Clostridium.*	20	CO2
III	Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, *Yersinia, Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella., Spirochaetes-Leptospira, Treponema* and *Borrelia*. Nosocomial, zoonotic and opportunistic infections -prevention and control.	20	CO3
IV	Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. *Trichophyton, Epidermophyton & Microsporum*. Yeasts of medical importance – *Candida, Cryptococcus*. Mycotoxins. Antifungal agents, testing methods and quality control.	15	CO4
V	Dimorphic fungi causing Systemic mycoses, *Histoplasma, Coccidioides, Sporothrix, Blastomyces.* Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing	15	CO5

	secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents.		
	Total	90	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
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

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

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

Web Resources	
1.	http://textbookofbacteriology.net/nd
2.	https://microbiologysociety.org/members-outreach-resources/links.html

3.	https://www.pathelective.com/micro-resources
4.	http://mycology.cornell.edu/fteach.html
5.	https://www.adelaide.edu.au/mycology/

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	M				S				M					
CO2	M				S				M					
CO3	M				S				M					
CO4					S				M					
CO5					S				M					

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
P23MBT24	**Medical Virology and Parasitology**	**Core Course V Theory**	**3**	**3**	**-**	**-**	**5**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	Describe the replication strategy and cultivation methods of viruses.
CO2	Acquire knowledge about oncogenic virus and human viral infections.
CO3	Develop diagnostic skills, in the identification of virus infections.
CO4	Impart knowledge about parasitic infections.
CO5	Develop diagnostic skills, in the identification of parasitic infections.

UNIT	Details	No. of Hours	Course Objectives
I	General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point).	20	CO1
II	Virus Entry, Host Defenses Against Viral Infections, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, treatment for the following viruses: DNA Viruses- Pox , Herpes , Adeno , Papova and Hepadna , RNA Viruses- Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV and other Hepatitis viruses, Arbo – Dengue virus, Ebola virus, Emerging and reemerging viral infections	20	CO2
III	Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle-typing and application in bacterial genetics. Diagnosis of viral infections –conventional serological and molecular methods. Antiviral agents and viral vaccines.	15	CO3
IV	Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba,* Aerobic and Anaerobic amoebae, *Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania,* and *Trypanasoma.*	15	CO4
V	Classification, life cycle, pathogenicity, laboratory	20	CO5

	diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia Solium, T. Saginata, T. Echinococcus*. Trematodes – *Fasciola Hepatica, Fasciolopsis Buski, Paragonimus, Schistosomes*. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides* and *Wuchereria*. Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti-protozoan drugs.		
	Total	90	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
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

Text Books

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

Reference Books

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

3.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical

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

	Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
5.	Levanthal R. and Cheadle R. S. (2012). Medical Parasitology. (6th Edition). S.A. Davies Co. Philadelphia.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1					M		L	L		M				
CO2					M		L	L		M				
CO3					M		L	L		M				
CO4					M		L	L		M				
CO5					M		L	L		M				

Subject Code	Subject Name	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
P23MBP22	**Practical II -** Medical Bacteriology, Mycology, Medical Virology and Parasitology	**-**	**-**	**6**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	Develop skills in the diagnosis of bacterial infections and antimicrobial sensitivity.
CO2	Impart knowledge on fungal infections and its diagnosis.
CO3	Diagnose parasitic
CO4	To gain knowledge about industrially important microbes.
CO5	Screen and utilize microorganisms for effective industrial production of metabolites.

UNIT	Details	No. of Hours	Course Objectives
I	taining of clinical specimens - Wet mount, Differential and Special staining methods. olation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests. numeration of bacteria in urine to detect significant bacteriuria. ntimicrobial sensitivity testing - Kirby Bauer method and Stokes method. Minimum inhibitory concentration (MIC) test. Minimum bactericidal concentration (MBC) test.	20	CO1
II	dentification and Classification of common fungi. Mounting and staining of VAM spores. xamination of different fungi by Lactophenol cotton blue staining. xamination of different fungi by KOH staining. ultivation of fungi and their identification - *Mucor, Rhizopus, Aspergillus, Penicillium.* Microscopic observation of different asexual fungal spores. Microscopic observation of fungal fruiting bodies. dentification of Dermatophytes. olation and characterization of bacteriophage from natural sources by phage titration. ultivation of viruses –Egg Inoculation methods.	20	CO2

	)iagnosis of Viral Infections –ELISA –HIA. potters of viral inclusions and CPE-stained smears.		
III	xamination of parasites in clinical specimens - Ova/cysts in faeces. oncentration: methods – Floatation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods- Formal ether method. lood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain. dentification of common arthropods of medical importance - spotters of *Anopheles, Glossina, Phlebotomus, Aedes,* Ticks and mites.	20	CO3
IV	ood Laboratory Practices in Industrial Microbiology laboratory. tudy of Bioreactor and its essential parts. ulturing and Characterization of microorganisms used in Dairy and Pharmaceutical industry. creening for Enzyme producers (amylase /protease).)ptimization of parameters for Amylase production. creening for Organic acid producers (acetic acid/lactic acid). creening for Antibiotic producers.	15	CO4
V	mmobilization of microbial cells and enzyme and its assessment. Microbiological assays of fermentation products – MIC- MBC. Microbiological assay of antibiotics by cup plate method and other methods. terility testing of pharmaceuticals.	15	CO5
	Total	90	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
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	PO7, PO8, PO9, PO10

	laboratory tests in the diagnosis of infectious diseases.	
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

Text Books	
1.	Cullimore D. R. (2010). Practical Atlas for Bacterial Identification, 2nd Edition. Publisher-Taylor and Francis.
2.	Abbott A.C. (2010). The Principles of Bacteriology. Nabu Press.
3.	Parija S. C. (2012). Textbook of Practical Microbiology. Ahuja Publishing House.
4.	Cappuccimo, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, (6thEdition). Pearson Education, Publication, New Delhi.
5.	Morag C. and Timbury M.C. (1994). Medical Virology. 4th edn. Blackwell Scientific Publishers.
References Books	
1.	Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). Mackie & McCartney Practical Medical Microbiology. (14th Edition). Elsevier, New Delhi.
2.	Chart H. (2018). Practical Laboratory Bacteriology. CRC Press.
3.	Moore V. A. (2017). Laboratory Directions for Beginners in Bacteriology. Triste Publishing Ltd.
4.	.Cheesbrough M. (2006). District Laboratory Practice in Tropical countries.-Part 22nd Edition.Cambridge University Press.
5.	Murray P.R., Rosenthal K.S. and Michael A. (2013). Medical Microbiology. Pfaller. 7th Edition. Elsevier, Mosby Saunders
Web Resources	
1.	http://textbookofbacteriology.net/
2.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
3.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
5.	https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics- and-biotechnological-applications/vaccines-and-antiviral-agents

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14

CO1							M	M	M					
CO2							M	M	M					
CO3							M	M	L	L				
CO4							M	M	M	L				
CO5							M	M	M					

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
P23MBE2A	**Epidemiology**	**Elective Course III (Choice 1)**	**2**	**2 Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course Objectives

CO1	Describe the role of epidemiology in public health.
CO2	Explain about epidemiology tools and disease surveillance methods.
CO3	Analyze various communicable and non-communicable diseases in India.
CO4	Discuss on mechanism of antimicrobial resistance.
CO5	Outline on National health programmes that have been designed to address the issues.

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Fundamentals of epidemiology - Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission -Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - Factors, routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis.	12	CO1
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	CO2

III	Epidemiological aspects of diseases of national importance - Background to communicable and non-communicable diseases. Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Mucor mycosis, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.	12	CO3
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 *Pseudomonas*, *Acinetobacter*, *Clostridium difficile*, HBV, HCV, Rotavirus, *Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and management of nosocomial infections.	12	CO4
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), Curie Point PyMS (Pyrolysis Mass spectrometry), Protein profiling, Molecular typing methods.	12	CO5
	Total	60	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
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,

Text Books

1.	Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). Principles of

	Epidemiology in Public Health Practice., (3rd Edition). CDC.
2.	Gerstman B. (2013). Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology. (3rd Edition). Wiley Blackwell.
3.	Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) Medical Microbiology, (18th Edition). Churchill Livingstone, London.
4.	Jawetz E., Melnick J. L. and Adelberg E. A. (2000). Review of Medical Microbiology. (19th Edition). Lange Medical Publications, U.S.A.
5.	Dimmok N. J. and Primrose S. B. (1994). Introduction to Modern Virology.5th edn. Blackwell Scientific Publishers.
References Books	
1.	Bhopal R. S. (2016).Concepts of Epidemiology - An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology. (3rd Edition). Oxford University Press, New York.
2.	Celentano D. D. and Szklo M. (2018). Gordis Epidemiology. (6th Edition). Elseiver, USA.
3.	Cheesbrough, M. (2004). District Laboratory Practice in Tropical Countries - Part 2, (2nd Edition). Cambridge University Press.
4.	Ryan K. J. and Ray C. G. (2004). Sherris Medical Microbiology. (4th Edition), McGraw Hill, New York.
5.	Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). Principles of Bacteriology. (9th Edition). Edward Arnold, London.

Mapping with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	M													
CO2				L	L	S								
CO3	M				S									
CO4					S									
CO5				S	S									

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
P23MBE2B	**Clinical and Diagnostic Microbiology**	**Elective Course III (Choice 2)**	**2**	**2**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course Objectives			
CO1	Describe appropriate safety protocol and laboratory techniques for handling specimens and biomedical waste management.		
CO2	Develop working knowledge of techniques used to identify infectious agents in the clinical microbiology lab.		
CO3	Elucidate various diagnostic procedures in microbiology.		
CO4	Acquire knowledge on different methods employed to check antibiotic sensitivity.		
CO5	Gain knowledge on hospital acquired infections and their control measures.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Microbiology Laboratory Safety Practices -General Safety Guidelines, Handling of Biological Hazards, Infectious health care waste disposal - Biomedical waste management, Emerging and Re-emerging infections.	12	CO1
II	Diagnostic procedures - General concept of Clinical specimen collection, transport, storage and general processing in Microbiology laboratory - Specimen acceptance and rejection criteria.	12	CO2
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	CO3
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	CO4
V	Nosocomial infections – common types, sources, reservoir and mode of transmission, pathogenesis and control measures. Hospital Infection Control Committee (HICC) – Functions.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Apply Laboratory safety procedures and hospital waste disposal strategies.	PO5, PO6, PO7
CO2	Collect various clinical specimens, handle, preserve and process safely.	PO6, PO7

CO3	Identify the causative agents of diseases by conventional and molecular methods following standard protocols.	PO6, PO7, PO9, PO11
CO4	Assess the antimicrobial susceptibility pattern of pathogens.	PO7, PO9
CO5	Trace the sources of nosocomial infection and recommend control measures.	PO5, PO7

TEXT BOOKS

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

References Books

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

Web Resources

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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1					S	M	M							
CO2						M	S							
CO3						M	S		M		S			
CO4							S		M					
CO5					S		M							

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
P23MBE2C	**Bioremediation**	**Elective Course III (Choice 3)**	**2**	**2**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course Objectives	
CO1	Describe the nature and importance of bioremediation and use in real world applications.
CO2	Describe the typical composition of waste water and application of efficient technologies for water treatment.
CO3	Explain the fundamentals of treatment technologies and the considerations for its design and implementation in treatment plants.
CO4	Explain the potential of microbes in ore extraction and acquaint students with methods of reducing health risks caused by xenobiotics.
CO5	Familiarize the role of plants and their associated microbes in remediation and management of environmental pollution.

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Bioremediation - process and organisms involved. 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	CO1
II	Microbes involved in aerobic and anaerobic processes in nature. 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	CO2
III	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.	12	CO3
IV	Microbial leaching of ores - process, microorganisms involved and metal recovery with special reference to copper and iron. Biotransformation of heavy metals and xenobiotics. Petroleum biodegradation - reductive and oxidative. Dechlorination. Biodegradable of plastics and super bug.	12	CO4
V	Phytoremediation of heavy metals in soil - Basic principles of	12	CO5

	phytoremediation - Uptake and transport, Accumulation and sequestration. Phytoextraction. Phytodegradation. Phytovolatilization. Rhizodegradation. Phytostabilization – Organic and synthetic amendments in multi metal contaminated mine sites. Role of Arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria in phytoremediation.		
	Total	60	

Course Outcomes		
Course 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, PO11
CO3	Identify, formulate and design engineered solutions to environmental problems.	PO5, PO7, PO8, PO11
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 *Rhizobacteria* in phytoremediation.	PO1, PO5, PO6, PO7, PO8

Text Books	
1.	Bhatia H.S. (2018). A Text book on Environmental Pollution and Control. (2nd Edition). Galgotia Publications.
2.	Chatterjee A. K. (2011). Introduction to Environmental Biotechnology. (3rd Edition). Printice-Hall, India.
3.	Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial, 2nd edition, CRC Press.
4.	Liu, D.H.F and Liptak, B.G (2005). Hazardous Wastes and Solid Wastes, Lewis Publishers. .
5.	Rajendran, P. & Gunasekaran, P. (2006). Microbial Bioremediation. 1st edition. MJP Publishers
References Books	
1.	Sangeetha J., Thangadurai D., David M. and Abdullah M.A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development. (1st Edition). Apple Academic Press.
2.	Singh A. and Ward O. P. (2004). Biodegradation and Bioremediation. Soil Biology. Springer.
3.	Singh A., Kuhad R. C., and Ward O. P. (2009). Advances in Applied Bioremediation (1st Edition). Springer-Verlag Berlin Heidelberg, Germany.
4.	Atlas, R.M & Bartha, R. (2000). Microbial Ecology. Addison Wesley Longman Inc.

5.	Rathoure, A.K. (Ed.). (2017). Bioremediation: Current Research and Applications. 1st edition. I.K. International Publishing House Pvt. Ltd.
Web Resources	
1.	Bioremediation- Objective, Principle, Categories, Types, Methods, Applications (microbenotes.com)
2.	https://agris.fao.org › agris-search
3.	https://www.sciencedirect.com/topics/earth-and-planetary-sciences/bioremediation
4.	https://www.intechopen.com/chapters/70661
5.	https://microbiologysociety.org/blog/bioremediation-the-pollution-solution.html

Mapping with Programme Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	S	M		M	S									
CO2	S			M	S						S			
CO3					S		S	S			S			
CO4					S	S	S	S	S					
CO5	M				S	M	S	S						

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
P23MBS21	**Vermitechnology**	**Skill Enhancement Course 1**	**2**	**2**	**-**	**-**	**2**	**4**	**25**	**75**	**100**

Course Objectives

CO1	ntroduce the concepts of vermicomposting.
CO2	Explain the physiology, anatomy and biology of earthworms.
CO3	cquire the knowledge of the vermicomposting process.
CO4	Explain the trouble shooting, harvesting and packaging of vermin composts.
CO5	ain knowledge on applications of vermin composts and their value added products.

UNIT	Details	No. of Hours	Course Objectives
I	Introduction to Vermiculture - Definition, classification, history, economic importance- In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food and their value in maintenance of soil structure. Its role in the bio transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.	6	CO1
II	Earthworm Biology and Rearing - Key to identify the species of earthworms. Biology of *Eisenia fetida.* a) Taxonomy Anatomy, physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy Anatomy, physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).	6	CO2
III	Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.	6	CO3

IV	Vermicomposting - Trouble Shooting-Temperature-Aeration-Acidity- Pests and Diseases- Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques-Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method-migration method. Packing & Nutritional analysis of vermicompost.	6	CO4
V	Applications of Vermiculture - Vermiculture Bio-technology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products-Verm wash- vermicompost tea-vermi meal-enriched vermicompost-pelleted vermicompost.	6	CO5
	Total	30	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
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, PO8
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

Text Books

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

References Books

1	Roy D. (2018). Handbook of Vermitechnology. Lambert Academic

	Publishing.
2	umar A. (2005). Verms and Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
3	ekshmy M. S., Santhi R. (2012). Vermitechnology, Sara Publications, New Delhi, India.
4	Edwards CA, Arancon NQ ShermanRL. (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management 1st edn.CRC Press.
5	Ismail, S.A. (1997). Vermicology-The Biology of Earthworm.1st edn. Orient longman.
Web Resources	
1.	https://en.wikipedia.org/wiki/Vermicompost
2.	http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
3.	https://www.kngac.ac.in/elearning-portal/ec/admin/contents/4_18K4ZEL02_2021012803204629.pdf
4.	https://composting.ces.ncsu.edu/vermicomposting-2/
5.	https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	S			M	S				S					
CO2	S			M		S			S					
CO3	S			S		S	S	S						
CO4						S	S	S	S					
CO5	S			M	S	M	S							