Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(AUTONOMOUS)

Lead college

of

Karmaveer Bhaurao Patil University, Satara

Syllabus For

Master of Science

Part - II

APPLIED MICROBIOLOGY

Syllabus to be implemented w.e.f. June 2024

as Per NEP-2020

Preamble:

This syllabus is framed to give advanced knowledge of Applied Microbiology to postgraduate students at second year of two years of M.Sc. degree course. The goal of the syllabus is to make the study of Applied Microbiology popular, interesting and encouraging to the students for higher studies including research. The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students

M.Sc. Part II

Credit Framework for M.Sc. II

Structure of Course: M.Sc. – II Semester – III

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	III	MAMiT 531	Microbial Ecology and Extremophiles	4	4
		MAMiT 532	Molecular Biology	4	4
		MAMiT 533	Gene Technology and Genomics	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MAMiT 534 E-I MAMiT 534 E-II	E-I) Essentials of cell biology E-II) Food and Dairy Microbiology	2	2
		MAMiP 535	Research Project	12	6
		MAMiP 536	LAB- III (based on MAMiT-531, 532 and 533)	4	2
Total					**22**

Structure of Course: M.Sc. – II Semester –IV

el	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	IV	MAMiT 541	Essentials of Bioinformatics	4	4
		MAMiT 542	Essentials of Immunology	4	4
		MAMiT 543	Microbiological Quality Control and Assurance	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MAMiT 544 E-I MAMiT 544 E-II	E-I)Industrial Waste Management E-II) Medical Microbiology	4	4
		MAMiP 545	On Job Training (OJT)	8	4
		MAMi 546	LAB- IV (based on MAMiT-541, 542 and 543)	4	2
Total					**22**

SEMESTER III

MAMiT 531: MICROBIAL ECOLOGY & EXTREMOPHILES

Course Objectives:

The student should be able to :-

1. Understand the significance of microbial ecology.
2. Study ecology as a tool for global sustainability.
3. the applications of extremophiles.
4. Study the human microflora and its effects on health.

CREDIT = 4	**MICROBIAL ECOLOGY & EXTREMOPHILES**	**No. of hours : 60**
Unit I	**Basic Concepts of Microbial Ecology**	15
	1.1. Microbial Ecology – Concepts, niche, habitat, ecosystem and applications. 1.2. Introduction to microbial diversity, types of microorganisms- bacteria, archaea, eukarya, interactions between microorganisms, ecological succession. 1.3. Quantitative ecology-Sample collection- soil, water, air, sediment, biological samples 1.4 Sample processing 1.5.Determination of microbial number- Direct count, viable count procedure-Plate count and MPN	
Unit II	**Unit II - Recent Concepts in Microbial Ecology**	15
	2.1 Microbial biofilm Physiology, morphology, biochemistry of microbial biofilm formed in natural environment. 2.2 Mechanism of microbial adherence. 2.3 Laboratory methods used to obtain biofilm (with respect to physiology, growth, special arrangement, depth, surface physio chemistry) 2.4 Beneficial and harmful role of biofilms. 2.5 Biomimicry – Concept and Applications. 2.6 Bioremediation and Biodegradation - Engineering and bioremediation process its needs and limitations. 2.7 Molecular technique in Bioremediation.-Degradation of aromatic and alicyclic compounds- important organisms, use of mixed cultures in common	

	pathways of aromatic degradation, aerobic and anaerobic degradation of aromatic compounds	
Unit III	**Microbiome**	15
	3.1 Introduction-Microbiome Ecosystem Ecology 3.2 Human Microbiome project: Scientific background; Initiation of the HMP; The goal of the HMP; Implementation of the National Institute of Health HMP; The International Human Microbiome Consortium (IHMC). 3.3 Healthy Human Microbiome: Typical components and diversity of the microbiome; archaea, viruses, fungi, and other eukaryotes; 3.4 Geographical variation in the healthy microbiome; Microbiome establishment and early colonization; Hallmarks of health;outlook. 3.5 Human Microbiome at the interface of health and disease: Influences on the microbiota during host life cycles; Disease links and health implications.	
Unit IV	**Extremophiles and their Applications**	15
	4.1 Extremophiles- Concept 4.2 Thermophiles – Nucleic acids, Membrane adaptations, Proteins. 4.3 Psychrophiles – Membrane adaptation, Proteins 4.4.Acidophiles – Mechanism to tolerate acid and metal and acid toxicity. 4.5 Alkalophiles- Bioenergetics adaptations. 4.6 Extremozymes-Extremozyme – Characteristics, examples, structure 4.7 Biotechnological uses of archea as extremozymes and applications. 4.8 Biotechnological, applications of extreme proteins from different groups of methanogens. 4.9 Polyextremophiles – characteristics, examples and uses	

Course Outcomes:

Student will be able to :-

1. Comprehend the concepts of microbial ecology.
2. Apply recent trends in ecology for global sustainability.
3. Utilize extremophiles as industrial tools.
4. Imbibe basic concepts of the human microbiome.

References:-

1) R.M.Atlas, R. Bartha Microbial Ecology: Fundamentals and Applications, 4th Ed. Pearson India Education Services 2008

2) Charles Greday, Nicolas Glansdorff.,Physiology and Biochemistry of Extremophiles, ASM Press.2007

3) RajendranP,Gunasekaran P. Microbial Bioremediation, MJP Publishers,Chennai 2011

4) Odum Eugene Fundamentals of Ecology, Cengage Learning 2004

5) Ilseung Cho and Martin J. Blaser ,The Human Microbiome: At the Interface of Health and Disease-Nature Journal, 2013.

MAMiT 532: MOLECULAR BIOLOGY

Course Objectives:

The student should be able to :-

1. Understand the process of DNA replication in prokaryotes and eukaryotes
2. Study the process of transcription and translation in prokaryotes and eukaryotes
3.. explain various methods for gene sequencing
4.. Learn methodology, concept and applications of human genome project

CREDIT=4	**MOLECULAR BIOLOGY**	**No. of hours : 60**
Unit I	**DNA Replication**	15
	1.1 DNA replication in prokaryotes - Origin of replication, types of E. coli DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. 1.2 DNA replication in eukaryotes - Multiple replicons, eukaryotic DNA polymerases, ARS in yeast, ORC,regulation of replication. 1.3 Regulation of S phase of cell cycle – Introduction of cell cycle, phases: G1, G2, S and M. 1.4 Regulation of S phase: Replication and regulation, cdk kinases.	
Unit II	**Transcription & Regulation of Gene Expression**	15
	2.1 Transcription in Prokaryotes and Eukaryotes: 2.2 RNA Polymerase – Structure and function. 2.3 Transcription – Initiation, elongation, termination. 2.4 Post transcriptional modifications and structure of mRNA, rRNA. 2.5 Regulation of gene expression in bacteria 2.6 Concept of Negative and Positive regulation - Lac operon – nature of repressor, structure of repressor, Allosteric change in conformation of repressor. 2.7 Tryptophan operon- Tryptophan's Role in Negative Control of the tryptophan Operon, Control of the trp Operon by Attenuation, Defeating Attenuation 2.8 Regulator RNAs present in bacteria	

Unit III	**Translation**	15
	3.1 Translation Prokaryotes and Eukaryotes 3.2 Genetic code- Deciphering genetic code and its importance Altered code in mitochondria and induced variations in genetic code 3.3 Translation – Activation of amino acid, Initiation, Elongation and Termination process at molecular level 3.4 Translational frame shifting, RNA editing	
Unit IV	**Sequencing Genes and Genomes**	15
	4.1 Sequencing Genes and Genomes. -Methodology for DNA sequencing, Chain termination DNA sequencing (sanger's Method) 4.2 Pyro sequencing. 4.3 Shot gun approach of genome sequencing. 4.4 Clone coting approach of sequence assembly. 4.5 Use of maps to aid sequence assembly- Introduction to Genetic mapping, physical mapping 4.6 Mapping – Linkage maps, tetrad analysis, mapping with molecula markers, mapping using somatic cell hybrids, mapping by transformation and conjugation. 4.7 Human Genome Project.-Applications of Genome Project.	

Course Outcomes:

Students will be able to

1.Describe the process of gene expression and its regulation in prokaryotes and eukaryotes.

2. updated with techniques used in present research in genetics.

3. discuss methodology, concept and applications of human genome project

4. explain linkage maps, tetrad analysis

References:

1. Anthony JF Griffiths, Jeffrey H Miller, An introduction of Genetic Analysis 10th Edition. Freeman, 2010.

2. Harvey Lodish, James E. Darnell, Molecular Cell Biology,W.H.Freeman & Co Ltd, 2003

3. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry: 6th Edition – (W. H. Freeman, 2013

4. Jocelyn E Krebs, Lewin's Genes X (Jones & Bartlett Learning, 2009

MAMiT 533 : GENE TECHNOLOGY AND GENOMICS

Course Objectives:

Student should be able to:-

1. Study the basic knowledge on gene technology
2. Understand with the recent research in the sphere of gene technology.
3. discuss the tools and techniques used in genetic engineering.
4. describe the emerging trends in gene technology

CREDIT=4	**GENE TECHNOLOGY AND GENOMICS**	**No. of hours =60**
Unit I	**DNA Libraries**	15
	1.1 Introduction and types- Genomic and cDNA library. 1.2 Preparation of Genomic Library- Isolation of genomic DNA, generation of suitable sized fragments, cloning in suitable vector systems, and transformation in suitable host. 1.3 Preparation of cDNA library- Isolation of mRNA, preparation of cDNA fragments, cloning in suitable vector systems, and transformation in suitable host. 1.4 Screening of Libraries-Criteria to identify particular gene from gene library – 1.5 DNA sequencing 1.6 Expression of particular protein with immunological epitope - Enzymatic activity	
Unit II	**Directed Mutagenesis and Protein Engineering**	15
	2.1 Directed Mutagenesis: 2.2 Oligonucleotide directed mutagenesis with M-16 phage, PCR-amplified oligonucleotide directed mutagenesis, error-prone PCR, Random insertion and deletion mutagenesis,selection of mutant peptide – phage display and cell surface display 2.3 Protein Engineering: Adding disulfide bonds, changing aspargine to other amino acids, reducing number offree sulfhydryl residues, increasing enzymatic activity, modifying metal cofactor requirement, decreasing protein sensitivity, modifying protein sensitivity increasing enzyme stability and specificity, altering multiple properties	

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Unit III	**Genetic Engineering in Plants and Animals**	15
	3.1 Plants Plant transformation with Ti and Ri plasmid. 3.2 Ti plasmid derived vector systems. 3.3 Physical methods for transformation. 3.4 Chloroplast engineering animals 3.5 Gene transfer vectors 3.6 Transfection – Physical,Chemical. 3.7 Production of transgenic mice, Retroviral vector method, DNA microinjection method 3.8 Applications of transgenic mice, Transgenic Disease Models: Alzheimer's disease, Duchenne muscular dystrophy, Transgenic mice as test system	
Unit IV	**Recent Trends in Gene Technology**	15
	4.1 Genomics- Concept, Introduction, Comparative genomics of bacteria 4.2 Proteomics-Concept, Introduction, Expression analysis and characterization of proteins 4.3 CRISPR / Cas9 in Genome Editing- Concept, Introduction, Applications.	

Course Outcomes:

Student will be able to:-

1. Discuss types of Genomic and cDNA library
2. Comprehend recent trends in protein engineering.
3. Explain the applications of genetic engineering to industrial use.
4. Describe the concept of genomics, proteomics and CRISPR , Cas9 technique in Genome Editing

References:-

1. Glick, Bernard R., and Jack J. Pasternak. "Principles and applications of recombinant DNA." *ASM, Washington DC* 683, 1998.
2. Karani, Nyaga George, Kumer Kakon Uzzal, and Izegaegbe Daniel Omoikhoje. "Probiotics As Promising Therapeutics: a Review of Literature." *Researchgate. Net, February* 2023.
3. Borgio, J. Francis, K. Sahayaraj, and I. Alper Susurluk. *Microbial insecticides: principles and applications*. Nova Science Publishers, 2011.
4. Glick, Bernard R., and Cheryl L. Patten. *Molecular biotechnology: principles and applications of recombinant DNA*. John Wiley & Sons, 2022.

MAMiT 534: E 1: ESSENTIALS OF CELL BIOLOGY

Course Objectives:

The student should be able to :-

1. discuss cell structure in detail.
2. Study structural organization and function of the organelles.
3. describe the process of cell cycle.
4. Understand the concept of genes and chromosomes.

CREDIT=4	**ESSENTIALS OF CELL BIOLOGY**	**No. of hours=60**
Unit-I	**Introduction to cell biology**	**15**
	1.1 Introduction to cell, prokaryotic cell, eukaryotic cell, Chemical components of the cell 1.2 Structural organization and function of intracellular organelles 1.3 Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast 1.4 structure & function of cytoskeleton and its role in motility.	
Unit-II	**Cell division and cell cycle**	**15**
	2.1 Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. 2.2 Organization of genes and chromosomes Operon, unique and repetitive DNA 2.3 Interrupted genes, 2.4 gene families 2.5 structure of chromatin and chromosomes, 2.6 heterochromatin, euchromatin, 2.7 transposons	

Course Outcomes:

Student will be able to:

1. Imbibe basic concepts of cells.
2. Explain structural organization of intracellular organelles.
3. Discuss the process of mitotic, meiosis, and cell cycle.
4. Discuss the concept of genes and chromosomes.

References:

1. Lodish, Harvey F. Molecular Cell Biology. Macmillan, 2008.

2. Alberts, Bruce. Molecular Biology of the Cell. Garland Science, 2017.

3. Pollard, Thomas Dean, William C. Earnshaw, Jennifer Lippincott-Schwartz, and Graham T. Johnson. *Cell Biology*, 2017.

4. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander D Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Essential Cell Biology. Garland Science, 2015.

MAMiT 534 : E2: FOOD AND DAIRY MICROBIOLOGY

Course Objectives:

The student should be able to :-

1. Understand the significance of starter culture for in food and dairy industry
2. Study concept of prebiotic and probiotics
3. learn the techniques used in food preservation
4. discuss the Artificial intelligence in food industry and food safety and standards.

CREDIT=2	**FOOD AND DAIRY MICROBIOLOGY**	**No. of hours =60**
Unit I	**Microbiology of Starter Cultures and fermented dairy products**	15
	1.1 Introduction and annual utilization of starter cultures; History and taxonomy 1.2 Starter cultures; Classification of starter organisms: Starter types: single, mixed and multiple strain starter cultures; 1.3 Propagation and preservation of starter cultures; commercial starter preparations: concentrated and super concentrated starters 1.4 Metabolism of starter Organisms: biochemical characterization of lactic acid bacteria; carbohydrates, citrate and protein metabolism of starter cultures 1.5 Role of starter cultures in the preparation of various fermented milk 1.6 Microbiology of fermented milk products: their nutritional and therapeutic significance.	
Unit II	**Microbiology in Food**	15
	2.1 Microorganisms in food spoilage: Types of foods and their spoilage 2.2 Microbial, biochemical aspect of food spoilage 2.3 Physiology of food spoilage organisms : Importance, Response of microbes, future prospectus 2.4 Control by combination of methods (Hurdle concept) Novel emerging techniques of preservation – Bacteriocin – Introduction, types, mode of action, applications.	

	2.5 Applications of artificial intelligence in food industry 2.6 Quality control and Regulations of food industry: Microbiological quality control of milk and milk products: ISI standards, FAO/WHO regulations, FDA regulations and APHA/IDF regulations. 2.7 Principles of HACCP in Food industries, Quality Manuals and documentations for different products, Basic GMP in the industry	

Course Outcomes:

Student will be able to :-

1. Understand the significance of starter culture for in food and dairy industry
2. Apply the techniques in food preservation
3. apply the basics of artificial intelligence in food industry.
4. describe the rules and regulations of food safety .

References:-

1. K. Vijaya Ramesh Food Microbiology, MJP Publishers, Chennai 2007
2. Swaminathan M Essentials of Food and Nutrition (2nd Edition) Ganesh and Co.1974
3. Modi H.A. Dairy Microbiology, Pointer Publishers, India. 2009
4. J.S. Yadav, Grover S., Batish V.K. Comprehensive Dairy Microbiology, Metropolitan Book Cooperative Pvt. Ltd. 1993
5. Frazier W, Westoff D. Food Microbiology (5th Edition) Tata McGraw Hill Education 2013

MPP 535: Research Project (6 Credits)

Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 6 credit Research Project for semester III under the guidance of faculty members.Research project should be subject specific.

Practicals: 20 (2 Credits)

Practical Course Lab III : MAMiP 536

Course Objectives

Students should be able to

1.Isolate, identify extremophilic microorganisms from natural samples

2. Isolate and characterize etiological agents of dental caries.

3.Determine the rate of degradation of dye using microbial isolate.

4.produce probiotic curd using pure microbial strain and perform physical and chemical analysis

Practical Course : MAMiP 536

1. Laboratory production of probiotic curd and its physical and chemical analysis.
2. Estimation of pectin from plant material.
3. Adhesion of microorganisms to surface by dip slide method.
4. Study of siderophore producing microorganisms.
5. Isolation of petroleum degrading bacteria and determination of degradation rate.
6. Determination of rate of degradation of dye using microbial isolate.
7. Isolation of thermophiles from compost heap.
8. Screening of alkaliphilic bacteria from soil/water.
9. Isolation and enrichment of psychrophiles.
10. Screening of halophilic and halotolerant microorganisms.
11. Qualitative analysis of the hand microbiome by suitable method.
12. Isolation of etiological agents of dental caries.
13. DNA amplification by PCR.
14. Isolation and Identification of Anaerobic organisms.
15. Isolation of plasmid by chemical method.
16. Plasmid curing.
17. Isolation of lysozyme from egg white.
18. Preparation of protoplast using lysozyme and protoplast fusion.

19. Study of bacterial transformation.
20. Demonstration of Southern Blotting.

Course Outcomes:

Students will be able to

1.Isolate, identify extremophilic microorganisms from natural samples

2.cultivate etiological agent of dental caries.

3.Determine the rate of degradation of dye using microbial isolate.

4. produce probiotic curd using pure microbial strain and perform physical and chemical analysis

References:

1. Amaresan, Natarajan, Prittesh Patel, and Dhruti Amin, eds. *Practical handbook on agricultural microbiology*. Springer US, 2022.
2. Viljoen, Gerrit J., Louis H. Nel, and John R. Crowther, eds. *Molecular diagnostic PCR handbook*. Springer science & business media, 2005.
3. Wang, Furong, Chao Du, Junjun Chen, Lisheng Shi, and Hailong Li. "A new method for determination of pectin content using spectrophotometry." *Polymers* 2017
4. Willis, A. Trevor. Anaerobic bacteriology: clinical and laboratory practice. Butterworth-Heinemann, 2014.
5. Toldrá, Fidel, and Leo ML Nollet, eds. Handbook of dairy foods analysis. CRC Press, 2021.

SEMESTER IV

MAMiT 541: ESSENTIALS OF BIOINFORMATICS

Course Objectives:

Students should be able to:-

1. Study the concepts regarding basics of bioinformatics.
2. Understand the Sequence alignment and phylogenetic analysis.
3. learn the tools for sequence alignment
4. describe the essentials of structural bioinformatics and gene annotation

CREDIT=4	**ESSENTIALS OF BIOINFORMATICS**	**No. of hours =60**
Unit I	**Introduction to Bioinformatics**	15
	1.1 Introduction, History of Bioinformatics, Applications. 1.2 Major databases in bioinformatics 1.3 Nucleic acid databases (GenBank, DDBJ, EMBL). 1.4 Protein Databases (Primary, Secondary and Composite). 1.5 Specialized Genome Databases. Structural Classification Databases 1.6 Structural Databases (PDB). 1.7 Data management and analysis 1.8 Molecular biology and bioinformatics 1.9 Information search and data retrieval	
Unit II	**Directed Mutagenesis and Protein Engineering**	15
	2.1 Introduction, 2.2 Alignment of pairs of sequence 2.3 Alignment of multiple sequences 2.4 Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, 2.5 Method of construction of Phylogenetic trees[distance-based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method	

Unit III	**Tools for similarity search and sequence alignment**	15
	3.1 Working with FASTA 3.2 Working with BLAST 3.3 Filtering and gapped BLAST 3.4 FASTA and BLAST algorithm comparison Other programs	
Unit IV	**Structural Bioinformatics and Gene annotation**	15
	4.1 Introduction to Gene Annotation 4.2 Protein structure visualization and classification 4.3 Protein structure databases and Introduction to visualization databases and tools 4.4 Protein structure alignment Protein classification approaches	

Course Outcomes:

Student will be able to:-

1. describe the concepts regarding basics of bioinformatics
2. discuss the Sequence alignment and phylogenetic analysis
3. apply the tools for sequence alignment
4. explain the essentials of structural bioinformatics and gene annotation

References:

1. S.C. Rastogi, Bioinformatics: Methods And Applications: Genomics, Proteomics And Drug Discovery, fourth edition, Phi publication, January.

2. C. Stan Tsai, Computational Biochemistry, John Wiley and Sons, 2004. .

3.S.T.Andrew, Computer Networks, fourth Edition, Prentice Hall PTR, 2003.

4. Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002.

6. Branden ,Tooze John. Introduction to Protein Structure.New York, Garland Publishing Inc. 1999.

MAMiT 542 : ESSENTIALS OF IMMUNOLOGY

Course Objectives:

Students should be able to:

1.Understand various immunotechniques.

2. Study advanced concepts in immunology.

3. learn immunodeficiency diseases.

4. describe cell signaling pathways and concept of apoptosis

CREDIT=4	**ESSENTIALS OF IMMUNOLOGY**	**No. of hours =60**
Unit I	**Cell signaling and Apoptosis**	15
	1.1 Cell Signaling Signaling molecules and Signal receptors in immune system 1.2 Signal Transduction Pathways- 1.3 JAK-STAT Pathway 1.4 Phosphatidyl-Inositol Pathway 1.5 RAS-MAPK Pathway 1.6 IL 2 Signaling Pathway 1.7 Chemokine Signaling Pathway 1.8 Apoptosis 1.9 Molecules involved in apoptotic cell death 2.0 Mechanism of apoptosis Extrinsic Pathway, FAS signaling pathway, Intrinsic Pathway	
Unit II	**MHC complex and experimental systems**	15
	2.1 Major Histocompatibility Complex 2.2 General Organization and Inheritance of the MHC 2.3 Inheritance of MHC haplotypes in inbred mouse strains MHC molecules and genes. 2.4 Detailed genetic map of MHC genes. 2.5 Cellular distribution of MHC molecule 2.6 Regulation of MHC expression	

	2.7 MHC and immune responsiveness. **2.8 Antigen Presenting Pathway** Exogenous pathways of antigen processing and presentation And Endogenous pathways of antigen processing and presentation	
Unit III	**Tumor immunology and immunotechniques**	15
	3.1 Immunity to tumors 3.2 Tumor of immune system 3.3 Tumor antigen 3.4 Immune responses to tumor- T cell , antibodies ,NK cell, Macrophages, Evasion of immune response by tumors 3.5 Cancer immunotherapy. 3.6 Immunotechniques and their applications, Principle, Procedure, Advantages and disadvantages Flow Cytometry 3.7 Immunogold labelling for electron microscopy 3.8 Immuno-PCR 3.9 Mixed lymphocyte reaction. 4.0 Radioimmunoassay and Immunoprecipitation	
Unit IV	**Immunodeficiency Disorders**	15
	4.1 Primary immunodeficiencies 4.2 Lymphoid immunodeficiencies- Humoral Deficiencies- XLA, XHM 4.3 Cell-mediated Deficiencies –DiGeorge Syndrome 4.4 Combined Deficiencies – Severe SCID 4.5 Immunodeficiencies of the myeloid lineage Phagocytic Deficiencies- CGD, reduction in neutrophils count 4.6 Complement defects- Defects in C3 component 4.7 Secondary immunodeficiencies Causative factors of secondary immunodeficiency diseases 4.8 AIDS – Target cells infection by HIV, HIV-1 Latency, Factors promoting HIV, Provirus, 4.9 Mechanism of immunodeficiency, Treatment of Immunodeficiency Diseases	

Course Outcomes:

Student will be able to-

1) Understand the concept of the immune system and its relation with various microbes.
2) Explain advances in the field of immunodeficiency.
3) describe immune response to diseases and tumors.
4) apply the techniques and experimental systems required in immunological research.

References:

1. Abul K. Abbas, Cellular and Molecular Immunology, Elsevier, 5th Edition, 2005.
2. Kindt, Thomas J., Richard A. Goldsby, Barbara A. Osborne, and Janis Kuby. Kuby immunology. Macmillan, 2007.
3. Tizard, Ian. "Comparative immunology." In Infection, Resistance, and Immunity, Second Edition, pp. 247-264. Routledge, 2022.
4. Rao, C. Vaman., Immunology: A textbook. Alpha Science Int'l Ltd., 2005.
5. Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt. *Roitt's essential immunology*. John Wiley & Sons, 2017.
6. Basic and clinical Immunology – Danie P. Stites, John Stobo, H. Fudenberg. Lange Medical Publications, 1982.

MAMiT 543 :MICROBIOLOGICAL QUALITY CONTROL AND ASSURANCE

Course Objectives:

The student should be able to -

1. Understand specific requirements for production of different products in the pharmaceutical industry.
2. Study the techniques and tools for facility and instrument qualification.
3. learn the concept of clean room technology and culture maintenance and disposal.
4. explain the quality management system in the pharmaceutical industry.

CREDIT = 4	**MICROBIOLOGICAL QUALITY CONTROL AND ASSURANCE**	**No. of hours =60**
Unit I	**Pharmaceutical Industry**	15
	1.1 Schedule M: Indian FDA Part I-A: Specific Requirements for Manufacture of Sterile Products, Parenteral Preparations, and Sterile Ophthalmic Preparations. 1.2 Part I-B: Specific Requirements for Manufacture of Oral Solid Dosage Forms (Tablets and Capsules). 1.3 Part I-C: Specific Requirements for Manufacture of Oral Liquids (Syrups, Elixirs, Emulsions, and Suspensions). 1.4 Part I-D: Specific Requirements for Manufacture of Topical products i.e. External Preparations (Creams, Ointments, Pastes, Emulsions, Lotions, Solutions, Dusting Powders, and Identical Products). 1.5 Part I-E: Specific Requirements for Manufacture of Metered Dose-Inhalers (MDI). 1.6 Part I-F: Specific Requirements of Premises, Plant, and Materials for Manufacture of Active Pharmaceutical Ingredients (Bulk Drugs)	
Unit II	**Facility and Instrument Qualification**	15
	2.1 Introduction: URS, IQ, OQ, PQ. 2.2 HVAC Qualification: Heating Ventilation Air Conditioning System Constituents of the System– Temperature, Relative Humidity, Air Velocity, Differential Pressure and Room to Room Air Balancing, HEPA Filtration, LAF, Viable Count. 2.3 Instrument Qualification: Autoclave, Dry heat sterilizer, Incubator , Laminar Air Flow Cabinet.	

Unit III	**Maintenance of Clean Room & Microbiological Laboratory**	15
	3.1 Facility Requirements: Introduction and guidelines. 3.2 Gowning Requirements: Introduction and guidelines. 3.3 Disinfectant Qualification: Introduction, Types of Disinfectants, Disinfectant Efficacy Testing. 3.4 Clean-in-Place (CIP) and Sterilize-in-Place (SIP): Introduction, Principle, Protocol and Applications of CIP and SIP. 3.5 Culture Maintenance: Reference cultures used in the pharmaceutical industry, maintenance. 3.6 Disposal Systems: Disposal protocols and systems for cultures and media.	
Unit IV	**Quality Management System**	15
	4.1 Six System Inspection model: Quality Management system, Production system, Facility and Equipment system, Laboratory control system, Materials system, Packaging and Labeling system. Concept of self-inspection. 4.2 Quality systems: Change Management/ Change control. Deviations, Out of Specifications (OOS), Out of Trend (OOT), Complaints - evaluation and handling, Investigation and determination of root cause, Corrective & Preventive Actions (CAPA), Returns and Recalls, Vendor Qualification, Annual Product Reviews, Batch Review and Batch Release. Concept of IPQC, area clearance/ Line clearance.	

Course Outcomes:

Student should be able to:-

1. Understand specific requirements for production of different products in the pharmaceutical industry.
2. Comprehend the techniques and tools for facility and instrument qualification.
3. Imbibe the concept of clean room technology and culture maintenance and disposal.
4. Use a quality management system in the pharmaceutical industry.

References:-

1. Rituraj Bharadwaj, Schedule M and its revision, LAP LAMBERT Academic Publishing, 2019.

2. Pharmaceutical Microbiology Manual (PMM), United States Food and Drug Administration (USFDA), ORA.007, Version 1.2, 2014.

3. Indian Pharmacopoeia (IP), Volume II (P-Z, Reference Spectra and Appendices), Ministry of Health and Family Welfare, Government of India, 1996.

4. Manohar A. Potdar, Pharmaceutical Quality Assurance, 2nd Edition, Nirali Prakashan, 2007.

5. Baird R.M., Hodges N.A.,DenyerS.P.,Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices,CRC press, 2000.

6. Christine Avery; Diane Zabel, Routledge, The Quality Management Sourcebook: An International Guide to Materials and Resources, 1997.

7. Al Endres, Wiley, Implementing Juran's Road Map for Quality Leadership: Benchmarks and Results, 2000.

8. Jiju Antony; David Preece, Routledge, Understanding, Managing and Implementing Quality: Frameworks, Techniques and Cases, 2002.

MAMiT 544 E1: INDUSTRIAL WASTE MANAGEMENT

Course Objectives:

The student should be able to -

1. understand characteristics of wastes of different industries
2. learn environmental legislation related to prevention and control of industrial effluents
3. study the methods for waste treatment
4. discuss advanced wastewater technologies implemented today.

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CREDIT= 4	**INDUSTRIAL WASTE MANAGEMENT SYSTEM**	**No. of hours =60**
Unit I	**Industrial waste**	15
	Types and Characterization of industrial wastes: 1.1 Types of industrial wastes : solid, liquid and gaseous (PAH, radioactive waste, heavy metals, xenobiotic compounds, etc.) 1.2 General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon. 1.3 Detailed discussion on the type of industry and the waste from the industry. 1.4 Environmental legislation related to prevention and control of industrial effluents and hazardous wastes. 1.5 Biomedical waste and its management.	
Unit II	**Industrial Waste Treatment**	15
	2.1 Methods of industrial waste treatment: 2.2 Biological methods-I Activated sludge process- Process, microbiology, sludge bulking 2.3 Trickling filters- Process, Microbiology and applications 2.4 Methods of industrial waste treatment: 2.5 Biological methods - II Lagooning- Aerobic and anaerobic, applications 2.6 Anaerobic digestion- Process, microbiology of bio-gas formation, Applications.	

Unit III	**Waste treatment of different industries**	15
	3.1 Industrial waste treatment: methods of treatment of wastes from Dairies 3.2 Treatment of wastes from Distilleries 3.3 Treatment of wastes from paper and pulp industries 3.4 Treatment of wastes from fertilizer industries 3.5 Treatment of wastes from Pharmaceutical industries 3.6 Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.	
Unit IV	**Advance wastewater treatment**	15
	4.1 Introduction, Nutrient removal - nitrification, denitrification. Biological phosphate removal (BPR) 4.2 Membrane processes - Fundamentals, membranes - types, classifications, 4.3 microfiltration, ultrafiltration, nanofiltration and reverse osmosis 4.4 electrodialysis, Membrane fouling. cleaning and mitigation techniques 4.5 lon exchange, Advanced oxidation process: Photocatalysis, ozonation ozone/UV, ozone /hydrogen peroxide, hydrogen peroxide /UV. applications, oxidation of refractory organic compounds	

Course Outcomes:

Students will be able to

1. characterize wastes of different industries
2. discuss environmental legislation related to prevention and control of industrial effluents
3. apply methods of waste treatment for various industries.
4. discuss advanced wastewater technologies implemented today.

References:

1. Middlebrooks, E. Joe. *Industrial pollution control*. 1979.
2. Besselievre, Edmund Bulkley, and Max Schwartz. "The treatment of industrial wastes." 1976.
3. Jogdand, S. N. *Environmental Biotechnology:(industrial Pollution Management)*. Himalaya Publishing House, 2010.
4. Ciaccio, Leonard L. *Water and Water Pollution Handbook: Vol. 2*. Marcel Dekker, Incorporated, 1971.
5. Rao, M. Narayana. *Wastewater treatment*. Oxford and IBH Publishing, 2018.
6. Mitchell, Ralph. "Water pollution microbiology." (1971).
7. Bregman, Jacob I., and Harry W. Gehm. *Handbook of water resources and pollution control*. 1976.
8. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi, 2016.

MAMiT 544 E2: MEDICAL MICROBIOLOGY

Course objectives:

Students should be able to -

1. Understand details of emerging microbial diseases
2. Study the techniques used for laboratory diagnosis of respiratory diseases
3. learn the techniques used for laboratory diagnosis of urinary tract infections
4. discuss advanced trends in diagnostic methods

CREDIT= 4	**MEDICAL MICROBIOLOGY**	**No. of hours=60**
Unit I	**Basics of epidemology**	15
	1.1 Historical aspects, definition, aim and uses 1.2 Descriptive epidemiology 1.3 Risk measurement Measurement of morbidity and mortality: Incidence, Prevalence, Age-adjustment and survival analysis, use of morbidity and mortality 1.4 Epidemiological study designs 1.5. Bias, confounding and interaction 1.6. Causal association 1.7. Disease Surveillance system	
Unit II	**Virulence of pathogenic microorganisms.**	15
	2.1 Virulence of pathogenic microorganisms Invasiveness – Enzymes as virulence factors, Antiphagocytic factors (Interference with phagocytosis) 2.2 Adhesion factors – mechanism of adhesion, Iron up take – role of siderophores, Spread in the tissue 2.3 Bacterial toxigenicity: Toxin producing Microorganisms 2.4 Toxins: Exotoxins and Endotoxins 2.5 Lipopolysaccharide Endotoxins of gram negative bacteria. 2.6 Protein toxins: (Exotoxins): Clostridial toxins - Botulinum toxin, Tetanus toxin (Tetanospasmin), Cholera toxin (choleragen) Diptheria Toxin, Pertussis toxin, Staphylococcal toxins, Streptococcal toxins. 2.7 Tissue damage	

	2.8 Spread of pathogen in the body - Viral pathogenesis – mechanisms of viral cellular pathogenesis. 2.9 Quorum sensing & pathogenicity	
Unit III	**Emerging microbial diseases in India**	15
	3.1 Antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention, control and treatment of diseases caused by- Treponema pallidum 3.2 Neisseria gonorrhoeae 3.3 Ebolavirus, 3.4 New Corona 19 virus 3.5 Nipah virus 3.6 Avian influenza (H7N9) .	
Unit IV	**Clinical Microbiology**	15
	4.1 Samples of choice, Collection, transportation and processing of samples for laboratory diagnosis of the following complications: 4.2 Urinary tract infections, Septicemia and bacteremia, Upper Respiratory tract infections, Lower 4.3 Respiratory tract infections, Wound, skin, and deep sepsis, Enteric fever, Pyrexia of unknown origin, 4.4 Genital Tract infections, Meningitis, Gastro intestinal infections, Tuberculosis (Pulmonary and Extrapulmonary) 4.5 Trends in clinical microbiology diagnostic methods: MALDI-TOF-MS, Next generation sequencing, Automated PCR	

Course outcomes:

The student will be able to -

1. explain detail antigenic property, mode of transmission and other properties of emerging microbial diseases
2. Discuss the techniques used for laboratory diagnosis of respiratory diseases
3. Apply the techniques used for laboratory diagnosis of urinary tract infections
4. describe advance trends in diagnostic methods

References:

1. Davis B. D, Delbacco, Microbiology, J.B. Lippincott Co. NY, 4th edition,1990.
2. Ananthnarayan Rand C.E. JayaramPanikar,Text book of Microbiology, Orient Longman publication, 5th edition, 1996.
3. Dey N.C. & Dey T.K., Medical Bacteriology, Allied Agency, Calcutta,17th edition, 1988.
4. N.C. Dey & T.K. Dey & D. Sinha, Medical Bacteriology including Medical Mycology & AIDS, New Central Book Agency (Delhi), 2013.
5. A. M. Emmerson, Principles and Practice of Clinical Bacteriology, Wiley - Blackwell Publication, 1997.
6. Dr. Kanal L. Mukherjee and Anuradha Chakravarty, Textbook of Medical Laboratory Technology Vol III,, McGraw Hill Education, 3rd edition, 2013.
8. Ananthnarayan and Paniker's Text book of Microbiology: Editor Arati Kapil, University Press, 9th edition, 2013.
9. Praful B.Godkarand DarshanP.Godkar, Bhalani, Textbook of Medical Laboratory technology : publishing house, 3rd edition, 2014.

MAMiP 545 : On Job Training (OJT) (4 Credits)

OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engaged with the employability opportunities. Students will undergo 4 credit work based learning/OJT/internship.

Practicals: 20 (2 Credits)

Practical Course Lab IV : MAMiP 546

Course Objectives

Students should be able to

1. Determine the bioburden on textile material
2. Carry out method for sterility testing of Autoclave
3. Know instrument qualification
4. Perform method to carry out preservative efficacy testing

Practical Course: MAMiT 546

1.Determination of efficacy of isopropyl alcohol.
2. Determination of bioburden on textile material by AATCC 101- 2004 method.
3. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms.
4. Evaluation of sanitary status of eatery by swab technique.
5. In-house determination of aerobic count of microbial load by settle plate technique.
6. Sterility testing of autoclave using *Bacillus stearothermophilus.*
7. Preservative Efficacy Testing.
8. Instrument Qualification of: a) Incubator, b) Hot air oven.
9. Determination of bioburden of non sterile product
10. Determination of antibody titer by Ouchterlony double diffusion test.
11.ELISA- Detection of antigen/ antibody by Sandwich ELISA.
12.Rocket immunoelectrophoresis
13. Radial Immunodiffusion test
14. Study of network IP.
15. Connecting computers in a Local Area Network (LAN).
16. Searching sequence databases by BLAST – BLASTn,
17. Searching sequence databases by BLAST - BLASTp
18.Determination and visualization of protein structure by Rasmol
19. Construction of a phylogenetic tree by MEGA.
20.Sequence analysis by Multiple Sequence Alignment

Course Outcome:

Students will be able to

1. Determine bioburden on textile material.
2. Perform sterility testing of Autoclave.
3. Perform instrument qualification of different instruments
4. Determine the preservative efficacy of pharmaceutical products

References:

1. Pharmaceutical Microbiology Manual (PMM), United States Food and Drug Administration (USFDA), ORA.007, Version 1.2, 2014.
2. Manual of Methods of Analysis of Foods – Microbiological Testing – Food, Safety and Standards Authority of India, Ministry of Health and Family Welfare, Government of India, New Delhi 2012
3. Murhammer, Martin W., Kok-Keong Lee, Payam Motallebi, Paolo Borghi, and Karl Wozabal. *IP Network Design Guide*. IBM Corporation, 1999.
4. Walker, John M. "Rocket Immunoelectrophoresis." *The Protein Protocols Handbook* 1996.
5. Hodges, Norman. "Bioburden determinations." In *Microbiological contamination control in pharmaceutical clean rooms*, CRC Press, 2016.