Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA
(An Autonomous College)

Reaccredited by NAAC with

'A+' Grade

New Syllabus

For Master of

Science Part - II

APPLIED MICROBIOLOGY

Syllabus

to be Implemented from June, 2024

onwards

Two Year PG Degree Programme
Credit Distribution

Level	Sem	Major						Total
		DSC Mandatory		DSE Elective	RM	OJT	RP	
		T	P	T				
6	I	12 (3 Papers)	2	4 (1 Paper out of Two)	4	---	---	22
	II	12 (3 Papers)	2	4 (1 Paper out of Two)	---	---	4	22
6.5	III	12 (3 Papers)	2	2 (1 Paper out of Two)	---	---	6	22
	IV	12 (3 Papers)	2	4 (1 Paper out of Two)	---	4	---	22
Total		48	8	14	4	4	10	88
			70			8	10	

DSC: Discipline Specific Course; DSE: Discipline Specific Elective RM : Research Methodology ; OJT : On Job Training; RP : Research Project; T: Theory; P: Practical

Rubrics for RP : 1. For Semester II : 2 credits for Project + 2 Credits for Dissertation
2. For Semester III : 2 Credits for Research Project Practical + 2 credits for Project + 2 Credits for Dissertation

PG Dean
Dr. P. V. Chavan

(Dr. H. P. Umap)

(Prin Dr B. T. Jad

A. **SYLLABUS FOR MASTER OF SCIENCE (M.Sc.):**

1. Title: Subject: - APPLIED MICROBIOLOGY

2. Year of implementation: June 2024 onwards

Total number of semesters:	**04**
(Two semesters per year)	
Total No. of Courses:	
Total no. of practical courses:	**04**
No. of theory Courses per semester :	**04**
No. of practical courses per semester:	**02**
Maximum marks per Course (Practical):	**100**
Distribution of marks –	
Internal evaluation:	**40**
External evaluation:	**60**
(Semester exam)	
Total marks for M. Sc. Degree	
Theory Courses:	
Practical course:	

3. General Objectives of the Course:

A prime objective to maintain updated curriculum and providing therein inputs to take care of fast paced developments in knowledge of Applied Microbiology and in relation to international context, a two-year programmed is formulated for M.Sc. Applied Microbiology as per UGC guidelines and to develop competent microbiologists to achieve desirable placements in the country and abroad. The programmed obliges students to read original publications and envisages significant inputs in the laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertake in addition to other disciplines viz. Virology, Immunology, Genetics, Molecular Biology, Enzymology, Biostatistics, Bioinformatics, Scientific writing, Computer Science etc.

The overall structure of the course to be implemented from the academic year 2018– 2019 onwards is as given below. Students are required to undertake a research project in all the semesters at the department. In the project, the student is expected to study research methodology that includes literature survey, experimental work and report writing following the IMRAD (Introduction, Aims and objectives, Materials and Methods, Results and Discussion) system. Students shall compulsorily deliver one seminar/research Course before submission of project and submit a certificate from the Head of the Department regarding satisfactory completion of the same at the time of the practical examination of semester IV. Students are also required to undertake a compulsory educational tour organized by the Department in each year (M. Sc. I and M. Sc. II) to various places of microbiological interest and submit a tour report duly signed by the Head of the Department, at the time of the practical examinations respectively. Students shall also undergo industrial training at the end of M.Sc. I through compulsory internships.

2. **Duration:**

- The course shall be a full-time course.
- The course shall be of two years, consisting of four semesters.

3. **Fee Structure:**

- **Entrance Examination fees:** as prescribed by the Institute.
- **Course Fee:** as prescribed by the Institute.

4. **Eligibility For Admission:**

- As per Rule (2) for graduates of this Institute.
- As per Rule (3) for graduates from other universities and merit of entrance exam.

5. **Medium of instruction: English**

6. Structure of the Course

M.Sc. Part II

Semester III

Nature of the Course	Course Code	Name of the Course
Theory	MAMiT 531	MICROBIAL ECOLOGY & EXTREMOPHILES
	MAMiT 532	MOLECULAR BIOLOGY
	MAMiT 533	GENE TECHNOLOGY AND GENOMICS
	MAMiT 534 E-I	ESSENTIALS OF CELL BIOLOGY
	MAMiT 534 E-II	FOOD AND DAIRY MICROBIOLOGY
Project	MAMiP 535	PROJECT WORK
Practical	MAMiP 536	PRACTICAL COURSE I: LAB I

Semester IV

Nature of the Course	Course Code	Name of the Course
Theory	MAMiT 541	ANALYTICAL TECHNIQUES
	MAMiT 542	MICROBIAL METABOLISM
	MAMiT 543	MOLECULAR BIOLOGY AND GENETICS

	MAMiT 544 E-I	RESEARCH METHODOLOGY
	MAMiT 544 E-II	ADVANCED RESEARCH METHODOLOGY
OJT	MAMiP 545	ON JOB TRAINING
PRACTICAL	MAMiP 546	PRACTICAL COURSE II: LAB II

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. Understand the applications of extremophiles.
4. Study the human microflora and its effects on health.

CREDIT	MICROBIAL ECOLOGY & EXTREMOPHILES	No. of hours per unit/ Credits
Credit I	Unit I- **Basic Concepts of Microbial Ecology**	(15)
	A) Microbial Ecology – Concepts, niche, habitat, ecosystem and applications. Introduction to microbial diversity, types of microorganisms- bacteria, archaea, eukarya, interactions between microorganisms, ecological succession. B) Quantitative ecology i) Sample collection- soil, water, air, sediment, biological samples ii) Sample processing iii) Determination of microbial number a) Direct count b) viable count procedure-Plate count and MPN	
Credit I	Unit II - **Recent Concepts in Microbial Ecology**	(15)
	A) Microbial biofilm i)Physiology, morphology, biochemistry of microbial biofilm formed in natural environment. ii) Mechanism of microbial adherence. iii) Laboratory methods used to obtain biofilm (with respect to physiology, growth, special arrangement, depth, surface physio chemistry) B) Beneficial and harmful role of biofilms. C) Biomimicry – Concept and Applications. D) Bioremediation and Biodegradation - Engineering and bioremediation process its needs and limitations. Molecular technique in Bioremediation.	

	ii) 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	
Credit I	Unit III- **Microbiome**	(15)
	A) Introduction-Microbiome Ecosystem Ecology B) 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). C) Healthy Human Microbiome: Typical components and diversity of the microbiome; archaea, viruses, fungi, and other eukaryotes; Geographical variation in the healthy microbiome; Microbiome establishment and early colonization; Hallmarks of health;outlook. D) Human Microbiome at the interface of health and disease: Influences on the microbiota during host life cycles; Disease links and health implications.	
Credit I	Unit IV- **Extremophiles and their Applications**	(15)
	A) Extremophiles i) Concept ii) Thermophiles – Nucleic acids, Membrane adaptations, Proteins. iii)Psychrophiles – Membrane adaptation, Proteins iv) Acidophiles – Mechanism to tolerate acid and metal and acid toxicity. v)Alkalophiles- Bioenergetics adaptations. B) Extremozymes i) Extremozyme – Characteristics, examples, structure, Biotechnological uses of archea as extremozymes and applications. ii) Biotechnological, applications of extreme proteins from different groups of methanogens. 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 (2008) Microbial Ecology: Fundamentals and Applications, 4th Ed. Pearson India Education Services – UNIT I, II, III.

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

3) RajendranP,Gunasekaran P. (2011) Microbial Bioremediation, MJP Publishers,Chennai – UNIT II.

4) Odum Eugene (2004) Fundamentals of Ecology, Cengage Learning – UNITI.

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

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.. Study various methods for gene sequencing
4.. Learn methodology, concept and applications of human genome project

CREDIT	MOLECULAR BIOLOGY	No. of hours per unit/ Credits
Credit I	**Unit I- DNA Replication**	(15)
	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. a) DNA replication in eukaryotes - Multiple replicons, eukaryotic DNA polymerases, ARS in yeast, ORC,regulation of replication. b) Regulation of S phase of cell cycle – Introduction of cell cycle, phases: G1, G2, S and M. Regulation of S phase: Replication and regulation, cdk kinases.	
Credit I	**Unit II - Transcription & Regulation of Gene Expression**	(15)
	1) Transcription in Prokaryotes and Eukaryotes: a) RNA Polymerase – Structure and function. b) Transcription – Initiation, elongation, termination. c) Post transcriptional modifications and structure of mRNA, rRNA. 2) Regulation of gene expression in bacteria Concept of Negative & Positive regulation - Lac operon – nature of repressor, structure of repressor, Allosteric change in conformation of repressor. 3) Tryptophan operon- Tryptophan's Role in Negative Control of the tryptophan Operon, Control of the trp Operon by Attenuation, Defeating Attenuation 4) Regulator RNAs present in bacteria	
Credit I	**Unit III- Translation**	(15)

	Translation Prokaryotes and Eukaryotes Genetic code- Deciphering genetic code and its importance Altered code in mitochondria and induced variations in genetic code a) Translation – Activation of amino acid, Initiation, Elongation and Termination process at molecular level b) Translational frame shifting, RNA editing	
Credit I	**Unit IV- Sequencing Genes and Genomes**	(15)
	1) Sequencing Genes and Genomes. a) Methodology for DNA sequencing, Chain termination DNA sequencing (sanger's Method) b) Pyro sequencing. c) Shot gun approach of genome sequencing. d) Clone coting approach of sequence assembly. e) Use of maps to aid sequence assembly- Introduction to Genetic mapping, physical mapping Mapping – Linkage maps, tetrad analysis, mapping with molecula markers, mapping using somatic cell hybrids, mapping by transformation and conjugation. 2) Human Genome Project. a) Applications of Genome Project.	

Course Outcomes:

Students will be able to

1.understand 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.(F reeman, 2010).- UNIT – IV

2. Harvey Lodish, James E. Darnell, Molecular Cell Biology. (W.H.Freeman & Co Ltd, 18 August 2003) - UNIT – I, II, III

3. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry: 6th Edition – (W. H. Freeman, 13 February 2013) -UNIT – II & III

4. Jocelyn E Krebs, Lewin's Genes X (Jones & Bartlett Learning, 1 January 2009)- UNIT – I 5. Robert Weaver, Molecular Biology (McGraw-Hill Education, 16 March 2011) – UNIT – I, II, II

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. Understand the tools and techniques used in genetic engineering.
4. Study about emerging trends in gene technology

CREDIT	GENE TECHNOLOGY AND GENOMICS	No. of hours per unit/ Credits
Credit I	**Unit I- DNA Libraries**	(15)
	A) Introduction and types- Genomic and cDNA library. B)Preparation of Genomic Library- Isolation of genomic DNA, generation of suitable sized fragments, cloning in suitable vector systems, and transformation in suitable host. C) Preparation of cDNA library- Isolation of mRNA, preparation of cDNA fragments, cloning in suitable vector systems, and transformation in suitable host. D) Screening of Libraries-Criteria to identify particular gene from gene library – 1) DNA sequencing 2) Expression of particular protein with immunological epitope 3.Enzymatic activity	
Credit I	**Unit II - Directed Mutagenesis and Protein Engineering**	(15)
	A) Directed Mutagenesis: 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 B) 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.	
Credit I	**Unit III- Genetic Engineering in Plants and Animals**	(15)
	Plants i) Plant transformation with Ti and Ri plasmid. ii) Ti plasmid derived vector systems. iii) Physical methods for transformation. iv) Chloroplast engineering animals i) Gene transfer vectors ii) Transfection – a) Physical, b) Chemical. iii) Production of transgenic mice, Retroviral vector method, DNA microinjection method Applications of transgenic mice, Transgenic Disease Models: Alzheimer's disease, Duchenne muscular dystrophy, Transgenic mice as test system	
Credit I	Unit IV- **Recent Trends in Gene Technology**	(15)
	A]Genomics- Concept, Introduction, Comparative genomics of bacteria B] Proteomics- Concept, Introduction, Expression analysis and characterization of proteins C] 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. explain the concept of genomics, proteomics and CRISPR , Cas9 technique in Genome Editing

References:-

1. Molecular Biotechnology-Principles and Applications of Recombinant DNA by Bernard R. Glick and Jack.J.Pasternak.
2. (PDF) Nucleic Acids as Therapeutic Agents (researchgate.net)
3. Microbial Insecticides: Principles and Applications" by J. F. Borgio, K. Sahayaraj, and I. A. Susurluk.

4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 6th Edition by Bernard R. Glick, Cheryl L. Patten

MAMiT 534: E 1: ESSENTIALS OF CELL BIOLOGY

Course Objectives:

The student should be able to :-

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

CREDIT	ESSENTIALS OF CELL BIOLOGY	No. of hours per unit/ Credits
Credit I	**Introduction to cell biology**	**(15)**
	1) Introduction to cell, prokaryotic cell, eukaryotic cell, Chemical components of the cell 2) Structural organization and function of intracellular organelles Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	
Credit I	**Cell division and cell cycle**	**(15)**
	1) Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. 2) Organization of genes and chromosomes Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, 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. Understand the techniques used in food preservation
4. Study the Artificial intelligence in food industry and food safety and standards.

CREDIT	FOOD AND DAIRY MICROBIOLOGY	No. of hours per unit/ Credits
Credit I	**Unit I- Microbiology of Starter Cultures and fermented dairy products**	(15)
	a) Introduction and annual utilization of starter cultures; History and taxonomy b) Starter cultures; Classification of starter organisms: Starter types: single, mixed and multiple strain starter cultures; c) Propagation and preservation of starter cultures; commercial starter preparations: concentrated and super concentrated starters d) Metabolism of starter Organisms: biochemical characterization of lactic acid bacteria; carbohydrates, citrate and protein metabolism of starter cultures e) Role of starter cultures in the preparation of various fermented milk f) Microbiology of fermented milk products: their nutritional and therapeutic significance.	
Credit I	Unit II - **Microbiology in Food**	(15)
	A) Microorganism in food spoilage: i) Types of foods and their spoilage ii) Microbial, biochemical aspect of food spoilage iii) Physiology of food spoilage organisms : Importance, Response of microbes, future prospectus. ii) Control by combination of methods (Hurdle concept) Novel emerging techniques of preservation – Bacteriocin - Introduction, types, mode of action, applications. A) Applications of artificial intelligence in food industry II) 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. 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. Understand the basics of artificial intelligence in food industry.
4. Understand the concepts of food safety and regulations in food industry.

References:-

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

Project : MAMiP 535

Practical Course I : MAMiP 536

Course Objectives

Students should be able to

1.Isolate, identify extremophilic micro organisms from natural samples

2. Isolate and characterize 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

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 agent of dental caries.
13. DNA amplification by PCR.
14. In-vitro seedling growth and multiplication of carrot.
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 micro organisms from natural samples

2. Isolate and characterize 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

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. Study the tools for sequence alignment
4. Understand the essentials of structural bioinformatics and gene annotation

CREDIT	ESSENTIALS OF BIOINFORMATICS	No. of hours per unit/ Credits
Credit I	**Unit I- Introduction to Bioinformatics**	(15)
	i) Introduction, History of Bioinformatics, Applications. ii) Major databases in bioinformatics a. Nucleic acid databases (GenBank, DDBJ, EMBL). b. Protein Databases (Primary, Secondary and Composite). c. Specialized Genome Databases. d. Structural Classification Databases e. Structural Databases (PDB). iii) Data management and analysis iv) Molecular biology and bioinformatics v) Information search and data retrieval	
Credit I	**Unit II - Directed Mutagenesis and Protein Engineering**	(15)
	i) Introduction, ii) Alignment of pairs of sequence iii) Alignment of multiple sequences iv) Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees[distance -based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method].	
Credit I	**Unit III- Tools for similarity search and sequence alignment**	(15)
	i) Working with FASTA ii) Working with BLAST iv) Filtering and gapped BLAST iv) FASTA and BLAST algorithm comparison	

	Other programs	
Credit I	**Unit IV- Structural Bioinformatics and Gene annotation**	(15)
	i) Introduction to Gene Annotation ii) Protein structure visualization and classification iii) Protein structure databases and Introduction to visualization databases and tools iv) Protein structure alignment Protein classification approaches	

Course Outcomes:

Student will be able to:-

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

References::

1. Rastogi S.C. Bioinformatics: Methods And Applications: Genomics, Proteomics And Drug Discovery, fourth edition, Phi publication,january 2013-

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

3. V.Rajaraman, Fundamentals of Computers, Phi Learning, ISBN:8120321758, 2001

4. Tanenbaum Andrew S, Computer Networks, fourth Edition, Prentice Hall PTR, ISBN:8120321758, 2003

5. Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554

6. Branden ,Tooze John. Introduction to Protein Structure.New York, Garland Publishing Inc. 1999. ISBN: 0815323050

MAMiT 542 : ESSENTIALS OF IMMUNOLOGY

Learning Objectives:

Students should be able to:

1. Understand various immunotechniques.
2. Study advanced concepts in immunology.
3. Study immunodeficiency diseases.
4. Study cell signaling pathways and concept of apoptosis

CREDIT	ESSENTIALS OF IMMUNOLOGY	No. of hours per unit/ Credits
Credit I	**Unit I- Cell signaling and Apoptosis**	**(15)**
	A)Cell Signaling 1) Signal receptors in immune system 2) Signal Transduction Pathway- a) JAK-STAT Pathway b) Phosphatidyl-Inositol Pathway c) RAS-MAPK Pathway 3) IL 2 Signaling Pathway 4) Chemokine Signaling Pathway **B) Apoptosis** 1) Molecules involved in apoptotic cell death 2) Mechanism of apoptosis a) Extrinsic Pathway b)FAS signaling pathway c)Intrinsic Pathway	
Credit I	Unit II - **MHC complex and experimental systems**	**(15)**
	Major Histocompatibility Complex a) General Organization and Inheritance of the MHC b) Inheritance of MHC haplotypes in inbred mouse strains c) MHC molecules and genes. d) Detailed genetic map of MHC genes. e) Cellular distribution of MHC molecule f) Regulation of MHC expression g) MHC and immune responsiveness.	

	Antigen Presenting Pathway i) Exogenous pathways of antigen processing and presentation ii) Endogenous pathways of antigen processing and presentation	
Credit I	Unit III- **Tumor immunology and immunotechniques**	(15)
	1) Immunity to tumors a) Tumor of immune system b) Tumor antigen c) Immune responses to tumor- T cell , antibodies ,NK cell, Macrophages d) Evasion of immune response by tumors e) Cancer immunotherapy. 2) Immunotechniques and their applications, Principle, Procedure, Advantages and disadvantages a) Flow Cytometry b) Immunogold labelling for electron microscopy c) Immuno-PCR d) Mixed lymphocyte reaction. e) Radioimmunoassay f) Immunoprecipitation	
Credit I	Unit IV- **Immunodeficiency Disorders**	(15)
	1) Primary immunodeficiencies a)Lymphoid immunodeficiencies i) Humoral Deficiencies- XLA, XHM ii) Cell mediated Deficiencies – DiGeorge Syndrome iii) Combined Deficiencies – Severe SCID b) Immunodeficiencies of the myeloid lineage Phagocytic Deficiencies- CGD, reduction in neutrophils count c) Complement defects- Defects in C3 component 2) Secondary immunodeficiencies a) Causative factors of secondary immunodeficiency diseases b) AIDS – Target cells infection by HIV, HIV-1 Latency, Factors promoting HIV, Provirus, Mechanism of immunodeficiency 3) 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) Explain about immune response to diseases and tumors.
4) Use techniques and experimental systems required in immunological research.

REFERENCE BOOKS:

1. Cellular and Molecular Immunology – Abul K. Abbas. (5th Edition) UNIT – I, II,III
2. Kuby Immunology – KindtGoldsby& Osborne. UNIT – I, II, III

3)Immunology – Tizard. UNIT – IV

3. Immunology – C. Vaman Rao. UNIT – IV
4. Essential Immunology – Roitt I.M. UNIT – I, II, III & IV
5. Basic and clinical Immunology – Danie P. Stites, John Stobo, H. Fudenberg. UNIT– IV

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. Study the concept of clean room technology and culture maintenance and disposal.
4. Understand the quality management system in pharmaceutical industry.

CREDIT	MICROBIOLOGICAL QUALITY CONTROL AND ASSURANCE	No. of hours per unit/ Credits
Credit I	**Unit I- Pharmaceutical Industry**	(15)
	Schedule M: Indian FDA Part I-A: Specific Requirements for Manufacture of Sterile Products, Parenteral Preparations, and Sterile Ophthalmic Preparations. Part I-B: Specific Requirements for Manufacture of Oral Solid Dosage Forms (Tablets and Capsules). Part I-C: Specific Requirements for Manufacture of Oral Liquids (Syrups, Elixirs, Emulsions, and Suspensions). 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). Part I-E: Specific Requirements for Manufacture of Metered Dose-Inhalers (MDI). Part I-F: Specific Requirements of Premises, Plant, and Materials for Manufacture of Active Pharmaceutical Ingredients (Bulk Drugs)	
Credit I	**Unit II - Facility and Instrument Qualification**	(15)
	A] Introduction: URS, IQ, OQ, PQ. B] 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. C) Instrument Qualification: 1) Autoclave, 2) Dry heat sterilizer, 3) Incubator 4) Laminar Air Flow Cabinet.	
Credit I	**Unit III- Maintenance of Clean Room & Microbiological Laboratory**	(15)
	A) Facility Requirements: Introduction and guidelines. B) Gowning Requirements: Introduction and guidelines. C) Disinfectant Qualification: Introduction, Types of Disinfectants, Disinfectant Efficacy Testing. D) Clean-in-Place (CIP) and Sterilize-in-Place (SIP): Introduction, Principle, Protocol and Applications of CIP and SIP. E) Culture Maintenance: Reference cultures used in the pharmaceutical industry, maintenance. F] Disposal Systems: Disposal protocols and systems for cultures and media.	
Credit I	**Unit IV- Quality Management System**	(15)
	A) 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. B) 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 quality management system in pharmaceutical industry.

References:-

1. Rituraj Bharadwaj, Schedule M and its revision, LAP LAMBERT Academic Publishing, 2019 (Unit I)

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.(Unit III)

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

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

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

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MAMiT 544 E1:INDUSTRIAL WASTE MANAGEMENT

Course Objectives:

The student should be able to -

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

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CREDIT	MAMiT 544 E1: INDUSTRIAL WASTE MANAGEMENT SYSTEM	No. of hours per unit/ Credits
Credit I	**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.	
Credit I	**Unit II - Industrial Waste Treatment**	(15)
	Methods of industrial waste treatment: Biological methods-I 1.1 Activated sludge process- Process, microbiology, sludge bulking 1.2 Trickling filters- Process, Microbiology and applications 2. Methods of industrial waste treatment: Biological methods - II 2.1 Lagooning- Aerobic and anaerobic, applications 2.2 Anaerobic digestion- Process, microbiology of bio-gas formation,Applications.	

Credit 1	**Unit III:Waste treatment of different industries**	(15)
	Industrial waste treatment: methods of treatment of wastes from Dairies,Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries 3. Waste disposal control and regulations: Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.	
Credit 1	**Unit IV:Advance waste water treatment**	(15)
	1.Introduction, Nutrient removal - nitrification, denitrification. Biological phosphate removal (BPR) 2. Membrane processes - Fundamentals, membranes - types, classifications, microfiltration, ultrafiltration, nanofiltration and reverse osmosis, electrodialysis, Membrane fouling. cleaning and mitigation techniques, 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 waste water technologies implemented today.

References

1. Industrial Pollution Control Vol. - I by E. J. Middlebrooks
2. The treatment of industrial wastes. (2nd ed) by E. B. Besselievre and M. Schwartz
3. Environmental Biotechnology (Industrial pollution management) by S. N. Jogdand, Himalaya Publishing House
4. Water and water pollution Handbook Vol. – I by Leonard L. Ciaccio
5. Wastewater Treatment by M.N. Rao and A. K. Datta
6. Industrial Pollution by N. L. Sax. Van Nostrand Reinhold Company
7. Encyclopaedia of Environmental Science and Technology Vol. – II by Ram Kumar
8. Water Pollution Microbiology by R. Mitchell
9. Handbook of Water Resources and Pollution Control by H.W. Gehm and J. I. Bregman
11. Environmental Microbiology by P. D. Sharma, Narosa Publishing House, New Delhi

MAMiT 544 E2: MEDICAL MICROBIOLOGY

Course objectives:

The student should able to -

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

CREDIT	MAMiT 544 E2: MEDICAL MICROBIOLOGY	No. of hours per unit/ Credits
Credit I	**Unit I : Basics of epidemology**	(15)
	1. Historical aspects, definition, aim and uses 2. Descriptive epidemiology 3. Risk measurement, Measurement of morbidity and mortality: Incidence, Prevalence, Age- adjustment and survival analysis, use of morbidity and mortality 4. Epidemiological study designs 5. Bias, confounding and interaction 6. Causal association 7. Disease Surveillance system	
Credit I	**Unit II -Virulence of pathogenic microorganisms.**	(15)
	Virulence of pathogenic microorganisms (a) Invasiveness – Enzymes as virulence factors, Antiphagocytic factors (Interference with phagocytosis), Adhesion factors – mechanism of adhesion, Iron up take – role of siderophores, Spread in the tissue (b) Bacterial toxigenicity: Toxin producing Microorganisms, Toxins: Exotoxins and Endotoxins, Lipopolysaccharide Endotoxins of gram negative bacteria. Protein toxins: (Exotoxins): Clostridial toxins - Botulinum toxin, Tetanus toxin (Tetanospasmin) Cholera toxin (choleragen), Diptheria Toxin, Pertussis toxin, Staphylococcal toxins, Streptococcal toxins. (c) Tissue damage	

	(d) Spread of pathogen in the body (e) Viral pathogenesis – mechanisms of viral cellular pathogenesis. (f) Quorum sensing & pathogenicity	
Credit I	**Unit III -Emerging microbial diseases in India**	(15)
	Antigenic structure, modes of transmission, pathogenesis, symptoms, laboratory diagnosis, prevention, control and treatment of diseases caused by- a] Treponema pallidum b] Neisseria gonorrhoeae c] Ebolavirus, d] New Corona 19 virus e] Nipah virus f] Avian influenza (H7N9) .	
Credit I	**Unit IV- Clinical Microbiology**	(15)
	A) Samples of choice, Collection, transportation and processing of samples for laboratory diagnosis of the following complications: B) Urinary tract infections, Septicemia and bacteremia, Upper Respiratory tract infections, Lower C) Respiratory tract infections, Wound, skin, and deep sepsis, Enteric fever, Pyrexia of unknown origin, D)Genital Tract infections, Meningitis, Gastro intestinal infections, Tuberculosis (Pulmonary and Extrapulmonary) E)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. Discuss the techniques used for laboratory diagnosis of urinary tract infections
4. Explain advance trends in diagnostic methods

References:

1. PMicrobiology : Davis B. D, Delbacco, J.B. Lippincott Co. NY, 4thedition,1990.

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

MAMiT 545 : OJT(On Job Training)

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 Sandwitch 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

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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)