Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(Autonomous)

Constituent College of

Karmaveer Bhaurao University, Satara

Reaccredited by NAAC with 'A+' Grade

Syllabus for Master of Science

Part - I

APPLIED MICROBIOLOGY

Syllabus

to be Implemented from June, 2024 onwards

(As Per NEP-2020 Guidelines)

Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
(Autonomous)

Syllabus for M.Sc. Part-I
Title: Applied Microbiology
Year of Implementation: The syllabus will be implemented from June, 2024 onwards.
Preamble:

A prime objective is to maintain an updated curriculum and provide their inputs to take care of fast-paced developments in knowledge of Applied Microbiology and in relation to the 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, Analytical techniques, Enzymology, Biostatistics, Bioinformatics, Scientific writing, Computer Science etc.

The overall structure of the course to be implemented from the academic year 2024– 2025 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 the 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 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 their M.Sc. I through compulsory internships.

Program Outcomes:

PO No.	PO Statement After completing the Master of Science in Applied Microbiology students will be able to-
PO-1	Students should possess advanced knowledge in areas relevant to applied microbiology, such as microbial biotechnology, industrial microbiology, clinical microbiology, food microbiology, and environmental microbiology.
PO-2	Students should be proficient in advanced laboratory techniques used in applied microbiology research and practice.
PO-3	Students should have research competence and be capable of conducting independent research projects in applied microbiology.
PO-4	Students should understand and adhere to ethical principles and standards in scientific research and professional practice.
PO-5	Qualified to continue Ph.D. in subject of microbiology

Program Specific Objectives:

1. To understand the scope of applied fields of microbiology thorough knowledge and hands-on experience in basic tools and techniques.
2. To gain knowledge of various biotechnological applications of microorganisms and will learn of industrially important products produced by microorganisms.
3. To become familiar with scientific methodology, hypothesis generation and testing, design and execution of experiments. Students will develop the ability to think critically and to read and analyse scientific literature that will help them to pursue Ph.D. programs.
4. To acquire practical skills of the tools/technologies and handle instruments used to study this field.
5. To secure profitable employment in industry or in government sector. The post graduate Microbiologist with thorough knowledge of microbiological techniques microscopic techniques and other basic analytical techniques to cater the need of various sections in industries such as QC, QA, R & D etc.

Program Specific Outcomes:

PSO No.	PSO Statement
PSO-1	Execute theoretical and practical knowledge in applied areas of Microbiology like Medical Microbiology, Industrial Microbiology, Virology, Marine Microbiology, Food Microbiology, etc. at work place.
PSO-2	Demonstrate expertise with a variety of conventional and advanced microbiology techniques.
PSO-3	Demonstrate proficiency in good laboratory practices in a microbiological laboratory to achieve placements in microbiological industries like food and beverages, dairy, pharmaceuticals etc.
PSO-4	Exhibit the skill of critical thinking and understanding to plan and conduct research projects and present/publish paper while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PSO-5	Take job positions in research institutes, microbiological organizations, and biotechnology industries as well as create self-employability.

Duration: Two-year full time.

Pattern: Semester examination.

Medium of Instruction: English.

Structure of Course: M.Sc. I Semester-I					
Level	**Semester**	**Course Code**	**Course title**	**No. of Hours Per Week**	**Credits**
6	**I**	**MAMiT 411**	Microbial biodiversity and ecology	4	4
		MAMiT 412	Recent trends in virology	4	4
		MAMiT 413	Microbial biochemistry and physiology	4	4
		MAMiT 414 E-I **MAMiT 414 E-II** **DSE** **(Elective: Any one among two)**	Essentials of genetics Advanced genetics	2	2
		MAMiT 415	Research Methodology	4	4
		MAMiP 416	Practical-I: LAB- I	4	2
		MAMiP 417	Practical-II: LAB- II	4	2
Total					**22**

Structure of Course: M.Sc. I Semester-II					
Level	**Semester**	**Course Code**	**Course title**	**No. of Hours Per Week**	**Credits**
6	**II**	MAMiT 421	Industrial microbiology	4	4
		MAMiT 422	Microbial metabolism	4	4
		MAMiT 423	Analytical techniques	4	4
		MAMiT 414 E-I **or** **MAMiT 414 E-II** **DSE** **(Elective: Any one among two)**-I	Quality management in pharmaceutical industry or Pharmaceutical Microbiology	2	2
		MAMiT 425	Research project	8	4
		MAMiP 426	Practical-III: LAB-III	4	2
		MAMiP 426	Practical-IV: LAB- IV	4	2
Total					**22**

SEMESTER I

MAMiT 411: MICROBIAL BIODIVERSITY AND ECOLOGY

Course Objectives: Students will be able to:

1. Study the basics of microbial systematics.
2. Understand Domains Eukarya, Eubacteria, and Archaea along with their component groups.
3. Understand the significance and global environmental issues of microbial diversity.
4. Study the basics of chemotaxonomy.

Credits 4	**MAMiT 411: MICROBIAL BIODIVERSITY AND ECOLOGY**	**No. of hours per unit/ Credits**
UNIT I	**Basic Concepts of Microbial Systematics**	**(15)**
	A) Microbial Systematics: Classification and Techniques I) Introduction: Need for classification of microorganisms, overview, aims and objectives. II) Techniques for Classification: a) On the basis of Serology. b) Chemotaxonomy: Cell Wall Composition Analysis. Lipid and Fatty Acid Profiling, Protein Profiling, Isozyme Analysis, 16s rRNA Analysis. **B) Approaches for Exploration of Uncultivable Microbes** I) Introduction: Basic outline of uncultivable microorganisms. II) Culture-independent molecular methods III) Methods of extracting total microbial DNA from habitats. IV) Metagenomics	
UNIT II	**Domain Eukarya**	**(15)**
	A) Introduction: i) General review and significance of domain Eukarya. **B) General Classification, Salient Features, and Industrial Significance of-** i) Phylum Fungi: Yeasts, Molds ii) Algae iii) Protozoa	
UNIT III	**Domains Archaea and Eubacteria**	**(15)**
	A) Introduction: General review and significance of domains Archaea and Eubacteria. **B) General Classification, Salient Features, and Industrial**	

	Significance of: Domain Archaea, Eubacteria, Actinobacteria, Cyanobacteria, Mycoplasma, Myxobacteria, Rickettsia.	
UNIT IV	**Global Environmental Issues and Significance of Microbial Diversity**	**(15)**
	A) Global environmental issues i) Introduction ii) Global Climate Change iii) Conservation Of Global Biodiversity **B) Significance of Microbial Diversity** Approaches to the examination of microbial diversity i) Bacterial Diversity ii) Fungal Diversity iii) Viral diversity	

Course Outcomes: Students should be able to:-

1. Comprehend the concepts of microbial systematics.
2. Analyze the domain system of microbial classification.
3. Differentiate between the constituent groups of domains Archaea, Eukarya, and Eubacteria.
4. Define the significance and global environmental issues of microbial diversity

References:

1. Bergey's Manual of Determinative Bacteriology.
2. Bergey's Manual of Systematic Bacteriology.
3. Michael T. Madigan, Brock's BiologyofMicroorganisms (Benjamin-Cummings Pub Co; 13th edition, 17 December 2010.
4. Moselio Schaechter (2004) The Desk Encyclopedia of Microbiology. Elsevier Ltd. British Library Cataloguing in Publication Data. Library of Congress Catalog Number: 2002114100 ISBN 0-12-621361-5.
5. Oladele Ogunseitan (2005) Microbial Diversity. Blackwell Publishing Ltd.

MAMiT 412: RECENT TRENDS IN VIROLOGY

Course Objectives: Students will be able to:

1. Study the evolution and classification of viruses.
2. Study the life cycles of selected groups of viruses.
3. Understand the role and significance of oncogenic viruses.
4. Understand the types of vaccines and antiviral drugs.

Credits 4	**MAMiT 412: RECENT TRENDS IN VIROLOGY**	**No. of hours per unit/ Credits**
UNIT I	**Evolution and Classification of Viruses**	**(15)**
	A) Evolution of Viruses i) Potential for rapid evolution in RNA viruses than DNA viruses. ii) Mechanisms of evolution. iii) Evolution of influenza virus. **B) Nomenclature and Classification of Viruses** i) Nomenclature and classification on the basis of: Disease, Host organism, Partial morphology of virus, Nucleic acid of virus, Taxonomy. ii) Concepts of Viroid, Prions, Slow Viruses, and DI particles. **C) Study of Virus Inhibition and Inactivation** i) Inhibition and inactivation of: a) Bacteriophages, b) Animal viruses, c) Plant viruses. ii) Methods of Virus Inhibition and Inactivation a) Photo dynamics b) Heat and Radiation c) Chemical. iii) Transmission of Viruses: a) Modes of transmission: Horizontal, Vertical and Zoonoses b) Animal models to study transmission.	
UNIT II	**Life Cycles of Viruses**	**(15)**
	A) Study of Reproductive Cycles of Animal Viruses i) DNA Viruses: Herpes and Pox viruses. ii) RNA Viruses: Reo and Rhabdo viruses. **B) Reproductive Cycles of Bacterial Viruses:** phi X 174, RNA phages, Lambda phages and the genetic regulation of lysogenic and lytic phases. **C) Lysogeny in Viruses** i) Study of lysogeny of μ phages. ii) Comparative study of lysogeny of P1, P2 and P22 phages. **D) Life Cycles of Emerging Viruses** i) Concept of Emerging Viruses ii) Life cycle of Ebolavirus.	

UNIT III	**Oncogenic Viruses**	**(15)**
	1) Introduction: i) Concept of Oncogenic Viruses. ii) Introduction to oncogenic viruses: RSV, SV40, HPV. **2) Oncogenes** i) Concept of oncogenes. ii) Classification and characteristics of oncogenes and their proteins. iii) Genetic basis of cancer: Conversion of protooncogenes to oncogenes by mutation and viruses. iv) Oncogenic Mutations in Growth Promoting Proteins: a) PDGF, b) Receptor Tyrosine Kinase. Erythropoietin Receptor, Ras Pathway, c-Fos, c-Myc. iv)Apoptotic gene as proto-oncogene or tumor suppressor gene. v)Mutations causing loss of growth inhibition and cell control – Rb, p53 protein.	
UNIT IV	**Vaccines and Antiviral Drugs**	**(15)**
	1) Types of vaccines, their immune response an adverse reaction. a) Live Attenuated b) Inactivated c) Subunit d) Toxoid **2) Modern Vaccines-** DNA Vaccine, RNA Vaccine, Viral Vector Vaccines **3. Components of a vaccine-** a) Active ingredients b) Added ingredients c) Products used in the manufacture of a vaccine d) Growing the ingredients. i) General Approach and Screening of Antiviral Drugs. ii) Mechanisms of antiviral activity by inhibition of: Viral Entry, Replication of Viral Nucleic Acid, Viral Protein Functionality. iii) Drug resistance among viruses to antiviral drugs. Bacterial Phage Therapy	

Course Outcome: Students should be able to

1. Summarize the evolution and classification of viruses.
2. Comprehend the life cycles of selected groups of viruses
3. Summarize the importance of oncogenic viruses.
4. Differentiate between various types of vaccines and antiviral drugs.

References: -

1. S.J. Flint, Principles of Virology, 3rd Edition, Vol. I and Vol. II, (American Society for Microbiology, 6 February 2009)
2. Edward K. Wagner, Basic Virology, 3rd Edition (Wiley-Blackwell Publications, October 29, 2007)
3. Ajit K. Banerjee, Fundamentals of Microbiology & Immunology –
4. Straus J.H., Evolution of RNA Viruses
5. Longman, Introduction to Plant Virology
6. N.J. Dimmock, A.J. Easton, Introduction to Modern Virology, 6th Edition
7. Luria, Virology
8. WHO Vaccine Safety Basics E-learning Course- Module 2-Types of vaccines and adverse reactions https://vaccine-safety-training.org/overview-and-outcomes- 2.html
9. University of Oxford, Vaccine Knowledge Project- Vaccine Ingredients https://vk.ovg.ox.ac.uk/vk/vaccine-ingredients

MAMiT 413: MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

Course Objectives: Students will able to-

1. Study the essentials of amino acids and proteins.
2. Study the properties, structures and role of saccharides, lipids, and vitamins.
3. Understand the fundamental nuances of bioenergetics and photosynthesis.
4. Study the branch of bacterial chemolithotrophy.

Credits **4**	**MAMiT 413: MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY**	**No. of hours per unit/ Credits**
UNIT I	**Amino Acids and Proteins**	**(15)**
	A) Amino Acids i) Structure and Classification of Amino Acids – a) Basic, b) Acidic, c) Neutral. ii) Properties of Amino Acids –Acid-base nature, Titration curve of glycine, Electric charge. iii) Peptide bond and its nature. iv) Peptide: Ionization behavior, Polypeptide and its Diversity- Size and Composition **B)Proteins** i) Structural levels of proteins a) Primary Structure (oxytocin). b) Secondary Structure – alpha helix, B-sheet, B-turn (α-keratin). c)Tertiary Structure (Myoglobin). d) Quaternary Structure (Hemoglobin). ii) Protein stability and forces stabilizing protein structure. iii) Ramachandran plot. iv) Denaturation and Renaturation of protein. v) Protein Folding 1. Folding pathways for protein structure. 2. Concept of chaperon and its role in protein folding.:Diseases caused by misfolding – an overview.	
UNIT II	**Carbohydrates**	**(15)**
	A) Carbohydrates: Definition and Functions-carbohydrates. i) Monosaccharides- Classification and structures of aldoses and ketoses. Configuration and Conformation. ii) Disaccharides- Lactose and Sucrose. iii)Polysaccharides Types of polysaccharides -Homopolysaccharide- a) Stearic forces and hydrogen bonding in homopolysaccharide folding. b) Structure and Role of Starch, Glycogen, Cellulose c) Heteropolysaccharide- Heparin, Hyaluronate.	

UNIT III	**Lipids and Vitamins**	**(15)**
	A) Lipids: Definition, General Properties and Functions of Lipids.**,** General Formula and Nomenclature of Fatty Acids. i) Classification of Lipids: Even and Odd Scheme of Nomenclature, Saturated and Unsaturated Fatty Acids. ii) PUFA (Poly Unsaturated Fatty Acid) and its chemical properties. iii) Structure, General Properties and Functions of: a) Simple Lipids (Triacylglycerols). i) Complex Lipids (Phosphoglycerides – Lecithin, Sphingolipids, Sphingomyelin). b) Derived Lipids- Sterols –Cholesterol, Ketone Bodies **B) Vitamins:** Definition, classification, and General Properties. i) tructures and Forms of Coenzymes. ii) Mode of Action, Sources, iii) Daily Requirement and Deficiency study of: a)Thiamine, b) Riboflavin, c) Ascorbic Acid	
UNIT IV	**Bioenergetics and Photosynthesis**	**(15)**
	A) Bioenergetics: i) Principles and Laws of Thermodynamics ii) Reaction Profile – Oxidation, Reduction, Redox couples. iii) Oxidative Phosphorylation iv) Architecture of Mitochondria. v) Electron Transport Chain (ETC) reactions in mitochondria. vi) Mechanism of ATP Synthesis by Chemiosmotic Model. vii) Uncouplers and Inhibitors of ETC. viii) ETC Process in Prokaryotes. **B) Photosynthesis** i) General Features of Photophosphorylation. ii) Evolution of Oxygenic Photosynthesis. iii) General Photochemical Events – Light driven electron flow. iv) Photochemical Reaction Centers in Bacteria: Pheophytin- Quinone Center and Fe-S Center, Photosystem II in Cyanobacteria, Photosynthetic Pigments in Halobacterium. v) Photochemical Reaction Centers in Plants a) Photosystems I and II, b)Electron Flow in PS I and PS II – Z Scheme. vi) ATP Synthesis by Photophosphorylation	

Course Outcomes: Students should be able to: -

1) Recall the basic concepts of amino acids and proteins.
2) Comprehend the properties and importance of saccharides, lipids, and vitamins.
3) Differentiate the bacterial and plant metabolic machinery.
4) Relate various types of bacterial chemo-lithotrophic reactions

References: -

1. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry:
2. 6th Edition – (W. H. Freeman, 13 February 2013)
3. Jeremy M. Berg, Lubert Stryer, Biochemistry, (WH Freeman, 8 April 2015)
4. David T. Plummer An introduction to practical biochemistry- 3rd edition, (McGraw Hill Education, 1 July 2017)
5. B. Buchanan, W. Cruissem, R. Jones, Biochemistry and Molecular Biology of Plants (Wiley Publishing, 4 September 2015)
6. David Metzer, Biochemistry – Chemical Reactions of Living Cell, Vol. I and II (Academic Press, 4 May 2003)
7. Michael T. Madigan, Brock Biology of Microorganisms (Benjamin-Cummings Pub Co, 17 December 2010)
8. H.W. Doelle, Bacterial Metabolism (Academic Press, 28 June 2014).
9. Byung Hong Kim, Geoffrey Michael Gadd, Bacterial Physiology and Metabolism (Cambridge University Press).

MAMiT 414 E1: ESSENTIALS OF GENETICS

Course Objectives: Students will be able to -

1. Study the essentials of Mendelian and Non-Mendelian inheritance.
2. Study the basics of multiple alleles, essential genes, and lethal genes.
3. Study properties, structures of chromosomes and their packaging
4. Study the pedigree analysis and various genetic disorders in humans

Credits 2	**MAMiT 414 E1: ESSENTIALS OF GENETICS**	**No. of hours per unit/ Credits**
UNIT I	**Mendelian and Non-Mendelian Genetics**	**(08)**
	I) Mendelism: Monohybrid crosses and Mendel's' Principle of segregation, Dihybrid crosses and Mendelian principle of independent assortment. a) Epistasis b) Statistical analysis of Genetic data. The Chi-square test. c) Multiple alleles – ABO blood groups. d) Essential genes and lethal genes. e) The environment and gene expression codominance, incomplete dominance, pleiotropy. f) Sex linkage, Sex limited & influenced characters II) Non- Mendelian Inheritance- Maternal effect	
UNIT II	**Chromosomes and their packaging**	**(07)**
	I) Structure of chromosomes: a) Lamp brush chromosomes b. Polytene chromosomes I) Heterochromatin – defense against mobile DNA elements. III)Chromosomal DNA and its packaging: a) Prokaryotic and eukaryotic chromosome unique & repetitive DNA sequences b) Nucleosome core particle – Histone, non-histone c) ATP-driven chromatin remodeling machines. d) Covalent modification of Histone tails	
UNIT III	**DNA damage and repair**	**(07)**
	A) DNA Repair i) Error-free mechanism: Mismatch repair, Base excision repair, Nucleotide excision repair, Direct repair. ii) Error prone mechanism- B) DNA Recombination. i) Homologous genetic recombination. ii) Heterologous genetic recombination.	

UNIT IV	Human Genetics	(08)
	i) Pedigree analysis. ii) Lod score for linkage testing. iii) Karyotype iv) Genetic disorders- Hemophilia, Color blindness, Hungstinson's disease	

Course outcomes: Students should be able to-

1. Recall the essentials of bacterial and human genetics.
2. Outline the structural levels of chromosomes.
3. Summarize DNA repair and gene recombination mechanisms.
4. Compare pedigree analysis and various genetic disorders in humans.

References:

1. Gardner, M. J. Simmons, Principles of Genetics (Wiley Publishing's, 12 December 2006)
2. Jocelyn E Krebs, Lewin's Genes X (Jones & Bartlett Learning, 1 January 2009)
3. John Cronan , David Freifelder, Microbial Genetics (Narosa Publishers, 1 January 2008) -
4. David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry: 6th Edition – (W. H. Freeman, 13 February 2013)
5. Harvey Lodish, James E. Darnell, Molecular Cell Biology. (W.H. Freeman & Co Ltd, 18 August 2003)
6. Anthony JF Griffiths, Jeffrey H Miller, An introduction of Genetic Analysis 10th Edition.(Freeman, 2010)

MAMiT 414 E2: ADVANCED GENETICS

Course Objectives: Students will be able to

1. Study the fundamentals of gene therapy
2. Study the basics of stem cell research
3. Understand genetic counseling
4. Study population genetics

Credits 2	**MAMiT 414 E2: ADVANCED GENETICS**	**No. of hours perunit/ Credits**
UNIT I	**Gene Therapy**	**(07)**
	i) Fundamentals of gene transfer Viral vectors for gene therapy a) Non-viral gene transfer: Plasmids and DNA vaccines; Balistic methods; Liposomes; Engineered zinc-finger nucleases b) Lentiviral and adenoviral vectors for correction of single gene disorders; trials in animal models of human disease. ii) Gene therapy of inherited or acquired diseases- Cystic fibrosis; inherited coagulopathies and HIV infection.	
UNIT II	**Stem Cell Research**	**(08)**
	I) Introduction to stem cells: Definition, properties, proliferation, culture of stem cells, medical applications of stem cells II) Types of stem cells, Stem Cell biology and therapy, types embryonic stem cell, Adult stem cell, Stem Cell Biology and Therapy, Embryonic Stem Cells, culture and the potential benefits of stem cell technology III) Therapeutic applications of stem cells IV) Ethical Issues associated with stem cell-based regenerative medicine field. Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies	
UNIT III	**Genetic Counseling and Ethics**	**(07)**
	A) Genetic screening and pre-implantation genetic diagnosis; Clinical, psychosocial, and ethical aspects of human genetics research; case studies Carrier detection, Forensic studies and paternity testing; Cord blood banking, New born screening in genetic disorders, genome editing. B) Prenatal Counseling Biochemical screening – timing, methods, result interpretation. Counseling regarding various prenatal diagnosis techniques, risks associated with invasive procedures, interpretation of laboratory results and their limitations. Observe	

	foetal sampling procedure (amniocentesis, chorionic villus sampling, cordocentesis)	
UNIT IV	**Human Evolutionary Genetics**	**(08)**
	i) Population Genetic Theory and Statistical Methods: Basic concepts in population genetics as well as the most important statistical methods for investigating demographic and evolutionary models using the distribution of genetic variation in time and space. ii) Human evolutionary history: Human demographic history including the relationship with archaic people (Neanderthals), "out-of-Africa migration," and the spread of agriculture in Europe and how these hypotheses find support in the distribution of genetic variation. Molecular Evolution-amino acids and nucleotide substitutions, synonymous codon; Molecular divergence and molecular clock..	

Course outcomes: Students should be able to-

1. Explain gene therapy of acquired diseases.
2. Apply the therapeutic applications of stem cell research.
3. Differentiate genetic counseling regarding various prenatal diagnosis techniques.
4. Know the human evolutionary theory and concept in population genetics

References:

1. Human Molecular Genetics, Strachan T and Read AP – Garland Science
2. Genomes, Brown TA – Wiley Liss
3. Human Genetics and Genomics, Korf BR - Wiley
4. The Book of Genes and Genomes, Willard and Haga, - Springer
5. Modern Genetic Analysis, Griffiths AJF, Gelbart WM, Miller JH et al., - Freeman
6. An Introduction to Genetic Analysis, Griffiths AJF, Miller JH, Suzuki D T et al., - Freeman

MAMiT 415: RESEARCH METHODOLOGY

Course Objectives:

The student should be able to: -

1. Study the basic knowledge on the fundamentals of research methodology.
2. Understand to present research in scientific manner.
3. Get acquainted with different bio statistical tools in modern research.
4. Understand the relationship between statistics and biological research.

Credits 4	**MAMiT 415: RESEARCH METHODOLOGY**	**No. of hours per unit/ credits**
UNIT I	**UNIT I: Introduction to Research Methodology I**	**(15)**
	A) **Research Methods vs. Methodology** i) Introduction. ii) Types: Library research, field research, laboratory research. B) **Defining a Research Problem** i) Concept. ii) Selecting the research problem. iii) Techniques involved in defining the problem. iv) Conclusion of the problem. C) **Research Design** i) Need for research design. ii) Concept in research design. iii) Types of research design. D)**Developing a Research Plan** i) Need. ii) Essential characteristics of research plan.	
UNIT II	**Introduction to Research Methodology II**	**(15)**
	A) Reporting Practical and Project Work i) Structure of the report ii) Title, authors and their institution, abstract, keywords, abbreviations. iii) IMRAD technique: Introduction, Material and methods, Result discussion and conclusion, Acknowledgements B) Preparing a Grant Proposal for a Research Project C) Manuscript Submission to Research Journals i) Statement of proposal. ii) Ethical considerations. iii) Publishing editorial issues.	

	iv) Preparation and submission.	
UNIT III	**Descriptive Statistics**	**(15)**
	A) Importance of statistics in Biology i) Samples and Population ii) Types of data, random sampling methods and sampling errors, scales and variables, accuracy and precision. B) Measures of Central Tendency i) Mean (arithmetic, geometric, harmonic), median, percentile and mode. ii) Measures of dispersion – mean deviation, standard deviation and variance. iii) Measures of a) Skewness, b) Kurtosis.	
UNIT IV	**Hypothesis Testing**	**(15)**
	A) Introduction to Hypothesis Testing i) Null hypothesis ii) Alternate hypothesis. B) Statistical Tools i) Significance level, type I and type II errors, p-value, one tailed and two tailed tests. ii) Distribution of sample means, standard error and confidence interval, Degrees of freedom iii) Equality of two population means, proportions: t-tests and ztest iv) Chi-square test - test for goodness of fit, independence and homogeneity v) F test and ANOVA	

Course Outcomes: Student should be able to:-

1. Design a research plan.
2. Present research in scientific language.
3. Analyse research data employing biostatistical tools.
4. Statistically signify the importance of research data.

References:

1. N. Gurumani, Scientific thesis writing and Paper presentation, (MJP Publishers, Chennai, 2010).
2. C. R. Kothari, Research Methodology; Methods and Techniques,2 ndEd, (New Age International Publishers, New Delhi, 2004).
3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3 rd (Ukaaz, Publications, Hyderabad, 2004)
4. Robert R. Sokal and F. James Rohlf, Introduction to Biostatistics,2ndEd, (Dover Publications, INC. Mineola, New York,1969).
5. P.N. Arora, P.K.Malhan , Biostatistics, (Himalaya Publishing House, Mumbai, 2006) .

MAMiP 416 Practical I: LAB I

Course objectives: Student will be able to -

1. Understand the techniques of isolation.
2. Study the identification and morphological of microorganisms.
3. Study the effects of environmental factors.
4. Understand the characterization methods.

Credit 2	MAMiP 416: LAB-I	No. of hour (60)
	1. Isolation, characterization and identification of *Actinomycetes* 2. Isolation, characterization and identification of yeast. 3. Isolation, characterization and identification of molds. 4. Isolation, characterization and identification of *Microaerophilic organisms.* 5. Isolation, characterization in identification of cyanobacteria and *Nostoc.* 6. Isolation of *Oscillatoria.* 7. Morphological studies of algae-*chlorella and spirulina* 8. Induction of ascospores *Saccharomyces cereviciae.* 9. Isolation, characterization and identification of sports of VAM fungi from soil. 10. Separation of photosynthetic pigments using TLC 11. Isolation of plaque morphology mutants of phages by using UV radiation. 12. Demonstration of egg inoculation technique. 13. Determination of cross and activity of *E.coli* 14. Phage typing of *E-coli* 15. One step growth curve experiment. 16. Isolation of bacteriophage from sewage or any other source. 17. Characterization of bacteriophage. 18. Effect of environmental factors on stability of bacteriophage. 19. Validation of coach postulates using phytopathogen infected plants. 20. Isolation of bacterial pigment.	

Course outcomes: Student should be able to -

1. Perform the techniques of isolation.
2. Know the identification and morphological microorganisms.
3. Know the methods of study environmental factors.
4. Know the characterization methods.

MAMiP 417: Practical II: LAB II
(Based on MAMiT 413& 414 course)

Course Objectives: Student will be able to -

1. Study estimation of protein, DNA, RNA, and amino acid.
2. Study qualitative analysis of polysaccharides.
3. Study problems related to pedigree, epistasis, alleles, etc.
4. Study the determination of carbohydrates.

Credit 2	**MAMiP 417 :LAB-II**	**No. of hour -(60)**
	1. Estimation of bacterial protein by Folin Lowry method. 2. Quantitative estimation of amino acids by using ninhydrin method 3. Estimation of DNA by diphenyl amine method 4 Isolation and estimation of RNA from yeast by Orcinol method 5.Estimation of vitamin C from biological source. 6. Detection of changes in confirmation of protein by viscosity measurement. 7. Estimation of carbohydrates by DNS method. 8. Study of galactose transport in yeast. 9. Effect of hypertonic and hypotonic solution on cells. 10. Isolation of bacterial genomic DNA. 11. Study of stages in mitosis of growing onion root tip cells. 12. Separation of DNA by agarose gel electrophoresis. 13. To generate variability in antibiotic susceptibility of bacteria using chemical mutagen. 14. Protein purification by membrane dialysis. 15.Determination of carbohydrates using phenol sulphuric acid method. 16. Qualitative analysis of polysaccharides a) microscopic examination b) iodine test c) precipitation test d) hydrolysis test. 17. Separation of soy- protein by precipitation using salt. 18. Problems solving -Epistasis -Gene interactions and phenotypic effects. 19. Problem solving -Pedigree analysis. 20. Problem solving – multiple alleles, dihybrid cross and non mendelian inheritance.	

Course outcomes: Student should be able to -

1. Know the methods of estimation and quantification of macromolecules (protein, carbohydrates, DNA/RNA).
2. Know the methods of qualitative analysis of polysaccharides.
3. Solve the problems related to pedigree, epistasis, alleles, etc.
4. Know the determination methods of carbohydarted,

SEMESTER II

MAMiT 421: INDUSTRIAL MICROBIOLOGY

Course Objectives: Student will able to:-

1. Understand the basic concepts of fermentation technology.
2. Study the significance of microbial sensors.
3. Study economical aspects of solid-state fermentation.
4. Understand with various concepts related to intellectual property.

Credits 4	**MAMiT 421 – INDUSTRIAL MICROBIOLOGY**	**No. of hours per unit/ credits**
UNIT I	**Fermentation Technology**	**(15)**
	A) Bioreactor i) Design and operation. ii) Batch culture fermenter: Main parts, peripherals parts and accessories, alternative vessel design, types of instrumentation, common measurement and control system, sensors. iii) Simple continuous culture: Accessories and peripherals. v) Fermenter preparation and use. vi) Inoculation techniques in a bioreactor, sampling from fermenter vessel. vii) Maintenance of fermenter components. viii) Type of organism used in fermentation. ix) Sub fermenter system – a new approach. x) Solution to common problems in fermentation.	
UNIT II	**Microbial Biosensors**	**(15)**
	A) Concept of Biosensors a) Cell Immobilization - Introduction, Immobilized cell system: Surface attachment of cells, Entrapment within porous matrices, Containment behind a barrier, Self-aggregation of cells. b) Design of immobilized cell reactors – i) Mass transport phenomena in immobilized cell system. ii) Reaction and diffusion in immobilized cell system iii) Bioreactor design iv)Physiology of immobilized microbial cells. B) Types of electrochemical microbial sensors i) Optical biosensors ii) other types	
UNIT III	**Solid State Fermentation and Fermentation Economics**	**(15)**
	A) Solid-state fermentation (SSF) :- Introduction, comparison of SSF and submerged fermentation, Advantages, disadvantages, problems, types, Factors affecting,	

	fermenter design for SSF, Koji manufacturing process, industrial application of SSF, amylase production. B] Fermentation economics:- Introduction, economic objectives. Various aspects influencing fermentation economics Strain improvement, High yielding strain, Market potential, fermentation media and raw material, fermentation equipment's, recovery cost, water uses and recycling, effluent treatment.	
UNIT IV	**IPR and Patenting**	**(15)**
	A) Intellectual Property Rights Introduction and concept of IPR, the World Intellectual Property Organization (WIPO), Fields of intellectual property protection, General introduction to patents, copyrights and Trademarks. B) Patents: i) Introduction, conditions of patentability, drafting and filing a patent, examination of a patent application, infringement, exploitation of the patented invention, compulsory licenses. Utility models ii) Indian Patent Act C]Intellectual Property and Bioethics: Introduction, general principles and key aspects.	

Course Outcomes: Students should be able to:

1. Use and manipulate different types of fermenters and fermentation processes.
2. Designing of immobilized cell reactors.
3. Appy the technique of solid-state fermentation for laboratory production of metabolites.
4. Relate bioethical concepts and fundamentals for social welfare.

References:

1. Mansi E. L. (2011) Fermentation Microbiology and Biotechnology (2nd Edition), CRCPress.
2. Patil S.C. (2010) Industrial Microbiology, S. Chand and Company.
3. Casida J.R. (2016) Industrial Microbiology, New Age International Pvt. Ltd.
4. Peppler H.J., Pearlman D. (1979) Microbial Technology (2nd edition), Academic Press.
5. Stanbury P.P., Whitekar A., Hall S.J. (2008) Principles of Fermentation Technology,Elsevier.
6. Intellectual Property Rights in India, Shodhganga, Chapter 2.
7. WIPO Intellectual Property Handbook (2004) 2nd Edition, Chapters 1 and 2.
8. 8.Intellectual Property and Bioethics: An Overview – WIPO Booklet.

MAMiT 422: MICROBIAL METABOLISM

Course Objectives: Students will be able to:

1. Study the concept of pH and biological buffer system
2. Study of enzymology, and enzyme kinetics.
3. Study pathways in the utilization of different substrates in *E. coli*.
4. Understand the cell signaling and stress response.

Credits 4	**MAMiT 422: MICROBIAL METABOLISM**	**No. of hours per unit/ Credits**
UNIT I	**Bacterial Permeation**	**(15)**
	1) Concept of pH and buffers: a) Ionization of water, weak acid and weak bases. b) pH – pH scales, Bronsted Lowry concept of acids and bases. c) Buffer – Buffer solutions, Henderson Hasselhalch equation, Biological buffer system – Phosphate buffer system, bicarbonate buffer system, proteins, amino acids. 2) Membrane biochemistry: a) Components of membrane, b) Membrane structural models, c) Methods to study diffusion of solutes. d) Eukaryotic and prokaryotic protein transport systems, e) Membrane protein. f) Ion channels K+, Na+, Cl - g) Na +/ K+ pump	
UNIT II	**Essentials of Enzymology**	**(15)**
	1. Enzymes: a) Structure, function & reaction mechanism of - i) Pyruvate dehydrogenase ii) Fatty acid synthetase iii) ATPase b) Allosteric enzymes - i) Concept of allosterism ii) Positive and negative cooperativity. iii) Structural aspects of allosteric enzymes and their significance in regulation. c) Mechanism of action of enzymes- i) Single displace reaction. ii) Double displace reaction 2. Enzyme kinetics:: Historical aspects, Methods used for investigating the kinetics of enzyme catalysed reactions –initial velocity a) Michaelis Menten equation, graph, progressive curve and its significance. b) Alternative plots – Line weaver Burk Plot, Eadie Hofstee plot. 3. Enzyme inhibition: Significance, One example, Michaelis Menten equation,M.M graph, L.B.equation & graph for a) Competitive inhibition, b) Noncompetitive inhibition c) Un- Competitive inhibition	

UNIT III	**Carbohydrate and Lipid Metabolism**	**(15)**
	1) Pathways in Utilization of different substrates in *E. coli.* a) Overview of glucose metabolism b) Substrates other than glucose: Fructose, Lactose -Transport and breakdown of lactose, utilization of galactose, Acetate, Pyruvate, Malate. c) Relation with TCA and glyoxylate bypass. d) Gluconeogenesis. 2) Lipid Metabolism. a) Beta oxidation – pathway and regulation. b) Role of acyl carnitine in fatty acyl transport. c) Synthesis of fatty acid d) Structure and composition of fatty acidsynthetase complex reaction and regulation. e) Synthesis of triacylglycerides. f) Ketone bodies – formation and utilization.	
UNIT IV	**Signaling and Stress Response in Microbes**	**(15)**
	1) Microbial response to stress: a) Microbial stress response, b) Stress proteins, and their roles, c) Cold and heat shocks d) Oxidative and starvation stress 2) Signaling and Behavior in Prokaryotes: a) Adaptive responses by facultative anaerobes to anaerobiosis b) Regulatory system. c) Two components signaling system. d) Porin structure e) Common signaling systems of plants, microbes & mammals.	

Course outcomes: Students should be able to-

1. Recall various biochemical processes and communication in bacteria.
2. Explain structure, function and reaction mechanisms in cell.
3. Summarize various metabolic pathways in bacteria.
4. Demonstrate signaling and stress response in microbes.

References:

1. K. Wilson, J. Walker, Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, 3 November 2006)
2. Jeremy M. Berg, Lubert Stryer, Biochemistry, (WH Freeman, 8 April 2015).
3. J L Jain, Sunjay Jain, Fundamental of Biochemistry (S Chand Publications, 1 January 2016)
4. R.L. Foster, Nature of Enzymology (Croom Helm Ltd, 1 November 1979) .

5. Trevor Palmer, Philip L. R Bonner, Enzymes: biochemistry, biotechnology and clinical chemistry (Woodhead Publishing, 4 April 2007)
6. G. Gottschalk, Bacterial Metabolism (Springer Publishing, 19 December 1985).
7. Geoffrey Zubay, Biochemistry (Brown (William C.) Co, U.S, 1 April 1997)
8. David White, The Physiology and Biochemistry of Procaryotes (Oxford Uni. Press, 2 December 2011)
9. Doelle H.W, Introduction to bacterial metabolism (Academic Press:1975)

MAMiT 423: ANALYTICAL TECHNIQUES

Course objectives: Students will be able to:

1. Study the details of microscopy and electrophoretic techniques.
2. Understand the principles and types of chromatography.
3. Study principles and various types of centrifugations.
4. Know various methods of protein purification.

Credits 4	**MAMiT 423: ANALYTICAL TECHNIQUES**	**No. of hours per unit/ credits**
UNIT I	**UNIT I: Microscopy and Electrophoretic Techniques**	**(15)**
	1. Microscopy- Types, principle, specimen preparation, staining, applications of Phase contrast, Fluorescence, 2. Electron Microscope. 3. Electrophoretic techniques General principles a) Support Media b) Electrophoresis of proteins c) Electrophoresis of nucleic acids d) Capillary electrophoresis e) Microchip electrophoresis	
UNIT II	**UNIT II: Chromatography and Centrifugation**	**(15)**
	1. Chromatography – basic principles & applications a) Ion Exchange chromatography. b) Gel Filtration chromatography. c) Affinity chromatography. d) Gas liquid chromatography. e) High performance liquid chromatography. 2. Centrifugation- Principle & mathematical derivation about centrifugal force, sedimentation rate & sedimentation coefficient. a) Components of centrifuge- types of rotors & centrifuge tubes. b) Types & applications of different types of centrifuges. c) Ultra Centrifuge – preparative- differential & density gradient centrifugation; analytical type. Care & maintenance of centrifuge.	
UNIT III	**Spectroscopy**	**(15)**
	1. Spectroscopy a) Basic principles of spectroscopy – EMR, photons, types of spectrum, interaction of Light with matter. b) Principles of photometry - Laws of photometry.	

	c) Types of spectroscopy: Atomic spectroscopy – Atomic emission and absorption spectroscopy, Mass spectroscopy, Plasma emission spectroscopy. 2. Spectroscopy – II a) Molecular spectroscopy: U.V./ visible spectroscopy, Infrared & Raman spectroscopy, NMR, ESR b) CD/ORD Spectroscopy. c) X – ray spectroscopy – X- ray diffraction	
UNIT IV	**Protein purification and protein structure determination**	**(15)**
	1) Protein purification a) Determination of protein concentration b) Cell disruption and production of initial crude extract c) Fractionation methods – Monitoring of protein purification, Preliminary purification steps. 2) Protein Structure determination a) Determination of relative molecular mass b) Amino acid analysis- c) Primary Structure determination d) Tertiary Structure determination	

Course outcomes: Student should be able to:

1. Choose bio-analytical techniques useful in research and industries.
2. Demonstrate practical significance of separation techniques of biomolecules.
3. Know the techniques related to molecular level analysis.
4. Update with techniques used in current research.

Reference

1.T. Devasena & G. Rajgopal, Techniques in Biochemistry (Ahuja Book Company Pvt.Ltd, 2010)

2.K. Wilson, J. Walker, Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, 3 November 2006)

3.L.Veera Kumari , Bioinstrumentation (MIP Publishers, Chennai, 1 January 2011)

4.Dr. P. Ashokan , Analytical Biochemistry (Chinnaa Publications, 2005)

5.Terrance G. Cooper, Tools in Biochemistry (Wiley India Pvt Ltd, 24 February 2011)

6.B.K.Sharma, Instrumental methods of chemical analysis (Krishna Prakashan Media Pvt Ltd, 1 January 2011)

MAMiT 424 E1: QUALITY MANAGEMENT IN PHARMACEUTICAL INDUSTRY

Course Objectives: Student will able to-

1. Understand the recent research in drug discovery and development.
2. Understand the tools and techniques used in antimicrobial testing.
3. Study emerging trends in biopharmaceuticals.
4. Study microbial spoilage of pharmaceutical products.

Credits **2**	**MAMiT 424 E1: QUALITY MANAGEMENT IN PHARMACEUTICAL INDUSTRY**	**No. of hours Per unit/ Credits**
UNIT I	**Introduction of quality control and assurance**	**(07)**
	1) Introduction of quality control Definition - Quality control basics. Quality control for: all instruments, clothing's, packing, processing line. Quality control of processes and products: pharmaceutical products 2. Introduction of quality assurance, GMP for: building (premises) for manufacture of drugs, Packaging material, Personnel, hygiene, sanitation, waste and disposal. Quality assurance and regulatory aspect for: manufacture and sale of drug and formulation clinical and nonclinical testing, animal trials. Records and documents: Records related to products release, Quality review, and Quality audits. Complains and recalls	
UNIT II	**Essentials of Analytical Techniques in Pharma Industry**	**(08)**
	A) Media Preparation, Sterilization and Growth Promotion. Guidelines for a) Media Preparation, b) Sterilization and c) Growth Promotion. B) Environment Monitoring: Introduction, Need for EM, Procedure and Significance. C) Endotoxin Testing: Introduction, Gel Clot Method, Kinetic Assays, Medical Devices. D) Antibiotic / Vitamin Assay: General Information, Equipment, Test Organism, Inoculum preparation And Standardization, Antibiotic/Vitamin Standard and Sample Solution Preparation, Growth Media and Additional Test Solutions, Potency Testing –Plate Method and Tube Method.	
UNIT III	**Other analytical techniques in pharma industry**	**(07)**
	A] Microbiological Examination of Non- Sterile Products. Product storage and handling, gowning requirements, Growth promotion and inhibitory properties of the media ,Suitability of the test method, test procedure, interpretation of the results.	

	B] Preservative Efficacy Testing(PET). Media, Growth promotion of the media, suitability of the counting method in the presence of product, test organisms, preparation of the inoculum, procedure and interpretation	
UNIT IV	**Biopharmaceuticals**	**(08)**
	A) Introduction: Concept and significance of biopharmaceuticals. B) Regulations and Recommendation i) Regulatory authorities and their role – the FDA. ii) The concept of Pharmacopoeia – USP, EP, BP and IP. C) Drug Formulation Studies Drug formulations – carriers and delivery systems.	

Course Outcomes: Student should be able to: -

1. Explain the basic concepts of quality control.
2. Choose essential analytical techniques in pharma industry.
3. Comprehend the concept of biopharmaceuticals.
4. Demonstrate preservative efficacy testing.

References: -

1. K. Park (2009), Park's Textbook of Preventive and Social Medicine (20th Edition).
2. Konrad J. Karczewski, Roxana Daneshjou, Russ B. Altman (2012) Chapter 7. Pharmacogenomics PLOS.
3. Franklin T.J. and Snow G.A., (1975), Biochemistry of Antimicrobial Action, Chapman and Hall, London.
4. Gale E.F., Cundliffe E., Reynolds P.E., Richmond M.H. and Waring M.J., (1972), The molecular basis of antibiotic action, John Wiley and Sons, London.
5. Goldstein A., Aronow L. and Kalman S.M. (1969) Principles of Drug Action, The Basis of Pharmacology, Harper International Edition, New York.
6. Mannfred A. Holliger, (2008) Introduction to Pharmacology, 3rd Edition, CRC Press.
7. Kokate C. K., Purohit A.P., Gokhale A.B.(2000) Pharmacology,4th Edition, Nirali Prakashan.

MAMiT 424 E2– PHARMACEUTICAL MICROBIOLOGY

Course Objectives: Student will be able to:

1. Understand the basic concept of chemotherapeutic agents.
2. Understand the discovery and development of the drug.
3. Study the development of drug,
4. Understand the causes and preservation methods of pharmaceutical products.

Credits 2	**MAMIT 424 E2– PHARMACEUTICAL MICROBIOLOGY**	**No. of hours per unit/ credits**
UNIT I	**Introduction to chemotherapeutic agents:**	**(07)**
	i) History and development of chemotherapeutic agent, ii) Properties of antimicrobial agents, iii) Types of chemotherapeutic agents –Synthetic, Semisynthetic, Natural. iv) Antibiotics: Types of antibiotics with their mode of action; antibacterial, antifungal, antiviral, antiprotozoal	
UNIT II	**Drug Discovery and Development**	**(08)**
	A) Introduction i) Contributions and postulates of Paul Ehrlich ii) Significance of terms - lead optimization, candidate selection B) Drug Discovery and Design i) Conventional Process of bioprospecting (medicinal chemistry) ii) Extraction and purification principles, iii) Purification and characterization of bioactive molecules from natural sources C) Rational Drug Design – Principle (Structure Activity Relationship-SAR) and Tools (applications of High Throughput Screening, Combinatorial Synthesis, Pharmacogenomics) D) Drug Development i) Preclinical Development – Toxicity Testing: Acute, Sub- acute and Chronic. ii) Clinical Development Clinical Trials: Aims, Objectives, Conduct, Phases of Clinical Trials – I,II,III, IV.	
UNIT III	**Antibiotic resistance and development of new therapeutics**	**(07)**

	i) Development of antibiotic resistance, ii) Mechanism of antibiotic resistance, iii) Antimicrobial Peptides: History, properties, sources, mode of action, application. iv) Phage therapy: introduction to phages, lytic cycle, types of phages involved in phage therapy v) Plant based therapeutic agents.	
UNIT IV	**Microbial spoilage and preservation of pharma products**	**(08)**
	i) Microbial contamination spoilage and hazard: Sources of contamination, ii) Factors affecting survival and growth, breakdown of active ingredient and general formulations. iii) Principles of sterilizations with respect to pharmaceutical industries. iv) Methods of sterilizations: Steam, dry heat, Radiation, Gaseous and Filtration v) Principles of preservation: objectives of preservation, the ideal preservative, rational development of a product preservative system etc. vi) Antimicrobial preservatives and their properties: antimicrobial activity, factors affecting antimicrobial activity, preservative monographs. vii)Preservative stability and efficacy. viii)Methods of Preservative evaluation and testing	

Course Outcomes:

Student should be able to

1. Comprehend the chemotherapeutic agent.
2. Illustrate the drug design and drug development method.
3. Recall the concept of drug resistance and development of new drug.
4. Compare various methods of preservations of pharmaceutical products.

References:

1. Pharmaceutical Microbiology Manual (PMM), United States Food and DrugAdministration (USFDA), ORA.007, Version 1.2, 2014.
2. Indian Pharmacopoeia (IP), Volume II (P-Z, Reference Spectra and Appendices), Ministryof Health and Family Welfare, Government of India, 1996.
3. Manohar A. Potdar, Pharmaceutical Quality Assurance, 2nd Edition, NiraliPrakashan,2007.
4. Baird R.M., Hodges N.A.,DenyerS.P.,Handbook of Microbiological Quality Control inPharmaceuticals and Medical Devices,CRC press, 2000.

MAMIT 425: RESEARCH PROJECT

Credits 4	MAMIT 425: RESEARCH PROJECT	No. of hours-120

MAMiP 426: Practical III: LAB III

Course objectives: Student will be able to -

1. Study separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons, pesticides, organic solvents, methane by gas chromatography.
3. Prepare buffers of various pH
4. Study preparation of immobilized cells of yeast cells and determination of invertase

Credit 2	MAMiP 426: LAB III	No. of hours -(60)
	1. Production of wine from grapes 2. Estimation of yeast biomass and lactic acid bacteria under different nutrient composition. 3. Screening of lactic acid bacteria for probiotic characters pH bile salt and antibiotic sensitivity. 4. Preparation of sauerkraut using lactic acid bacteria. 5. Preparation of kimchi using lactic acid bacteria. 6. Induction of endospore production in stress condition. 7. Determination of KM value of enzyme. 8. Microbiological assay of Cellulase. 9. Emulsification index determination of biosurfactant agent. 10. Determination of molar extinction coefficient. 11. Preparation of phosphate /acetate carbonate buffer. 12. Titration curve of glycine 13. Study of organisms subjected to nutritional stress. 14. Essay of protease and lipase enzymes. 15. Protein assay by tyrosin curve 16. Preparation of immobile cells of yeast cells and determination of invertertase activity. 17. Study of effect of gel concentration on immobilized enzyme activity. 18. Detection of siderophore for production by pseudomonas species. 19. Laboratory production of alkaline protein by solid state fermentation. 20. Isolation of cellulase producers from soil.	

Course outcomes: Student should be able to**: -**

1. Demonstrate method for separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons, pesticides, organic solvents, methane by gas chromatography.
3. Prepare various buffers like phosphate, acetate and carbonate.
4. Apply the technique for quantitative estimation of hydrocarbons.

MAMiP 427: Practical IV: LAB IV

Course objectives: Student will be able to -

1. Study separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons, pesticides, organic solvents, methane by gas chromatography.
3. Prepare buffers of various pH
4. Study preparation of immobilized cells of yeast cells and determination of invertase

Credit 2	MAMiP 427 : (LAB-IV)	No. of hours (60)
	1.Separation and identification of amino acid mixture by 2D paper chromatography 2. Separation and identification of amino acid mixture by TLC. 3. Separation and identification of sugar mixture by paper chromatography. 4. Separation and identification of sugar mixture by TLC. 5. Determination of capacity of ion exchange resin (Dowex 50) 6. Demonstration of scanning electron microscopy. 7. Determination of protein concentration using uv spectroscopy 8. Cell Disruption technique by sonication. 9. Separation of biomolecules using Density Gradient Centrifugation 10. Study of Secondary structure of proteins by visualizing software Rasmol. 11. Study of 3 Dimensional structure of proteins by visualizing software Rasmol. 12. Determination of bioburden on medical device. 13. Isolation of antibiotic resistant organism from Pharma products. 14. Determination of bioburden from non sterile products. 15. Quality control of instruments- a. Incubator b. Hot Air Oven c. Autoclave. 16. To determine biological oxygen demand of industrial effluent. 17. Bioremediation of industrial waste by suitable method. 18. To determine chemical oxygen demand of industrial effluent. 19. Demonstration of fumigation of laboratory. 20. Analysis of water by plate count method.	

Course outcomes: Student should be able to**: -**

1. Demonstrate method for separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons, pesticides, organic solvents, methane by gas chromatography.
3. Prepare various buffers like phosphate, acetate and carbonate.
4. Apply the technique for quantitative estimation of hydrocarbons.

Gautekar