Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OFSCIENCE, SATARA

(AUTONOMOUS)

CBCS

Reaccredited by NAAC with

'A+'Grade

Revised Syllabus for Master of

Science

Part - I

APPLIED MICROBIOLOGY

Syllabus to be implemented from ,2021 onwards

A. RULES AND REGULATIONS:

1. Any person who has taken the degree of B. Sc. of this Institute or the degreeof any other statutory University and has kept four terms in the Institute as apost-graduate student be admitted to the examination for the degree of Master of Science (M. Sc.) in Applied Microbiology.
2. A student shall be held eligible for admission to the M. Sc. Applied Microbiology course provided s/he has passed the B. Sc. examination with Microbiology as a principal subject or with a subsidiary/interdisciplinary/applied/allied subjects and has passed the entrance examination conducted by the Institute.
3. The students with B. Sc. from other universities shall be eligible if they qualify through the entrance examination.
4. While preparing the merit list for M. Sc. admission, the performance at B.Sc.III (Microbiology) and the performance at the entrance examination should be given equal weightage (50:50).
5. The examination shall be split up into four semesters.
6. The commencement and conclusion of each semester shall be notified by the Institute from time to time.
7. A student who has passed in semester examination shall not be allowed to take the examination in the same semester again.
8. Each theory paper in each semester as well as each practical course shall be treated as separate head of passing.
9. The result shall be declared at the end of each semester examination as perInstitute rules.

B. SYLLABUS FOR MASTER OF SCIENCE (M.Sc.):

1. Title: Subject: - APPLIED MICROBIOLOGY

2. Year of implementation: June 2019 onwards

Total number of semesters :	**04**
(Two semesters per year)	
Total No. of papers :	**16**
Total no. of practical courses :	**08**
No. of theory papers per semester :	**04 / 04 / 04 / 04**
No. of practical courses per semester :	**02**
Maximum per mark spaper(practical) :	**100**
Distribution of marks –	
Internal evaluation :	**20**
External evaluation :	**80**
(Semester exam)	
Total marks for M. Sc. Degree	
Theory papers :	**1600**
Practical course :	**800**
	2400

3. General Objectives of the Course:

A prime objective to maintain updated curriculum and providing therein inputs totake care of fast paced developments in knowledge of Applied Microbiologyandin relation to International context, a two year programme is formulated for M.Sc. Applied Microbiology as per UGC guidelines and to develop competent microbiologists to achieve desirable placements in the country andabroad. Theprogramme 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 Scienceetc.

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 paper 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 eachyear (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 I

Semester I

Nature of the Course	Paper Code	Name of thePaper
Theory	MAMiT 101	MICROBIAL BIODIVERSITY
	MAMiT 102	RECENT TRENDS IN VIROLOGY
	MAMiT 103	MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY
	MAMiT 104	ESSENTIALS OF GENETICS
Practical	MAMiP 105	PRACTICAL COURSE I: LAB I
	MAMiP 106	PRACTICAL COURSE I: LAB II

Semester II

Nature of the Course	Paper Code	Name of the Paper
Theory	MAMiT 201	ANALYTICAL TECHNIQUES
	MAMiT 202	MICROBIAL METABOLISM
	MAMiT 203	MOLECULAR BIOLOGY AND GENETICS
	MAMiT 204	RESEARCH METHODOLOGY & BIOSTATISTICS
Practical	MAMiP 205	PRACTICAL COURSE II: LAB III
	MAMiP 206	PRACTICAL COURSE II: LAB IV

M.Sc. Part II

Semester III

Nature of the Course	Paper Code	Name of the Paper
Theory	MAMiT 301	MICROBIAL ECOLOGY AND EXTREMOPHILES
	MAMiT 302	ESSENTIALS OF IMMUNOLOGY
	MAMiT 303	GENE TECHNOLOGY
	MAMiT 304	PHARMACEUTICAL MICROBIOLOGY
	MAMiT 305 E-1	FOOD AND DAIRY TECHNOLOGY - I
	MAMiT 305 E-2	ESSENTIALS OF BIOINFORMATICS
Practical	MAMiP 306	PRACTICAL COURSE III: LAB V
	MAMiP 307	PRACTICAL COURSE III: LAB VI

Semester IV

Nature of the Course	Paper Code	Name of the Paper
Theory	MAMiT 401	INDUSTRIAL MICROBIOLOGY
	MAMiT 402	MICROBIOLOGICAL QUALITY CONTROL ANDASSURANCE
	MAMiT 403 E-1	FOOD AND DAIRY TECHNOLOGY - II
	MAMiT 403 E-2	ADVANCED BIOINFORMATICS
Practical	MAMiP 404	PRACTICAL COURSE IV: LAB VII
	MAMiP 405	PRACTICAL COURSE IV: LAB VIII

SEMESTER I

MAMiT 101: MICROBIAL BIODIVERSITY

Learning Objectives:

The student should be able to: -

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

UNIT I: Basic Concepts of Microbial Systematics **15**

A) Microbial Systematics: Classification and Techniques

i) Introduction: Need for classification of microorganisms, overview, aimsand 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.
- *a)* Yeasts.
- *b)* Molds.

ii) Algae.

iii) Protozoa.

UNIT III: Domains Archaea and Eubacteria 15

A) Introduction:

i) General review and significance of domains Archaea and Eubacteria.

B) General Classification, Salient Features and Industrial Significance of –

i) Domain Archaea.

ii) Domain Eubacteria-
- *a)* Actinobacteria.
- *b)* Cyanobacteria.
- *c)* Mycoplasma.
- *d)* Myxobacteria
- *e)* 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

Learning Outcomes:

After learning the theory paper, the student will be able to:-

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

References: -

1) Bergey's Manual of Determinative Bacteriology. – **UNIT I, II, III.**
2) Bergey's Manual of Systematic Bacteriology **- UNIT I, II, III.**
3) Michael T. Madigan, Brock's Biology of Microorganisms – **UNIT I, II, III.**
4) Chandra Wickramasinghe and R. Gabriel Joseph, The Evolution of Lifefrom Space: Astrobiology, Viruses, Microbiology and Genetics – **UNIT IV.**
5) David C. Catling, Astrobiology:A Very Short Introduction **-UNIT IV.**

MAMiT 102: RECENT TRENDS IN VIROLOGY

Learning Objectives:

The student should be able to:-

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

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 :

a) Disease

b) Host organism

c) Partial morphology of virus

d) Nucleic acid of virus

e) Taxonomy

ii) Concepts of Viriods, 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) Photodynamics 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**

i) phi X 174

ii) RNA phages.

iii) 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 Ebola virus.

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 TyrosineKinase.
- Erythroprotin Receptor, Ras Pathway, c-Fos, c-Myc.

v) Apoptotic gene as protooncogene or tumour suppressor gene.

vi)Mutations causing loss of growth inhibition and cell control – Rb, p53 protein.

UNIT IV: Vaccines and Antiviral Drugs **15**

Antiviral Drugs

1) **Types of vaccines, their immune response and adverse reactions.**
   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:

a) Viral Entry.

b) Replication of Viral Nucleic Acid.

c) Viral Protein Functionality.

iii) Drug resistance among viruses to antiviral drugs.

iv) Bacterial Phage Therapy

Learning Outcomes:

After learning the theory paper,

the student will be able to: -

1) Understand the evolution and classification of viruses.
2) Comprehend the life cycles of selected groups of viruses
3) Get an idea of 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 – **UNIT I, UNIT IV**
2) Edward K. Wagner, Basic Virology, 3rd Edition – **UNIT I.**
3) Ajit K. Banerjee, Fundamentals of Microbiology & Immunology – **UNIT IV.**
4) Straus J.H., Evolution of RNA Viruses – **UNIT II.**
5) Longman, Introduction to Plant Virology – **UNIT III.**
6) N.J. Dimmock, A.J. Easton, Introduction to Modern Virology, 6th Edition – **UNITII.**
7) Luria, Virology – **UNIT II.**

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 **UNIT IV**

9) University of Oxford, Vaccine Knowledge Project- Vaccine Ingredients https://vk.ovg.ox.ac.uk/vk/vaccine-ingredients **UNIT IV**

MAMiT 103: MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

Learning Objectives:

The student should be able to: -

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

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 –

1. Acid base nature, b) Titration
2. curve of glycine, c) Electric charge.

iii. Peptide bond and its nature.

iv. Peptide.

1. Ionization behavior
2. Polypeptide and its Diversity- Size and Composition

b. Proteins

i. Structural levels of proteins

1. Primary Structure (oxytocin).
2. Secondary Structure – alpha helix, B-sheet, B-turn (α keratin).
3. Tertiary Structure (Myoglobin).
4. 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.
3. Diseases caused by misfolding – an overview.

UNIT II: Carbohydrates, Lipids and Vitamins **15**

A) Carbohydrates

i) Definition and Functions- carbohydrates.

ii) Monosaccharides

a) Classification and structures of aldoses and ketoses.

b) Configuration and Conformation.

iii) Disaccharides

a) Lactose and Sucrose.

iv) Polysaccharides

a) Types of polysaccharides – Homopolysaccharide and Heteropolysaccharide.

b) Homopolysaccharide

- Stearic forces and hydrogen bonding in homopolysaccharide folding.
- Structure and Role of Starch, Glycogen, Cellulose
- Heteropolysaccharide- Heparin, Hyaluronate.

v) Glycoconjugates – Proteoglycan, Glycoproteins, Glycolipids.

B) Lipids

i) Definition, General Properties and Functions of Lipids.

ii) General Formula and Nomenclature of Fatty Acids:

a) Classification of Lipids

- Even and Odd Scheme of Nomenclature.
- Saturated and Unsaturated Fatty Acids.
- PUFA(Poly Unsaturated Fatty Acid) and its chemical properties.

iii) Structure, General Properties and Functions of :

a) Simple Lipids (Triacylglycerols).

b) Complex Lipids (Phosphoglycerides – Lecithin, Sphingolipids – Sphingomyelin).

c) Derived Lipids- Sterols – Cholesterol, Ketone Bodies.

C) Vitamins

i) Definition, classification and General Properties.

ii) Structures and Forms of Coenzymes.

iii) Mode of Action, Sources, Daily Requirement andDeficiency Study of:

a) Thiamine, b) Riboflavin, c) Ascorbic Acid.

UNIT III: Bioenergetics and Photosynthesis **15**

A) Bioenergetics:

i) Principles and Laws of Thermodynamics

ii) Reaction Profile – Oxidation, Reduction, Redox couples.

iii) Oxidative Phosphorylation

- Architecture of Mitochondria.
- Electron Transport Chain (ETC) reactions in mitochondria.

iv) Mechanism of ATP Synthesis by Chemiosmotic Model.

v) Uncouplers and Inhibitors of ETC.

vi) 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

a) Pheophytin- Quinone Center and Fe-S Center.

b) Photosystem II in Cyanobacteria.

c) 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

UNIT IV: Bacterial Chemolithotrophy **15**

***A)* Introduction**
i) Overview and Modes of Microbial Metabolism.

***B)* Chemolithotrophs**
i) General features of chemolithotrophs.
ii) Physiological Groups of Chemolithotrophs.
iii) Types of Chemolithotrophic Reactions with examples:
a) Ammonia Oxidation.
b) Nitrite oxidation.
c) Oxidation of Molecular Hydrogen.
d) Ferrous and Sulphur Oxidation.

Learning Outcomes:

After learning the theory paper, the student will be able to: -

1) Understand the basic concepts of amino acids and proteins.
2) Comprehend the properties and importance of saccharides, lipids and vitamins.
3) Get an idea about the bacterial and plant metabolic machinery.
4) Differentiate between various types of bacterial chemolithotrophic reactions

References: -

1) Nelson and Cox, Lehninger's Biochemistry, 9th Edition – **UNIT I, II.**
2) Lubert Stryer, Biochemistry, 2010 – **UNIT II.**
3) White and Smith, Principles of Biochemistry – **UNIT II.**
4) Voet and Voet, Biochemistry – **UNIT III.**
5) David Plummer, Practical Biochemistry – **UNIT I, II.**
6) Shrivastava, Elements of Biochemistry – **UNIT I, II, III.**
7) Malhotra, Practical Biochemistry for Students – **UNIT II**
8) B. Buchanan, W. Cruissem, R. Jones, Biochemistry and Molecular Biology ofPlants – **UNIT IV.**
9) David Metzer, Biochemistry – Chemical Reactions of Living Cell, Vol. I and II –**UNIT IV.**
10) Sadasivam, Biochemical Methods – **UNIT II.**

11) Cooper, The Cell – **UNIT III.**
12) Michael T. Madigan, Brock’s Biology of Microorganisms – **UNIT IV.**
13) Doelle, Bacterial Metabolism – **UNIT IV.**
14) Kim, Bacterial Physiology – **UNIT IV.**

MAMiT. 104: ESSENTIALS OF GENETICS Lectures: 48

Learning Objectives:

The student should be able to -

1. Learn 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 chromosome and their packaging
4. Know the various repair mechanisms in the body
5. Learn about the pedigree analysis and various genetic disorders in humans

UNIT –I: Mendelian and Non-Mendelian Genetics Lectures: 12

I) Mendelism :

a) Monohybrid crosses and Mendel's' Principle of segregation.
b) Dihybrid crosses and Mendelian principle of independent assortment
c) Epistasis
d) Statistical analysis of Genetic data. The Chi-square test.
e) Multiple alleles – ABO blood groups.
f) Essential genes and lethal genes.
g) The environment and gene expression- co-dominance, incomplete dominance, pleiotropy.
h) Sex linkage, Sex limited & influenced characters

II) Non-Mendelian Inheritance**:**

a) Determining Non-Mendelian Inheritance
b) Maternal effects.
c) Cytoplasmic inheritance (Mitochondria, chloroplast, infective particles)

UNIT –II: Chromosomes and their packaging Lectures: 12

I. Structure of chromosomes:

a) Lampbrush chromosomes
b) Polytene chromosomes
c) Heterochromatin – defense against mobile DNA elements.
d) Mitotic chromosomes – their patterns
e) Mitotic chromosomes – their patterns

II. Chromosomal DNA and its packaging:
a) Procaryotic 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
e) Split genes – Exon, Intron,
f) Splicing mechanism i) Autocatalytic RNA ii) Spliceosome

UNIT –III : DNA damage and repair **Lectures: 12**

I. DNA Repair
a) Error free mechanism –
i) Mismatch repair. Base excision repair.
ii) Nucleotide excision repair.
iii) Direct repair.
b) Error prone mechanism-
II. DNA Recombination.
a) Homologous genetic recombination.
b) Site specific recombination.
c) Eukaryotic transposons.

UNIT –IV : Human Genetics **Lectures: 12**

I. Pedigree analysis,
II. Lod score for linkage testing,
III. Karyotype
IV. Genetic disorders- Haemophilia, Colour blindness, Hungstinson's disease
V. Quantitative genetics- polygenic inheritance, heritability & its
measurements & QTL
mapping.

LEARNING OUTCOMES :

Students will be able to-

1) understand essentials of bacterial and human genetics.
2) know structural levels of chromosomes.
3) learn about DNA repair and gene recombinationmechanisms.
4) learn pedigree analysis and various genetic disorders in humans .

REFERENCE BOOKS :

1) **UNIT – I:** Principles of Genetics – Gardner
2) **UNIT – II:** Genes by Lewin – V and IX
3) **UNIT – III:** Microbial Genetics – Friefielder
4) **UNIT – I:** Gene – Watson
5) **UNIT – II:** Genetics – Klug & Commings.
6) **UNIT – III:** Lehninger's Principles of Biochemistry – Nelson & Cox
7) **UNIT – IV:** Molecular Cell biology by Lodish -2010
8) **UNIT – IV:** An introduction of Genetic Analysis 10th Edition. Freeman 2010.Anthony &J.F.Griffith, Susan R. Wessler

M.Sc.Part-I, Sem.I MAMiP. 105 Practical

Course – I (LAB-I)

Learning Objectives:

The student should be able to:

1) Learn the technique of isolation, identification & characterization of various micro organisms

2) Learn the technique of isolation of mutant coliphages.

3) Learn the technique of Egg inoculation .

4) Determine cross infectivity of coliphages with other bacteria

Unit – I

1) Isolation, Identification & Characterization of Actinomycetes.
2) Isolation, Identification & Characterization of Yeasts.
3) Isolation, Identification & Characterization of Molds.
4) Isolation & Characterization of Microaerophilic Microorganisms.
5) Isolation, Identification & Characterization of Cynobacteria- *Nostoc*, *Oscillotoria*.
6) Morphological studies of Algae- *Chlorella*, *Spirullina*,
7) Induction of ascospores in *S. cereviciae*.
8) Isolation, identification of spores of VAM fungi from soil.

Unit – II

1) Isolation of plaque morphology mutant of phages by using U.V. radiation.

2) Demonstration of Egg inoculation technique.

3) Determination of cross infectivity of E. coli with *Pseudomonas*, *Salmonella & Proteus vulgaris* phages

4) Preparation of high titre of *E.coli* phages.

5) Phage typing of *E.coli*.

6) Amplification of lambda DNA by PCR

LEARNING OUTCOMES :

The student will be able to:

1) Learn the technique of isolation, identification & characterization of various micro organisms
2) Learn the technique of isolation of mutant coliphages.
3) Learn the technique of Egg inoculation technique
4) Determine cross infectivity of coliphages with other bacteria

REFERENCE BOOKS:

1) An introduction to practical biochemistry – 3rd edition, David T. Plummer
2) Practical handbook of microbiology – Shouldiam M. O'Leary
3) Practical microbiology – S. Chand
4) A textbook of practical biochemistry – Joshi A. Rashmi

MAMiP. 106 Practical Course – I

(LAB-II)

LEARNING OBJECTIVES:

The student should be able to:

1) Perform estimation of biomolecules like DNA, RNA, Vitamin C by various methods
2) Perform isolation of plasmid DNA
3) Solve problems on genetic code and population genetics
4) Learn effect of various factors on bacterial amylase enzyme.

Unit-I

1) Estimation of bacterial protein by Lowry method.
2) Quantitative estimation of amino acids by using ninhydrin method.
3) Estimation of DNA by Diphenylamine method.
4) Isolation of RNA from yeast.
5) Estimation of RNA by Bial's orcinol method.
6) Isolation & characterization of photosynthetic pigments chlorophyll a &bfrom plant.
7) Estimation of vitamin C from biological source.
8) Detection of changes in conformation of protein by viscosity measurement.

Unit-II

1) Isolation of bacterial plasmid.
2) Isolation of antibiotic resistant mutants by chemical mutagenesis.
3) Isolation of thiamine requiring mutants.
4) Effect of U.V. radiations to study the survival pattern of E.coli / yeast.
5) Study of repair mechanisms in E.coli. (photoreactivation & dark repair)
6) Problems on population genetics.
7) Problems on genetic code.

LEARNING OUTCOMES:

Students will be able to-

- understand various biochemical methodsto study biomolecules.

- Students should know various concepts of mutation.
- Students should learn about population genetics.
- Student should be updated with techniques used to study enzymes.

REFERENCE BOOKS:

1) An introduction to practical biochemistry – 3rd edition, David T. Plummer
2) Practical handbook of microbiology – Shouldiam M. O'Leary
3) Practical microbiology – S. Chand
4) A textbook of practical biochemistry – Joshi A. Rashmi

M.Sc. Part- I , Sem. II

M.AMiT. 201: ANALYTICAL TECHNIQUES **Lectures: 48**

Learning Objectives:

The student should be able to:

1. Learn the details of microscopy and electrophoretic techniques
2. Learn the principles and types of chromatography.
3. Study principles and various types of centrifugation.
4. learn various methods of protein purification.
5. Study principles and various types of spectroscopy

UNIT –I: Microscopy and Electrophoretic Techniques **Lectures: 12**

1) Microscopy- Types, principle, specimen preparation, staining , applications of Phase contrast, Fluorescence, Electron Microscope.

2) Electrophoretic techniques

a) General principles

b) Support Media

c) Electrophoresis of proteins

d) Electrophoresis of nucleic acids

e) Capillary electrophoresis

f) Microchip electrophoresis

UNIT –II: Chromatography and Centrifugation **Lectures: 12**

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.
d) Care & maintenance of centrifuge.

UNIT –III: Spectroscopy **Lectures: 12**

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 – i) Atomic spectroscopy – Atomic emission & absorption spectroscopy.
d) Mass spectroscopy
e) Plasma emission spectroscopy.
2) Spectroscopy – II
a) Molecular spectroscopy
i) U.V./ visible spectroscopy.
ii) Infrared & Raman spectroscopy.
iii) NMR
iv) ESR
b) CD/ORD Spectroscopy.
d) X – ray spectroscopy – X- ray diffraction

UNIT –IV: Protein purification and protein structure determination
Lectures: 12

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

LEARNING OUTCOMES:

Students will be able to-

- understand bio-analytical techniques useful in research and industries.
- know practical significance of separationtechniques of biomolecules.
- learn about techniques related tomolecular level analysis.
- Student should be updated with techniques used in present research

REFERENCE BOOKS –

i) **UNIT – I & II:** Techniques in Biochemistry – T. Devasena & G. Rajgopal
ii) **UNIT – I, II & IV :** Principles & techniques of Biochemistry & Molecular Biology – Wilson & Walker
iii) **UNIT – III & IV:** Bioinstrumentation – L.Veera Kumari , MIP Publishers , Chennai
vi) **UNIT – IV:** Analytical Biochemistry – Dr. P. Ashokan- Chinna Publications.
vii) **UNIT – I, II & III:** Tools in Biochemistry – David Cooper.
Instrumental methods of chemical analysis, Goel Publication House by –B.K.

MAMiT 202: MICROBIAL METABOLISM Lectures: 48

Learning Objectives:

The student should be able to:

1. Learn the concept of pH and biological buffer system
2. Learn the details of enzymology, enzyme kinetics.
3. Study Pathways in Utilization of different substrates in E. coli.
4. Learn the mechanism of Beta oxidation and fatty acid synthesis in lipid metabolism
5. learn Signaling and Stress Response in Microbes

UNIT –I: Bacterial Permeation **Lectures: 12**

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.
d) 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 **Lectures: 12**

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:

a) Historical aspects

b) Methods used for investigating the kinetics of enzyme catalysed reactions –initial velocity

c) Michaelis Menten equation, graph, progressive curve and its significance.

d) 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 Lectures: 12

1) Pathways in Utilization of different substrates in E. coli.

a) Overview of glucose metabolism

b) Substrates other than glucose –

i) Fructose

ii) Lactose -Transport and breakdown of lactose, utilization of galactose.

iii) Acetate

iv) Pyruvate

v) 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 acid synthetase complex reaction and regulation.

e) Synthesis of triacylglycerides.

f) Ketone bodies – formation and utilization.

UNIT –IV: Signaling and Stress Response in Microbes Lectures: 12

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 Behaviour in Procaryotes :
a) Adaptive responses by facultative anaerobes to anaerobiosis
b) Regulatory system.
e) Two components signaling system.
f) Porin structure
h) Common signaling systems of plants , microbes & mammals .

LEARNING OUTCOMES:

Students will be able to-

- understand various biochemical processes and communication in bacteria.
- know structure, function and reaction mechanisms in cell.
- learn about various metabolic pathways in bacteria.
- learn Signaling and Stress response in Microbes

REFERENCE BOOKS:

2) **UNIT – I, II &III:** Lehninger's Principles of Biochemistry 5th edi – Nelson& Cox
3) **UNIT – I, II &III:** Biochemistry – 2nd edition D. Voet, J. Voet.
4) **UNIT – I, II &III:** Biochemistry – 4th edition Lubert Stryer.
5) **UNIT – I, II &III:** Fundamental of Biochemistry by Jain.
6) **UNIT – II:** The Nature of Enzymology by Foster.
7) **UNIT – II:** Enzymes by Palmer
8) **UNIT – II:** Bacterial Metabolism by G. Gottschalk.
9) **UNIT – I, II &III:** Biochemistry by Zubay.
10) **UNIT – II:** The Physiology and Biochemstry of Procaryotes by White(Oxford Uni. Press)
11) **UNIT – III:** Introduction to bacterial metabolism – Doelle H. W.(1975) (Academic Press)
12) **UNIT – IV:** The Microbial world – Stanier.
13) **UNIT – IV:** Biochemical Calculations – Segal.
14) **UNIT – IV:** General Microbiology – Schlege.

MAMiT: 203 : MOLECULAR BIOLOGY AND GENETICS

Learning Objectives:

The student should be able to:

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

UNIT –I : DNA Replication   Lectures:12

DNA replication in prokaryotes - Origin of replication, types of E.coli
DNA polymerases, details
of replication process, regulation of replication, connection of replicationtocell 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.

UNIT –II : Transcription & Regulation of Gene Expression]
Lectures: 12

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 ofrepressor, 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.

UNIT –III : Translation **Lectures: 12**

1) 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

UNIT –IV: Sequencing Genes and Genomes **Lectures: 12**

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 molecularmarkers, mapping using somatic cell hybrids, mapping by transformation and conjugation.

2) Human Genome Project.
a) Applications of Genome Project.

LEARNING OUTCOMES:

- Students should understand gene expression and its regulation in prokaryotes and eukaryotes.
- Students should know mechanism of protein synthesis.
- Student should be updated with techniques used in present research in genetics.

REFERENCE BOOKS:

2) **UNIT – IV:** An introduction of Genetic Analysis 10th Edition. Freeman2010, Anatomy & J.F. Griffith.
3) **UNIT – IV**: Introduction to Genetic analysis – Lodish.
4) **UNIT – II & III:** Lehninger – Biochemistry.
5) **UNIT – I:** Gene : Lewin- X
6) **UNIT – I, II, III:** Molecular Cell Biology by Lodish – 2010.
7) **UNIT – I, II, III:** Molecular Biology F. Weaver- 2010
8) **UNIT – I:** Molecular Biology of gene 5th edition Benjamin & Cumin 2010.
9) **UNIT – IV:** An Introduction of Genetic Analysis 5th edition Freeman 2010

MAMiT 204: RESEARCH METHODOLOGY AND BIOSTATISTICS

Learning Objectives:

The student should be able to:-

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

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 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 report-
ii) Title, authors and their institution , abstract ,keywords, abbreviations.
iii) IMRAD technique
  a) Introduction
  b) Material and methods
  c) Result discussion and conclusion

d) Acknowledgements.

B) Preparing a Grant Proposal for 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 twotailed 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

Learning Outcomes:

After learning the theory paper, the student will 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 (2010) Scientific thesis writing and paper presentation, MJP Publishers, Chennai – **UNIT I, II.**
2. C. R. Kothari (2004) Research Methodology; Methods and Techniques, 2^{nd}Ed,New Age International Publishers, New Delhi **- UNIT I, II.**
3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3^{rd} Ed.Ukaaz, Publications, Hyderabad - **UNIT III, IV.**
4. Robert R. Sokal and F. James Rohlf (1969) Introduction to Biostatistics,2^{nd}Ed, Dover Publications, INC. Mineola, New York – **UNIT III,IV.**
5. P.N. Arora, P.K.Malhan (2006) Biostatistics, Himalaya Publishing House, Mumbai. – **UNIT III, IV.**

M.Sc.Part-I
Semester -II

MAMiP. 205

Practical Course (LAB-I)

LEARNING OBJECTIVES:

The student should be able to:-

1. Get skill for separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons , pesticides ,organic solvents ,methane by gas chromatography.
3. Determine mutation rate in bacteria
4. Prepare immobilized cells of yeast cells and determination of invertase activity.

Unit – I

1) Separation and identification of amino acid mixture by 2D paper chromatography.

2) Study of U.V. absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).

3) Separation and identification of amino acid mixture by TLC.

4) Purification of plasmid by phenol/chloroform method.

5) Preparation of immobilized cells of yeast cells and determination of invertase activity.

6) Study of effect of gel concentration on immobilized enzyme activity.

7) Determination of capacity of ion exchange resin [Dowex – 50].

8) Determination of molar extinction coefficient.

Unit – II

1.Determination of mutation rate in bacteria.

2. Fluctuation test.

3. Testing of chemical for mutagenicity using Ames test.

4.Demonstration of PCR , DNA sequencer and fermentor.

5. Separation of serum protein by horizontal submerged gel electrophoresis .

6. Separation of DNA by agarose gel electrophoresis

7.Quantitative estimation of hydrocarbons , pesticides ,organic solvents ,methane by gas chromatography.

LEARNING OUTCOMES:

The student will be able to:-

1. Get skill for separation of biomolecules using chromatography techniques
2. Perform quantitative estimation of hydrocarbons , pesticides ,organic solvents ,methane by gas chromatography.
3. Determine mutation rate in bacteria
4. Prepare immobilized cells of yeast cells and determination of invertase activity.

REFERENCE BOOKS:

a. An introduction to practical biochemistry – 3rd edition, David T. Plummer
b. Practical handbook of microbiology – Shouldiam M. O'Leary
c. Practical microbiology – S. Chand
d. A textbook of practical biochemistry – Joshi A. Rashmi

M.AMiL. 206 Practical Course – II (LAB-II)

LEARNING OBJECTIVES:

1. Prepare buffers of various pH
2. Study effect of activator, inhibitors and substrate concentration on enzyme activity
3. Get acquainted with different biostatistical tools in modern research.
4. prepare abstract for manuscript writing

Unit – I

1) Preparation of buffers e,g. Phosphate , Acetate & Carbonate..
2) Isolation of cellulase producers from soil.
3) Determination of effect of activator on amylase activity.
4) Determination of effect of inhibitor on amylase activity.
5) Determination of substrate concentration effect (KM) for enzyme amylase.
6) Titration curve of glycine
7) Study of organisms subjected to nutritional stress (Carbon)
8) Detection of Siderophore produced by Pseudomonas spp.
9) Assay of Protease and Lipase enzymes

Unit-II

A] Research Methodology

1) Abstract writing.
2) Review Writing.
3) E-poster Presentation.

B]Biostatistics

1) Determination of measures of central tendency :

   a) Mean, b) Median, c) Mode

2) Determination of measures of dispersion –

   b) Mean deviation, b) Standard deviation, c) Coefficient of verification.

3)Estimation of confidence interval for a normal distribution.

4) T-test and chi-square with test on sample data.

LEARNING OUTCOMES:

The student will be able to:-

1. Process and comprehend biological data using biostatistical tools and

techniques

2. Analyze and present research data employing the media of abstract, review and e-poster.

3. Perform quantitative estimation of hydrocarbons , pesticides ,organic solvents methane by gas chromatography

REFERENCE BOOKS:

1) An introduction to practical biochemistry – 3rd edition, David T. Plummer
2) Practical handbook of microbiology – Shouldiam M. O'Leary
3) Practical microbiology – S. Chand
4) A textbook of practical biochemistry – Joshi A. Rashmi
5) N. Gurumani (2010) Scientific thesis writing and paper presentation, MJP Publishers, Chennai **.**
6) C. R. Kothari (2004) Research Methodology; Methods and Techniques, 2nd Ed,New Age International Publishers, New Delhi

Chairman,
BOS committee