K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2023

NOTIFICATION

Sub :- CBCS Syllabi of M. Sc. in Microbiology (Sem. I & II)

Ref. :- Decision of the Academic Council at its meeting held on 26/07/2023.

The Syllabi of M. Sc. in Microbiology (First and Second Semesters) as per **NATIONAL EDUCATION POLICY - 2020** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2023-24.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

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समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७–२२३७३६३, २२३४२८१ । ई–मेलः mjcollege@kces.in । वेबसाईटः mjcollege.kces.in

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

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SYLLABUS

M.Sc. I Microbiology

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. AcademicYear:2023-24]

Preface

Skilled human resource is a prerequisite in higher education, and it is to be acquired through in-depth knowledge of theoretical concepts and hands-on laboratory methods of the subject. The present syllabus of M.Sc. part I in the subject of Microbiology has been prepared as per the guidelines of UGC, NEP-2020 and Government of Maharashtra. It aims to cultivate theoretical and practical knowledge of different fields of Microbiology among the students. The contents of the syllabus have been prepared to accommodate the fundamental aspects and advanced developments in various disciplines of Microbiology and to complement the needs of various applied sectors of Microbiology. Besides this, the students will be enlightened with knowledge in the newer areas of Bioinstrumentations, Biomolecules, Microbial Genetics, virology, Immune response, tissue culture, microbial fermentations, IPR, Patents, bioethics etc. Furthermore, the syllabus is structured to cater to Microbiology's present and future needs in the research field, industrial and environmental sectors, Entrepreneurship etc., emphasizing imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

The overall curriculum of one/ two-year covers general microbiology, biomolecules and microbial metabolism, cell biology, extremophiles, molecular biology and microbial genetics, and immunology, industrial and applied microbiology, environmental microbiology, and also covers various advanced biotechniques such as bioinformatics, immunotechniqes, Tissue culture and biosensors etc. Furthermore, the syllabus is structured to cater to Microbiology's present and future needs in the research field, Industrial and Environmental Sector, Entrepreneurship etc., emphasizing imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

Program Outcomes (PO) for M.Sc. Program:

Program outcomes associated with an MSc degree are as follows:

1. Student possess an in-depth understanding of advanced theories, concepts, and methodologies in their specific field of study.
2. Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3. Student should be capable of critically analyzing complex problems and synthesizing information from various sources.
4. Student should be proficient in effectively communicating scientific information to both technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and the use of appropriate visual aids.
5. Student should demonstrate leadership qualities and the ability to work effectively as part of a team.
6. Student should have developed advanced research skills and the ability to independently design and conduct rigorous scientific investigations. They should be able to analyze scientific literature, formulate research questions, develop research plans, collect and analyze data, draw valid conclusions and know about IPR.
7. Student should understand and adhere to ethical principles and professional standards in their field.
8. Student should recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

Program Specific Outcome PSO (M.Sc. Microiology):

After completion of this course, students are expected to learn/understand the:

No.	PSO
1	Advance techniques in microbiology, enzymology and purification of biomolecules.
2	Biochemistry of microbes with respect to metabolism of biomolecules and bio-energetics.
3	Molecular biology with respect to DNA replication, central dogma and gene regulation.
4	Concepts in cell biology, microbial genomics and microbial diversity.
5	Principle and applications of various bio-analytical tools and immune techniques.
6	Applications of microbes in food, agriculture, pharmaceutical, fermentation and environmental sectors.
7	Newer and appied areas such as applications of extremophiles, bioinformatics, biostatistics.
8	Research methodology, IPR, Bioentreprenuership, bioethics and professional development.

Credit distribution structure for two years/one-year PG MSc programme

Level	Sem	Major (Core) Subjects		Minor Subjects	OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)				
6.0	I	DSC-1 (4T) DSC-2 (4T) DSC-3 (4T) DSC-4 (2P)	DSE-1(2T) A/B DSE-2(2P) A/B	RM (4T)		22	First year PG OR One year PG diploma after 3year UG
	II	DSC-5 (4T) DSC-6 (4T) DSC-7 (4T) DSC-8 (2P)	DSE-3(2T) A/B DSE-4(2P) A/B		OJT/Int (4)	22	
	Cum. Cr.	28	8	4	4	44	
	Exit option: PG diploma (44 Credits) after three year UG degree						
6.5	III	DSC-9 (4T) DSC-10 (4T) DSC-11 (4T) DSC-12 (2P)	DSE-5(2T) A/B DSE-6(2P) A/B	--	RP (4)	22	Second year PG after 3 year UG OR PG degree after 4 year UG
	IV	DSC-13 (4T) DSC-14 (4T) DSC-15 (2P) DSC-16 (2P)	DSE-7(2T) A/B DSE-8 (2P) A/B	...	RP (6)	22	
	Cum. Cr.	54	16		4+10	88	
2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree							

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical,
RM- Research Methodology, **OJT**- On Job Training, **Int**- Internship, **RP**- Research Project,
Cum. Cr. : Cumulative Credits

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	One-year PG Diploma program after 3 Yr Degree	40	44	2	1
6.5	Two-year master's Degree program After 3-Yr UG Or PG Degree after 4- Yr UG	80	88	4	2

Examination Pattern for MSc

Theory Question Paper Pattern:

- 60 (External) +40 (Internal) for 4 credits
    - External examination will be of three hours duration
    - There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 3 out of 4 sub-questions; each 4 marks
    - Q 2, Q3, Q4 and Q5 Attempt any 2 out of 3 sub-question; each 6 marks.
- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
    - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.

The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.
- Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule for 2 consecutive days in case of practical where incubation condition, allied aspects are essential.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

M.Sc. Microbiology Course Structure

Semester	Course Module	Credit	Hours/ week	TH/ PR	Code	TITLE
I	DSC	4	4	TH	MIB-DSC-511	Advanced techniques in microbiology
	DSC	4	4	TH	MIB-DSC-512	Biochemistry of microbes
	DSC	4	4	TH	MIB-DSC-513	Molecular biology
	DSE	2	2	TH	MIB-DSE-514A	Microbial diversity and extremophiles
	DSE	2	2	TH	MIB-DSE-514B	Cell biology
	DSC	2	**4**	**PR**	MIB-DSC-515	Practical course on biochemistry and molecular biology
	DSE	2	**4**	**PR**	MIB-DSE-516A	Practical course on techniques in microbiology
	DSE	2	**4**	**PR**	MIB-DSE-516B	Practical course on cell biology
	DSC	4	4	TH	MIB-RM-517	Research methodology for microbiology
II	DSC	4	4	TH	MIB-DSC-521	Advanced immunology
	DSC	4	4	TH	MIB-DSC-522	Advanced microbial enzymology
	DSC	4	4	TH	MIB-DSC-523	Applied molecular biology
	DSE	2	2	TH	MIB-DSE-524A	Bioanalytical techniques
	DSE	2	2	TH	MIB-DSE-524B	Microbial genomics
	DSC	2	**4**	**PR**	MIB-DSC-525	Practical on enzymology
	DSE	2	**4**	**PR**	MIB-DSE-526A	Practical course on immunotechniques
	DSE	2	**4**	**PR**	MIB-DSE-526B	Practical course on microbial genetics
	DSC	4	**8**	**OJT**	MIB-OJT-527	Intership / On job trainning

DSC	**:**	Department-Specific Core course
DSE	**:**	Department-Specific elective
TH	**:**	Theory
PR	**:**	Practical

Exam Pattern

Theory / Practical	Credit	Internal	External
Theory	**4**	**40**	**60**
Theory	**2**	**20**	**30**
Practical	**4**	**40**	**60**

External Theory Examination (60 marks)

- External examination will be of 3 hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Q1 attempt any 4 out of 5 sub-questions; each 3 marks.
- Q2, Q3, Q4 attempt any 2 out of 3 sub-questions; each 6 marks.
- Q5 attempt any 3 out of 4 sub-questions, each 4 marks

External Practical Examination (60 marks):

- Practical examination shall be conducted by the respective department at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule. There shall be 05 marks for journal, 10 marks for *viva-voce*. Certified journal is compulsory to appear for practical examination.

Internal Theory/ Practical Examination (40 marks):

- Internal theory assessment of the student by respective teacher will be comprehensive and continuous, based on written test/ assignment. The written test may comprise of both objective and subjective type questions.
- Internal practical examination should be conducted by respective department as per schedule given. For internal practical examination student should perform at least one major and one minor experiment and should have completed journal.

M.Sc. I (Microbiology)

Semester I

MSc I (Microbiology)
Semester I
MIB-DSC-511 Advanced Techniques in Microbiology

Total Hours: 60 **Credits: 4**

Course objectives	• To study advanced techniques associated with enzymology • To understand protein purification methods • Learn the diagnostic methods in virology • To understand the allied techniques in microbiology	
Course outcomes	After successful completion of this course, students are expected to: • Correlate the concepts in enzymology with applied techniques. • Facilitate to plan of the protein purification protocol • Gain knowledge about diagnostic methods in virology • Deduce to allied topics such as bio-markers, bio-reporters and bio-sensors	
Unit	**Contents**	**Hours**

Unit I	**Enzyme technology**
	• Basic principle of enzyme assay
	  o Initial velocity, progressive curve, transient kinetics & Relaxation
	• Standardization and optimization of enzyme assay
	  o The concentration of substrate, activators & inhibitors
	  o Optimum pH, Ionic strength and temperature
	• Measurement of enzyme activity
	  o Direct & fixed incubation method - continuous and discontinuous assay
	  o Indirect/kinetic study
	• Immobilisation of enzyme
	  o Adsorption, covalent binding, entrapment & membrane confinement
	  o Kinetics of immobilized enzyme
	  o Effect of diffusion and productivity
	  o Application of immobilized enzyme
		15

Unit II	**Protein purification**
	• Sample preparation
	  o Define the properties of a target protein
	  o Develop analytical assay
	  o Sample extraction and clarification
	• Three-phase purification strategy
	  o Capture – removal of contaminant Streamlining
	  o Intermediate purification
	  o Polishing
	• Example of any one purification strategy, e.g. enzyme/ antigen/ membrane protein
		15

	• Sample storage conditions	
Unit III	**Unit III Diagnostic and detection methods for Viruses** • Sampling techniques and Processing of samples – Enrichment and concentration • Direct methods of detection – light microscopy (inclusion bodies), electron microscopy and fluorescence microscopy • Immunodiagnosis, hemagglutination, and hemagglutination-inhibition tests Complement fixation, neutralization, Western blot, Radioactive Immunoprecipitation Assay (RIPA), Flow cytometry and Immunohistochemistry. • Nucleic acid-based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing, LINE probe assay • Infectivity assay for animal and bacterial viruses - plaque method, pock counting, endpoint methods, LD50, ID50, EID50, TCID50 • Infectivity assays of plant viruses	**15**
Unit IV	**Bio-markers, reporters, sensors, transformations** • Concept and approaches to metagenomics analysis & ecological inference • Biomarker gene: concept and types • Bioreporter genes (antibiotic and heavy metal resistance genes, ice nucleation, bioluminescence genes, green fluorescent genes) • Biosensor: General features, principle, types, components, working and applications • Biotrasformations: Types of reactions, source of biocatalyist and techniques, product recovery, use in commercial products.	**15**

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MSc I (Microbiology)
Semester I
MIB-DSC-512 Biochemistry of microbes

Total Hours: 60 **Credits: 4**

Course objectives	• To study overview of biomolecules • To understand Transport and energy metabolism • To know the metabolism of carbohydrates and lipids • To learn the metabolism of amino acid and nucleotide	
Course outcomes	After successful completion of this course, students are expected to: • Differentiate the biomolecules on the basis of structure and properties. • Cite the biological membrane structure and its relation with transport • Correlate metabolism pathway for carbohydrates and lipids with its bioenergetics. • Relate metabolism pathway for amino acid and nucleotide and its bioenergetics	
Unit	**Contents**	**Hours**
Unit I	**Overview of Biomolecules** Definition, structure, components, classification, general properties, chemical bonds and functions of following with examples • Carbohydrates • Amino acids and Proteins • Fatty acid and Lipids • Nucleic acid	**15**

Unit II	**Membrane Transport**
	• Fundamental and common features of a biological membrane
	• Ultrastructure of cell membrane
	  ○ Composition (lipids, proteins etc.)
	  ○ Architecture (Lipid and Lipid Bilayer Models, Unit Membrane Model (Protein-Lipid Bilayer-Protein), Fluid Mosaic Model)
	• Concept of membrane dynamics
	• Thermodynamics of molecule transport:
	• Types of transport – (a) Active, (b) Passive, (c) Facilitated, (d)Translocation. Na/K+ ATPase.,(e) Ionophores and siderophores
	• Membrane-bound transport system for *E. coli*
		15

Unit III	**Metabolism of Carbohydrates and Lipids**
	Carbohydrates:
	• Metabolic pathway: reaction, bioenergetics and regulation
	  o EMP, HMP, TCA, Glyoxylate pathway, C3 and C4 pathway
	• Electron transport system: (components, site, energy relationship)
	  o Eukaryotic/mitochondrial and Bacterial ETC
	  o ATP Synthase
	Lipids:
	• Metabolic pathway, bioenergetics and regulation of Fatty acid synthesis
	• Oxidation of fatty acids: alpha, beta, omega
	• Biosynthesis of fatty acid: saturated, unsaturated, branched
	• Metabolism of phospholipids
	• FAS Complex
		15

Unit IV	**Amino acid and Nucleotide metabolism** **Amino acid** • Metabolic pathway, bioenergetics and regulation of amino acid degradation and biosynthesis • Transamination, Deamination, Stickland Reaction. **Nucleotide** • Metabolic pathway, bioenergetics and regulation: Purines and Pyrimidine biosynthesis: • De novo pathway and Salvage pathway, Ribonucleotide reductase and inhibitors of nucleic acid biosynthesis	**15**

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MSc I (Microbiology)
Semester I
MIB-DSC-513 Molecular Biology

Total Hours: 60 **Credits: 4**

Course objectives	• To learn DNA replication, damage and repair • To understand the process of transcription • To know the process of translation • To study the different mechanisms of gene regulation	
Course outcomes	After successful completion of this course, students are expected to: • Learn the process of DNA replication and the mechanism of damage/repair • Illustrate the process of transcription and post-transcriptional modifications • Correlate the genetic code and steps associated with translation • Liken the mechanism associated with pro and eukaryotic gene regulation.	
Unit	**Contents**	**Hours**
Unit I	**DNA replication, damage and repair** • DNA Structure and Replication: DNA replication machinery in Prokaryotes and eukaryotes, Replication fork. • Enzyme of DNA Replication: DNA polymerase (I, II, III), primases, ligases, helicases, topoisomerases, gyrases and SSBP. • Models of DNA Replication: theta mode of replication, rolling circle model of replication, unidirectional replication, Bidirectional replication, replication of linear, Regulation of DNA replication and inhibitors of DNA replication. • DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers, mechanical and chemical damage • DNA mutations: Spontaneous and inducible and mutagenic agents. • DNA repair pathways: Methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination (Specific and Nonspecific), mismatch, SOS.	**15**
Unit II	**Transcription** • Types of RNA polymerase (prokaryotic and eukaryotic), process of transcription • mRNA processing, editing: capping, adenylation, splicing, RNA transport • Transcriptional regulation: transcriptional bursting/pulsing, specificity factors, enhancers, repressors, activators and general transcription factors • Post-transcriptional modifications: RNA degradation, nuclear transport, mRNA localization, anti-sigma factors, RNAi (siRNA, miRNA and CRISPR mechanism)	**15**
Unit III	**Translation** • Genetic code and its properties • Ribosome (structure and composition), Activation of tRNA, tRNA	**15**

	synthetase • Steps: Initiation: factors and their regulation, Elongation, Termination Inhibitors • Post translational modification of proteins and protein degradation • Translational regulation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping	
Unit IV	**Gene regulation** • Concept, structure and regulatory mechanism of Operon • Structure and regulation of following operons o Lactose (lac) operon o Galactose (gal) operon o Arabinose (ara) operon o Typtophan (trp) operon o Histidine (his) operon • Regulation of lytic and lysogenic pathway in lamda bacteriophage • Gene regulation in eukaryotes: DNA rearrangements, Chromatin modification, Cis-acting site, RNA Silencing	**15**

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MSc I (Microbiology)
Semester I
MIB-DSE-514A Microbial diversity and extremophiles

Total Hours: 30 **Credits: 2**

Course objectives	• To acquaint students with algal and fungal diversity • To learn about virus and extremophiles	
Course outcomes	After successful completion of this course, students are expected to: • Know the ultrastructure, classification, and applications of algae and fungi • Understand various aspects associated with virus and extremophiles	
Unit	**Contents**	**Hours**
Unit I	**Fungi and Algae** **Fungi** • General Characteristics:yeast, moulds and dimorphic fungi, mycorrhizal fungi, Endophytic fungi • Morphology: Structure of thallus, Ultrastructure, Specialized somatic structures • Reproduction, growth and cultivation • Ecological Significance and Biogeochemical Role • Applications of fungi: Medical significance (Mycoses), Industrial and Biotechnological **Algae** • Morphological forms of algae and Ultrastructure of an algal cell • BGA: General characteristics, cultivation and significance • Nutrition: Physical and chemical requirements • Reproduction, growth and cultivation • Significance of algae in biogeochemical Cycle, food, Animal feed, fertilizers, cosmetics, therapeutic supplements, extracts (Agar, Alginate, Carrageenan), Biopigments, Algal farming for biodiesel	**15**
Unit II	**Virus and extremophiles** **Virus** • Structure and chemical composition of virus • Ultrastructure of Animal Virus (NIPA), Plant virus (TMV) and Bacterial virus (T4 phage). • Virus-related structures – viroids and prion • Virus reproduction – lytic and lysogenic • Cultivation of viruses -Basic and advanced methods. *In vivo, In vitro/Ex vivo* (concerning plant and animal viruses) • Detection/ enumeration (Plaque formation & cytopathic effect), purification of viruses **Extremophile bacteria (Archaea)**	**15**

	Types, properties and cultivation of Archaea: Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkalophile, Radiation-resistant bacteria, Methanogens, Xerophiles and Endoliths • Biochemistry and physiology of adaptation to extreme environment • Applications of extremophiles in Agricultural, Pharmaceuticals, Industries, Environment etc.	

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MSc I (Microbiology)
Semester I
MIB-DSE-514B Cell Biology

Total Hours: 30 **Credits: 2**

Course objectives	• To study cellular and molecular aspects of cell • To learn different cell organelles and cell division	
Course outcomes	After successful completion of this course, students are expected to: • Assembled the knowledge about different cell structure and functions • Learn the ultrastructure and function related to cell organelles and events associated with cell division	
Unit	**Contents**	**Hours**
Unit I	**Cell Components, Cell boundaries, external appendages** • Diversity of Cell (Prokaryotic/ Eukaryotic): components and their functions • Size, shape, Morphology of cell, Measurement of cells • Characteristics and comparison of animal, plant and bacterial cell • Plant cell wall: Chemical nature, structure (Primary, Secondary, tertiary), formation and formation • Plasma membrane: o Chemical nature, structure and molecular organization, Differentiation of cell surface: Invagination, Microvilli, Basement membrane, Tight Junctions, Desmosomes, Gap junction, o Cell to Cell Signaling: Hormones and Receptors, Intracellular signaling in Development and Disease, o Protein trafficking and Sorting: Organelle Biogenesis and Protein Secretion o Transport across Cell Membranes • Cillia and flagella: Structure and molecular organization	**15**
Unit II	**Cell organells and cell division** • Endoplasmic reticulum: Morphology, ultrastructure, types, modifications, origin and function • Golgi apparatus: Morphology, Chemical composition, origin, function • Lysosomes: Morphology, chemical composition, Types, origin and function • Mitochondria: Structure, Function, oxidative Metabolism in the Mitochondrion, Role of Mitochondria in the formation of ATP, Translocation of Protons and the establishment of a proton-motive force, machinery for ATP formation, mitochondrial RNA and Genome studies of Mitochondria • Microbodies: Peroxisomes and Glyocysomes • Chloroplast structure, function and overview of photosynthetic	**15**

	metabolism, • Components of the cytoskeleton, Microtubules, Intermediate filaments – Microfilaments, • Nucleus: Morphology, Ultrastructure and nucleocytoplasmic relationship, Chromatin structure in eukaryotes, Condensation and packaging of DNA in prokaryotes • Cell cycle: Central concept and molecular events of the cell cycle Phases of mitosis and Meiosis	

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MSc I (Microbiology)
Semester I
MIB-DSC-515 Practical course on Biochemistry and Molecular biology

Total Hours: 60 **Credits: 2**

Course objectives	• To understand buffers preparation and detection of biomolecules • To study qualitative and quantitative techniques in biochemical analysis • To isolate, detect and amplify nucleic acid • To study blotting techniques for protein and nucleic acid	
Course Outcomes	After successful completion of this course, students are expected to: • Make basic biochemistry preparations and detection • Interpret biochemical analysis of sugar and protein • Hands on qualitative and quantitative estimations nucleic acid • Use the modern tools creatively to estimate nucleic acid	
Sr. No.	**Contents**	**Hours**
1	Preparation of buffers of various pH and determination of pKa of a buffer system	4
2	Qualitative analysis of biomolecules by Thin Layer Chromatography: Sugars and amino acid.	4
3	Isolation and characterization of bacterial pigment with absorption chromatography	4

4	Quantitative estimation of Total carbohydrate - Phenol sulphuric acid method.	4
5	Quantitative estimation of amino acids in germinating seeds by ninhydrin method.	4
6	Quantitative estimation of free fatty acids by titration	4
7	Quantitative estimation of lipids using Iodine number and acid value	4
8	Isolation and estimation of bacterial/ Fungal DNA.	4
9	Determination of Tm and base composition of DNA using thermal denaturation	4
10	Detection and separation of DNA using agarose electrophoresis	4
11	PCR amplification of DNAs	4
12	Detection and quantification of purity of DNA/ Protein using spectrophotometer	4
13	Isolation and estimation of RNA from yeast cells	4
14	Isolation of plasmid from bacterial cell (e.g. *E. coli*)	4
15	Blotting technique: Western/ Southern/Northern blot	4

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MSc I (Microbiology)
Semester I
MIB-DSE-516A Practical course on Techniques in Microbiology

Total Hours: 60 **Credits: 2**

Course objectives	• To study isolation and cultivation techniques for microbes • To understand methods to cultivate extremophiles and virus • To know protein separation and preservation • To learn about advanced instrumentation

Course Outcomes	After successful completion of this course, students are expected to: • Isolate and characterize algae, fungi and endophytic fungi • Isolate extremophiles and cultivate the virus • Perform protein separation and preservation • Get hands-on advanced instrumentation such as HPLC, GC, AAS	
Sr. No.	**Contents**	**Hours**
1	Biosafety: Safe Laboratory techniques (GLP), Equipment related hazards, Biosafety cabinets, Transport of infectious material/cultures, Waste disposals, Fire and electricity hazards, Immunization of staff & MSDS.	4
2	Isolation and cultivation of cyanobacteria/ Algae.	4
3	Isolation and cultural characterization of Actinomycetes	4
4	Isolation and enumeration of Bacteriophages by Plaque Titer method	4
5	Identification of fungus based on morphological/biochemical features (anyone fungus)	4
6	Cultivation of Endophytic fungi	4
7	Isolation of Acidophile/ Alkalophile/ Halophile/ Thermophile/ Psychrophile bacteria from extreme environments.	4
8	Cultivation of anaerobic microbes using jar (candle/gas pack) method and demonstration of cultivation in an anaerobic chamber	4
9	Purification of protein by Three phase partitioning	4
10	Freeze-dry (lyophilization) techniques for preservation (protein/cells)	4
11	Demonstration of inoculation of the virus using chick embryo technique	4
12	Growth Curve of yeast by Turbidity (Spectrophotometer/ Nephelometer) and Dry mass (Centrifugation) measurement	4
13	Study of a microbiological specimen with a Phase contrast microscope & /or inverted microscope	4
14	Demonstration/ analysis of samples with HPLC / GC / AAS and UV-Vis Spectro.	4
15	Industrial visit (Food/ Diary/Pharma/Winery) or fild visit	4

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MSc I (Microbiology)
Semester I
MIB-DSE-516B Practical course on cell biology

Total Hours: 60 **Credits: 2**

Course objectives	• To study cells and their special features • To isolate cell organells • To estimate cell content • To study cell division and permanent slide preparation	
Course Outcomes	After successful completion of this course, students are expected to: • Measure cell size, observe nuclear material and special cell features • Isolate chloroplast and mitochondria from cell • Estimate carotene and chlorophyll • Demonstrate cell cycle, cell division and prepare permanent slides for microsopy	
Sr. No.	**Contents**	**Hours**
1	Measurement of the size of a given cell using a micrometre	4
2	Counting of cells/ spores using counting chambers	4
3	Microscopic observation of nuclear material by Giemsa staining	4
4	Microscopic observation of cells (plant, animal, bacterial)	4
5	Microscopic observation of special cell features (flagella/cilia, fungal spore, bud in yeast, heterocyst)	4
6	Isolation of chloroplast from a suitable source	4
7	Isolation of mitochondria from a suitable source	4
8	Isolation and culture of plant protoplast	4
9	Estimation of total carotene	4
10	Estimation of chlorophyll	4
11	Microscopic observation of mitosis and cell cycle in onion root tip cells	4
12	Microscopic observation of the miosis cycle	4

13	Preparation of microscopic slide of dicot leaf and identification of types of cells	4
14	Preparation of permanent microscopic slides of plant/animal/microbial cell	4
15	Demonstration of microtomy for thin sectioning	4

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MSc I (Microbiology)
Semester I
MIB-RM-517 Research Methodology for Microbiology

Hours: 60 **Credits: 4**

Course objectives	• To acquaint the student with fundamental research • To learn concept of research problems literature review • To study research design and concept of hypothesis • To introduce the technique of research documentation and anti-plagiarism	
Course outcomes	After successful completion of this course, students are expected to: • Cogitate with types and general process of research • Construct the research problem and write literature review • Create hypothesis and frame research design • Use the methods of report writing and apply anti-plagiarism	
Unit	**Contents**	**Hours**
Unit I	**Fundamentals of research** • Objectives of research • Type of research: o Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Exploring or Formulative Research, Diagnostic Research, Surveys, Case Study, Field Studies • Criteria for good research • General research process o Define the research problem, literature survey, formulating hypotheses, research design, data collection and analysis, interpretation and preparation of the report	15
Unit II	**Research problems and review of the literature** • Defining and selecting problems, necessities and techniques. • Need of research review • Sources of literature and search strategies • Research reading and note taking • Bibliography, webliography and literature citation	**15**
Unit III	**Research design and hypothesis** • Concepts: types of variables, hypothesis, control, treatment, experimental units etc. • Types of research design: exploratory, descriptive and diagnostic, hypothesis-testing • Basic principles of experimental designs • Important experimental designs: Informal and formal • Hypothesis: Concept, need, characterization, testing, decision rule, two-tailed and one-tailed test	

Unit IV	**Data collection, analysis and reporting** • Sampling types and criteria of selection of technique • Methods and tools of data collection (primary, secondary) • Processing of data: Editing, coding, classification and tabulation • Statistics in research: central tendency, dispersion, skewness, measures of relation • Interpretation: meaning, importance, technique and precaution • Structure and Content of Discussion • Report writing: steps, type, components and formatting • Numbering and captioning of figures • Presentation of research: oral and research paper • Plagiarism: Concept, prevalence, factors, strategies to tackle and detection	

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M.Sc. I (Microbiology)

Semester II

MSc I (Microbiology)
Semester II
MIB-DSC-521 Advanced Immunology

Total Hours: 60 **Credits: 4**

Course objectives	• To study mechanism of immune response • To learn hyperimmune responses • To know the immune response to diseases • To understand immuno-histochemical techniques	
Course outcomes	After successful completion of this course, students are expected to: • Learn the difffernce in various types of immune responses • Understand details of different types of hypersensitivity and autoimmunity • Know about immune response related to infections, tumor and immunodeficiency diseases • Categorize different immunological techniques for various diseases	
Unit	**Contents**	**Hours**
Unit I	**Mechanisms of immune response** • Cell-mediated Immune response: T-cell, Types of T cells, T cell activation • Humoral Immune response: B cell. Plasma cell, B cell activation (T-dependent and T- independent pathway) • Complement system - Pathway and Role, Complement deficiency. • Inflammatory response - Functions, Types and Mechanisms. • Immunotolerance: General features of immunologic tolerance, T and B lymphocyte tolerance, tolerance induced by foreign protein antigens	**15**
Unit II	**Hyperimmune response** • Hypersensitivity: Types (I-IV) and mechanism of each type. • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organspecific and systemic, treatment of autoimmune diseases.	**15**
Unit III	**Immune response to infections and diseases** • Immunity against bacterial, viral, Fungal and protozoal infections. • Tumour immunology: Types of tumours, oncogenesis and tumour antigens (TATAs, TSTA), Immune response to tumours. • Immunodeficiency diseases (e.g. SCID, CVI, AIDS)	**15**
Unit IV	**Histochemical and immune techniques** • Production and applications of monoclonal antibodies • Detection of Ag/Ab - ELISA, RIA, Western blot, Immunoprecipitation, immunofluorescence and Flow Cytometry , In situ localization by FISH and GISH	**15**

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MSc I (Microbiology)
Semester II
MIB-DSC-522 Advanced Microbial Enzymology

Total Hours: 60 **Credits: 4**

Course objectives	• To study basic concepts in enzymology • To understand the features of enzyme kinetics • To learn the regulatory mechanism of enzyme catalysis • To know the various industrial applications of enzymes	
Course outcomes	After successful completion of this course, students are expected to: • Relate the concepts in enzymology for advance applications • Learn theories of enzyme kinetics and types of inhibitions • Understand Catalytic mechanisms and regulation • Know the Industrial applications of enzymes and extremozymes	
Unit	**Contents**	**Hours**
Unit I	**Concepts in Enzymology** • Properties and chemical nature of enzyme • Nomenclature and classes of enzymes • Concept and significance: enzyme activity, specific activity, catal, substrate specificity, turnover number, active site • Enzyme specificity: Sterio, Reaction and substrate • Ribozyme, Abzyme, Zymogens and Coenzymes • Factors affecting on enzyme activity: pH, temperature, substrate concentration, radiation, activator and oxidation of enzymes. • Isoenzyme: Concept and properties e.g. LDH • Multienzyme complexes- pyruvate dehydrogenase (PDH) and fatty acid synthetase, advantages of multienzyme complex	**15**

Unit II	**Enzyme Kinetics** • Chemical reaction and energetics: Zeroth, first and second order reaction • Elementary reactions, Reversible reactions, Rates of reactions, Transition state theory • Theories of enzyme kinetics: Michaelis-Menten Equation and concepts of Equlibrium and steady state assumption, Km - Vmax Transformation of MM equation: Double reciprocal plot, Eadie Hoffstee plot, Hans-wolf plot, Eisenthal and Cornish-Boweden plot, Hill plot and Brigg's Haldane plot • Enzyme Inhibition: Irreversible and Reversible: Competitive, Non-competitive, Uncompetitive and Mixed Inhibition, Bi-substrate kinetics and Oligomeric enzymes	**15**
Unit III	**Mechanism and regulation of enzyme catalysis** • Catalysis through Proximity and Orientation Effects, Acid-Base Catalysis, Covalent Catalysis, Metal Ion Catalysis, Electrostatic Catalysis, Quantum Tunnelling, Catalysis by Preferential Transition State Binding • Example of enzyme catalytic mechanism (e.g Serine Proteases): catalytic mechanism (kinetics and catalytic groups), X-Ray crystallographic studies • Enzyme regulation: allosteric regulation (ATCase), Feedback inhibition, enzyme induction and repression, regulation by proteolytic cleavage, enzyme regulation by cAMP, covalent modification.	**15**
Unit IV	**Industrial applications of enzymes** • Source, significance and biotechnological applications of Cellulases (Cellulose hydrolysis), Proteases (protein hydrolysate). Amylases (maltodextrin preparation), Lipases (oil industry), Pectinases (clarification of fruit juices), Laccases (delignification) and Asparaginase • Biotransformation using enzymes (steroids, antibiotics and Vit. C) • Enzymes in diagnosis (dehydrogenase, alkaline phosphatase) • Applications of extremozymes: Microbial source, characteristics and biotechnological significance of extremozymes from thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles. Solvent-resistant enzymes.	**15**

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MSc I (Microbiology)
Semester II
MIB-DSC-523: Applied Molecular Biology

Hours: 60 **Credits: 4**

Course objectives	• To learn about the various enzymes involved in and methods of rDNA Technology • To know the concepts in rDNA Technology . • To make aware of techniques in molecular biology and protein engineering • To study techniques in moleular biology	
Course outcomes	After successful completion of this course, students are expected to: • Understand tools of rDNA such as enzymes, vectors and basic ideas on methods of rDNA • Know about rDNA technology along with its confirmation of DNA transfer. • Understand protein engineering with mapping and protein-protein interactions. • Corroborate molecular techniques for DNA sequencing, amplification and gene expression	
Unit	**Contents**	**Hours**
Unit I	**Tools of molecular biology (or rDNA technology)** • **Enzymes**: Restriction endonucleases and its types, DNA methylases, DNA polymerase, DNA ligases, Kinases, Phosphatases, topoisomerase	**15**

	• **Cloning vectors**: Choice and its properties, Bacterial vectors: plasmid, Bacteriophage, Cosmids, Phagmids, BACs. Eukaryotic vectors: YACs, Ti, SV40 • **Cloning hosts**: Prokaryotic and eukaryotic hosts: properties	
Unit II	**Methods in rDNA technology** • Vector-mediated and chromosomal integration • Genomic and cDNA library construction • Gene transfer techniques: Transfection, Electroporation, Microinjection, Biolistic • Screening, analysis and confirmation of rDNA o Genetic methods o Hybridization techniques - Dot Blot, Colony, Dipstick, Plaque o Immunochemical methods o Plus and minus screening, HRT and HART o Analysis - Restriction mapping, Blotting techniques o Confirmation by genetic marker and reporter genes o Applications of genetic engineering	**15**
Unit III	**Protein Engineering and Proteomics** • Protein identification and Expression Mapping: 2D-gel electrophoresis, Mass Spectrophotometry and isotope labelling • Protein-ligand docking • Experimental approach to Protein-Protein interaction mapping: o Yeast and Bacterial 2-hybrid systems o Protein-ligand interactions o Protein fragment complement assays o Protein arrays and chips: Antibody and peptide arrays	**15**
Unit IV	**Techniques in Molecular Biology** • DNA Sequencing: Sanger, Maxum Gilbert and high throughput [Polony, 454 pyrosequencing, Illumina (Solexa), Massively parallel signature sequencing (MPSS), SOLiD, Ion Torrent semiconductor, single molecule, Single-molecule real-time (SMRT)] • PCR: Basics, Reverse transcriptase PCR, Real time PCR, Applications • Analysis of polymorphism: RFLP, RAPD, AFLP, SSCP, DGGE • Analysis of gene expression: SAGE, Microarray	**15**

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MSc I (Microbiology)
Semester II
MIB-DSE-524A: Bioanalytical Techniques

Total Hours: 30 **Credits: 2**

Course objectives	• To study bio-separation and spectroscopic techniques • To learn radio and immuno techniques	
Course outcomes	After successful completion of this course, students are expected to: • Prioritize the appropriate method for bio-seperation • Apply radio and immunotechniques for diagnosis	
Unit	**Contents**	**Hours**
Unit I	**Separation and Spectroscopic Techniques** **Separation technniques** • Centrifugation techniques: - principles and working of centrifuge • RPM, rotors and its types, types of the centrifuge (high-speed centrifuge, ultra-centrifuge, and gradient centrifuge) • Chromatographic techniques: - basic principles of chromatography • Rf value calculation, adsorption, absorption, solvents and solutes • Paper chromatography, column chromatography, gel filtration, ion exchange chromatography, HPLC, and gas chromatography. • Electrophoresis: - gel electrophoresis (one and two-dimensional) • SDS-PAGE, Agarose. Various methods and agents are used in the detection of bands. • Blotting techniques – southern blotting, northern blotting, and western blotting, southwestern blotting. **Spectroscopic techniques** • Spectroscopic techniques: - relation of wavelength and energy, principles and working of a visible spectrophotometer, • UV spectrophotometer, IR spectrophotometer, flow cytometry, NMR and mass spectrometry, Atomic absorption spectrophotometer	**15**

Unit II	**Radio technique and immunotechniques** • Radio labelling and radioactive techniques • Properties of different types of radioisotopes in a biological system, radio degradation, half-life period, radio dating, radio labelling, auto radiography, dosimetry, and safety guidance. • Rocket immunoelectrophoresis and Ouchterlony double diffusion method	**15**

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MSc I (Microbiology)
Semester II
MIB-DSE-524B: Microbial Genomics

Total Hours: 30 **Credits: 2**

Course objectives	• To study various microbial recombination techniques • To learn diverse techniques associated with microbial genome	
Course outcomes	After successful completion of this course, students are expected to: • Compare different genetic recombinations • Comprehend various techaniques for structural and functional genomics	
Unit	**Contents**	**Hours**
Unit I	**Microbial recombination** • Comparative of prokaryotes and Eukaryotes recombination • Types of genetic recombination (Homologous and Site specific) • Transformation o Outline of the transformation process in bacteria, Competence, Uptake of DNA (Binding, Fragmentation, Penetration), Models for DNA uptake (Gram Positive and Gram-negative), Integration	**15**

	• Conjugation
	  ○ F factor and F pilus, Infectious transfer of F plasmid, Formation of Hfr Cells, F mediated sexduction, Chromosome transfer, Integration of donor DNA
	• Transduction
	  ○ A comparative account of generalized and specialized transduction
	  ▪ Process of Generalized transduction, Complete and aborative transduction, Cotransduction
	  ▪ Specialized transduction, Genetic map of lambda phage and transcription control, Lytic cylcle of lambda phage
	• Transposable element
	  ○ Types: Bacterial (IS element, Composite element), Eukaryotes (Yest Ty element, Maize transposons, Retro element)
	Mechanism and Significance of Transposition	

Unit II	**Techniques in Microbial Genomics**
	• Concept of - Genome density, GC content, CPG Islands, Isochores, codon usage bias, cDNAs and ESTs, Contigs, epigenomics
	• Structural, Functional, Application and Comparative Genomics:
	  ○ Methods for whole genome sequencing, gene annotation o Gene and SNP identification
	  ○ Genome mapping (Conjugation, Recombination and complementation) and map integration
	  ○ Genome editing using CRISPR-cas system
	• Concepts of Metagenomics
	• Gene transfer methods: Electroporation, Biolistics, Micro and Macro injection, use of liposomes
		15

References

- Pawar, C. B. (2003). Genetics Vol II, Himalaya Publishing House, Mumbai.
- Jogdand, S. N. (2016). Gene Biotechnology 4th Ed., Himalaya Publishing House, Mumbai.
- Pasupulete, Mukesh (2006). Molecular biotechnology, MJP publication, Chennai.
- Malacinski, G. M. (2003). Essential of Molecular Biology, 4thedn, Jones & Barlett Publishers, Boston.

MSc I (Microbiology)
Semester II
MIB-DSC-525: Practical on Enzymology

Total Hours: 60 **Credits: 2**

Course objectives	• To study enzyme assay and effect of physico-chemial factors on enzymes • To understand the enzyme kinetics • To purify the enzymes with different techniques • To charaterize the enzyme with suitable techniques	
Course Outcomes	After successful completion of this course, students are expected to: • Apply enzyme assay to study effect of physico-chemical factors • Charaterize the enzyme using kinetic study • Purify enzymes using appropriate method • Determine the molecular weight and predict structural aspects of enzyme	
Sr. No.	**Contents**	**Hours**
1	Quantitative estimation of enzyme (Enzyme activity, specific activity, IU)	4
2	Effect of pH on enzyme activity	4
3	Effect of temperature on enzyme activity	4
4	Effect of organic solvent on enzyme activity	4
5	Effect of activator on enzyme activity and determination of kinetic parameters	4
6	Determination of enzyme kinetics using suitable software (Sigma Plot	4
7	Screening and evaluation of inhibitor on enzyme and determination of Ki and Vmax	4
8	Inoculum development, Production and recovery of any suitable enzyme	4
9	Purification of enzyme by salting out and dialysis	4
10	Purification of enzyme by column chromatography and determination of purification fold and yield parameters	4
11	Detection of enzyme by zymography: Substrate gel electrophoresis	4
12	Electrophoretic determination of Molecular weight of enzyme by PAGE: SDS, Native	4
13	Demonstration of structural prediction of suitable enzyme with ExPasy server	4
14	Enzyme stabilization by immobilization technique (Gel entrapment/ Crosslinking)	4
15	Production of maltodextrin using amylase (% conversion method/Degree of hydrolysis method)	4

	NB: Use any ONE enzyme from the following: Amylase, Protease, Phytase, Laccase, Lipase, 3-Galactosidase, Xylanase, Cellulase	

References

- Thimmaiah, S. R. (2006). Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
- Bisswanger, Hans (2011). Practical Enzymology, Wiley-VCH, Germany.
- Robert Eisenthal & Michael Danson (2002). Enzyme Assays: A Practical Approach, 2nd Edn. Oxford University Press, USA.
- Plummer, D. T. (2001). In introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. N. Delhi.
- Sawhey, S. K. & Singh, R. (2002). Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
- Jayramaim, J. (2008). Laboratory Manual in Biochemistry, New Age International, New Delhi.

MSc I (Microbiology)
Semester II
MIB-DSE-526A: Practical Course on Immunotechniques

Total Hours: 60 **Credits: 2**

Course objectives	• To know gerneral consideration and organization of laboratory • To observe and count the blood cells • To perform routine haematological tests • To do Ag-Ab reactions based on precipitation and agglutination	
Course Outcomes	After successful completion of this course, students are expected to: • Use the knowledge for laboratory saftey and clinical sample handling • Count RBC, WBC and perform diffential staining • Analyze Hb, RBC indices and haematocrit • Demostrate techniques such as ELISA, VDRL, WIDAL	
Sr. No.	**Contents**	**Hours**
1	General Considerations for Blood and immunological collection	4
2	Organization of the clinical laboratory and safety regulation	4
3	Differential counting by Leishman stain	4
4	RBC and WBC counting	4
5	Routine haematological tests: Hb, RBC indices, determination of haematocrit	4
6	Blood grouping (A, B, O, Rh) and cross-matching	4
7	Immuno-diffusion by Ouchterlony double diffusion	4

8	Immuno-electrophoresis	4
9	Detection of antigen/ antibody using ELISA technique	4
10	Demonstration of agglutination reaction using known antigen-antibody reaction WIDAL/ Pregnancy/ VDRL **(any two)**	8
12	Preparation of common antigens from bacteria	4
13	Determination of antibody contain by quantitative precipitation test	4
14	Demonstration of Immunoglobulin purification from human serum	4
15	Demostration of ELISA plate reader	4

References

- Joe Sambrook, (2001). Molecular Cloning: A Laboratory Manual, 3rd Edn., (3 volume set) Cold Spring Harbor Laboratory Press.
- Sawhey, S. K. & Singh, R. (2002). Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
- Thimmaiah, S..R. (2006). Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.

MSc I (Microbiology)
Semester II
MIB-DSE-526B: Practical course on Microbial Genetics

Total Hours: 60 **Credits: 2**

Course objectives	• To study techniques for the isolation and detection of DNA and plasmid • To learn bacterial recombination techniques • To understand bacterial mutation • To know the method used in bioinformatics	
Course Outcomes	After successful completion of this course, students are expected to: • Isolate DNA, Plasmid and detect functions encoded on plasmid • Device the appropriate technique for bacterial recombination • Design the experiment for strain improvement by mutation • Compare the gene sequence and construct phylogenetic tree	
Sr. No.	**Contents**	**Hours**
1	Isolation and detection of bacterial DNA	4
2	Isolation and detection of bacterial plasmid	4
3	Detection of plasmid encoded function/s using plasmid curing technique	4
4	Bacterial transformation.	4

5	Bacterial conjugation.	4
6	Restriction digestion by endonucleases	4
7	Bacterial gene expression using IPTG /X-gal	4
8	To demostrate the evidance of spontaneous mutation using fluctuation test	4
9	Effect of physical mutagen on the growth of bacteria	4
10	Effect of chemical mutagen on the growth of bacteria	4
11	Isolation of auxotropic mutant strain	4
12	AMES test for mutagenesis in bacteria	4
13	16S rRNA gene sequence analysis using BLAST technique	4
14	To construct phylogenetic tree using MEGA software	4
15	Demostration of PCR and gel documentation system	4

References

- Schmauder, H. P., Schweizer, M. & Schweizer, L. M. (2003). Methods in Biotechnology. Taylor and Francis, London.
- Joe Sambrook, (2001). Molecular Cloning: A Laboratory Manual, 3rd Edn., (3 volume set) Cold Spring Harbor Laboratory Press.
- Thimmaiah, S. R. (2006). Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
- Davis, L. G., Dibner, M. D., & Battey, J. F. (1986). Basic Methods in Molecular Biology, Appleton and Lange, Norwalk.
- Sawhney, S. K. & Singh, R. (2002). Introductory practical biochemistry, Narosa Publishing House, New Delhi
- Kalaichelvan, P. T. (2005). Microbiology and biotechnology: A Laboratory Manual, MJP Publishers, Chennai.

MSc I (Microbiology)
Semester II
MIB-OJT-527: Internship/ On Job Training

Hours: 120 **Credits: 4**

Course objectives	• To provide the students with actual work experience • To make aware prescribe standards and guidelines at work • To develop the employability of participating student • To avail an opportunities to eventually acquire job experiences
Course outcomes	After successful completion of this course, students are expected to: • Get actual work experience with office and virtual exposure to various management styles, technical, industrial, and procedural systems • Acquaint the knowledge related to working hours, work protocols and guidelines • Understand the roles and responsibilities of employee as well as team work • Justify job experiences that match their potentials, skills, and competencies
	Internship An internship is a professional learning experience that offers meaningful, practical work related to a student's field of study or career interest. An internship gives a student the opportunity for career exploration and development, and to learn new skills. **On the job training** On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.