Scheme for M.Sc. Microbiology NEP 2020

For 2 Year PG programme

First Year

Scheme for M.Sc. Microbiology NEP 2020

For 2 Year PG programme

Scheme sem-1: (For the course of science having major practicum components)

M.Sc. Microbiology I Semester

S.No	Course Code	Course Name	Total Mark	Credit (s)	End Semester Exam Marks		Internal Marks	
					Max	Min.	Max	Min.
1.	MBM2-511	Principles of Microbiology	100	6	60	24	40	16
2.	MBM2-512	Microbial Biochemistry and Genetics	100	6	60	24	40	16
3.	MBM2-513	Practical - I	100	4	60	24	40	16
4.	MBM2-514	Practical – II	100	4	60	24	40	16
5.	MBM2-515	Internship/Seminar/Field Project	100	2	-	-	100	40
		Grand Total	500	22				

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Principles of Microbiology**	**MBM2-511**

Course Objective:-

The objectives of this course are to introduce the field of microbiology with special emphasis on microbial (Bactria, Fungi and virus) diversity, morphology, growth and nutrition; methods for control of microbes and viruses.

Course learning outcomes (CLO):-

The students should be able to: -

1. Understand the general features and characteristics of microbes.

2. Know about the history of microbiology and microorganisms.

3. Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;

4. Learn about general methods and techniques to isolate and culture of microorganisms.

Unit - I

Ancient History of Microbiology from Atharva Veda, Contribution of Risi Karva, Atri, Jamdagni and Agastya, origin and Prevalence of germs. Nomenclature of germs in Vedas, their classification based on Caraka, Historical development and scope of Microbiology-Contribution of scientists and spontaneous generation and germ theory, Classification and identification of microorganisms, polyphasic taxonomy. Bergey's Manual of determinative Bacteriology.

Unit – II

Techniques in Microbiology- Isolation, pure and enrichment culture, staining procedure, physical & chemical sterilization methods, physical and chemical agents- Antiseptics and disinfectants, Control of Microorganisms by Narrow and broad-spectrum antibiotics, Antifungal antibiotics, Preservation of bacterial cultures. Cultivation of bacteriaaerobic, anaerobic, types of culture media.

Unit – III

Morphology and ultrastructure of bacteria size, shape and arrangement, structure and chemical composition and function of cell walls of Gram positive and Gram negative bacteria; Structure, composition and function of cell rnembrane, capsule; flagella, pilli, gas vesicles, cytoplasmic matrix, reserve food materials; chromosomes, carboxysomes. magnetosomes and phycobilisomes; nucleoid. Reproduction and Recombination in bacteria. Nature and properties of spores: Bacterial exo and endospores, Germination of spores. Antibiotic resistance mechanisms and multiple drug resistance. Diversity of Microbesarchaea, Photosynthetic bacteria and Cyanobacteria.

Unit – IV

Current status of fungi; their classification with reference to Ainsworth;

General characters, somatic structure, asexual and sexual reproduction of microbiologically important genera of Myxomycota, Mastigomycotina. Zygornycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Heterothallism; sex hormones in fungi; physiological specialization and phylogeny of fungi. Parasexual life cycle; Symbiotic associations of fungi with algae; Economic importance of fungi.

General characters of algae; classification of algae; Somatic structure, asexual and sexual reproduction of Chlorophyceae, Phaeophyceae, Bacillariophyceae and Rhodophyceae. Microbial ecology General characteristics, structure, nomenclature and classification of microbial, animal and plant viruses.Disease symptomatology, transmission and diagnostic techniques ofanimal and plant viruses. Bacteriophages: structural organization, lytic and lysogenic cycle. Viroids, and virusoids. Prions and its diseases.

General characters of protozoans; Structure and reproduction in protozoans: Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma and Plasmodium, Paragonimus, Fasciola hepatica, Schistosoma.

Unit – V

The definition of microbial growth, Growth in batch culture, Mathematical representation of bacterial growth, Bacterial generation time, Specific growth rate, Monoauxic, Diauxic and synchronized growth curves, Measurement of microbial growth, Factors affecting microbial growth. Brief account of growth in fungi, Culture collection and maintenance of microbial cultures, Principles of microbial nutrition

Chemoautotrophs, chemoheterotrophs, photoautotrophs and photo heterotrophs.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	Microbial Biochemistry and Genetics	MBM2-512

Course Objective:-

Objectives of this course are to build the knowledge of biochemical principles with a specific emphasis on different metabolic pathways and microbial genetics. Course content highlights the Biochemistry, metabolism and genetics of microbes. Understand basic aspects of Bioenergetics and metabolism of microbes

Course learning outcomes (CLO):-

The content of this course, students should be able to: -

1. Gain fundamental knowledge on structure, functions and metabolism of biomolecules.

2. To understand the microbial genetics of microbes. Learn about gene expression.

Unit - I

Origin of Universe-Cosmogony, God particle, Big Bang theory, Atoms and Molecules in Vedic period. An introduction, General structure and important features of carbohydrates, glycoproteins & glycolipids. Metabolism of Carbohydrates-Glycolysis, Feeder pathways, Citric acid cycle, Gluconeogenesis and their regulations, Glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, Roles of epinephrine and glucagon and insulin in glycogen metabolism; Starvation responses and insulin signalling. Glyoxylate and Pentose phosphate pathways.

Unit – II

Definition and classification of lipids. Structure and functions of major lipid subclasses- Acylglycerols, Phospholipids, Glycolipids, Sphingolipids, Waxes, Terpenes and Sterols. Fatty acids biosynthesis, degradation and their regulations, Hormone trigger mobilization of stored triacylglycerol, Oxidation of fatty acidssaturated (odd and even carbon) and unsaturated, Ketone bodies synthesis. Biosynthesis of TAG, Phospholipids and Glycolipids. Mevalonate pathway.

Unit – III

Amino Acids- structure, classification and properties. Handerson and Hasselbach equation for ionization of amino acids, Reverse turns and Ramachandran plot. Structure- function relationships in model proteins like, myoglobin, hemoglobin, chymotrypsin etc. A brief account of amino acid biosynthesis and degradation, Urea cycle and its regulation. Chemical synthesis of peptides and small proteins. Protein sequencing.

Unit – IV

Enzymes as biocatalysts- Enzyme classification. Mechanism of enzyme action- specificity, active site, activity unit and isozymes. Factors affecting enzyrne efficiency, enzyme activators, coenzymes and

cofactors. Enzyme kinetics - Michaelis - Menton equation for simple enzymes, determination of kinetic parameters, multi-step reactions and rate limiting steps. Enzyme inhibition- reversible, irreversible, competitive and noncompetitive. Allostersim- kinetic analysis of allosteric enzymes, Principles of allosteric regulation.

Unit – V

Fine structure of nucleic acid, DNA replication, DNA damage and Repair pathways, Transcription-General Principles, basic apparatus and types of RNA polyrnerases. Initiation, elongation and termination steps, Maturation and processing of RNA: Methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA, Basic features of the genetic code, Wobble hypothesis, protein, synthesis; steps, details of initiation, elongation and termination, Regulation of gene expression: Operon concept, positive and negative regulation of lac operon; catabolite repression, inducers and co-repressors, arabinose and tryptophan operon. Biosynthesis and degradation of purines and pyrimidines, Salvage pathway.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - I**	**MBM2-513**

Course Objective:-

The objectives of this course are to introduce the field of microbiology with special emphasis on microbial (Bactria, Fungi and virus) diversity, morphology, growth and nutrition; methods for control of microbes and viruses.

Course learning outcomes (CLO):-

The students should be able to: -

1. Understand the general features and characteristics of microbes.

2. Know about the history of microbiology and microorganisms.

3. Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;

4. Learn about general methods and techniques to isolate and culture of microorganisms.

List of Practical

1. Sterilization, disinfection and safety in microbiological laboratory.

2. Media Preparation for Cultivation of Microorganisms.

3. Isolation of bacteria in pure culture by streak plate method.

4. Study of colony and growth characteristics of some common bacteria.

5. Preparation of bacterial smear and Gram's staining.

6. Enumeration of bacteria: standard plate count.

7. Growth–Factors affecting growth. Sporulation, Growth curve of bacteria in batch culture.

8. Antimicrobial sensitivity test and demonstration of drug resistance.

9. Maintenance of stock cultures: slants, stabs and glycerol stock cultures

10. Determination of phenol coefficient of antimicrobial agents.

11. Determination of Minimum Inhibitory Concentration(MIC)

12. Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).

13. Enrichment culture technique–isolation of asymbiotic, symbiotic nitrogen fixing bacteria.

14. Determination of viable and total number of cells.

15. Measurement of cell size. and spore germination in bacteria.

16. Protoplasts formation.

17. Inactivation of microorganisms by different mutagens. Production, isolation and characterization of mutants. Determination of mutation rate.

18. Determination of soil microbial population; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Study of rhizosphere effect.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - II**	**MBM2-514**

Course Objective:-

Objectives of this course are to build the knowledge of biochemical principles with a specific emphasis on different metabolic pathways and microbial genetics. Course content highlights the Biochemistry, metabolism and genetics of microbes. Understand basic aspects of Bioenergetics and metabolism of microbes.

Course learning outcomes (CLO):-

The content of this course, students should be able to: -

1. Gain fundamental knowledge on structure, functions and metabolism of biomolecules.

2. To understand the microbial genetics of microbes. Learn about gene expression.

List of Practical

1. Preparing various stock solutions and working solutions that will be needed for the

course.

2. To prepare an Acetic-Na Acetate Buffer and validate the HendersonHasselbach equation.

3. To determine an unknown protein concentration by plotting a standard graph of

BSA using UV-Vis Spectrophotometer and validating Beer-Lambert's Law.

4. Separation of aliphatic, aromatic and polar amino acids by paper chromatography.

5. Separation of lipids by thin-layer chromatography.

6. Purification and characterization of an enzyme from a natural/recombinant

source

(suchasAlkalinePhosphataseorLactateDehydrogenaseoranyenzymeofchoice).

7. Preparation of cell-free lysates

8. Ammonium Sulfate precipitation

9. Ion-exchange Chromatography

10. Gel Filtration Chromatography

11. Affinity Chromatography

12. Dialysis of the purified protein solution against60%glycerol as a demonstration of storage method.

13. Assessing the purity of samples from each step of purification by SDS-PAGE/ Gel Electrophoresis\

14. Enzyme Kinetic Parameters: Km, Vmax and Kcat.

15. Experimental verification that absorption at OD 260 is more for denatured DNA as compared to native double stranded DNA. Reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.

16. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Internship/Seminar/Field Project**	MBM2-515

Project /Dissertation work (Six Weeks) in the form of small thesis based upon the topic related to the M.Sc. Microbiology syllabus . The topics of the dissertation with synopsis will be decided by the

Departmental Research Advisory Committee (DRAC).

M.Sc. Microbiology II Semester

S.No	Course Code	Course Name	Total Mark	Credit (s)	End Semester Exam Marks		Internal Marks	
					Max	Min.	Max	Min.
1.	MBM2-521	Bioinstrumentation	100	6	60	24	40	16
2.	MBM2-522	Biostatistics and Bioinformatics	100	6	60	24	40	16
3.	MBM2-523	Practical - I	100	4	60	24	40	16
4.	MBM2-524	Practical – II	100	4	60	24	40	16
5.	MBM2-525	Value-added course (VAC) from /MOOCS, SWAYAM, NPTEL (Microbial Technology, Quality Control, Biosafety and Bioethics.	100	2	-	-	100	40
		Grand Total	500	22				

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**BIOINSTRUMENTATION**	**MBM2-521**

Course Objective:-

The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research toolkit better. This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in lifesciences.

Course learning outcomes (CLO):-

The course contents of the course students should be able to: -

1. To learn history, theoretical basis and applications of latest technologies in the advanced area of microbiology.

2. To gain fundamental knowledge about the light spectrum, absorption, fluorescence, NMR, mass spectroscopy

3. To acquire knowledge on the different. Chromatographic methods for the separation of biological products.

Unit - I

Principles & applications of microscopy: light microscopy: bright field, dark field, phase contrast, fluorescent microscopy, Flowcytometry, Electron microscopy: transmission & Scanning, Confocal microscopy, atomic force microscopy.

Unit – II

Macromolecular structure determination- Basics of X-ray Crystallography: symmetry, space groups, unit cells, structure factors, reciprocal lattice, Fourier transform, electron density, phase problems and it's solutions, bological application and interpretations of Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR)..

Unit – III

Centrifugation: basic principles, types: differential, zonal, density gradient & Ultracentrifugation- basic instrument design & application. Chromatography: basic principle, types: partition, absorption, paper, thin layer, gas, ion exchange, gel filtration, Affinity chromatography, HPLC. Basics principles and applications of various chromatography methods: Theory and biological applications of GC and FPLC.

Unit – IV

Immunological technique: immunoelectrophoresis, immunodiffusion, immunofluresence: radioimmunoassay, enzyme linked immunosorbant assay. Autoradiography: principles, methods of processing and application. Electrophoresis: basic principles, types: moving boundary & zonal electrophoresis; paper & gel techniques, (Polyacrylamide and agarose gel electrophoresis) its application & 2-D electrophoresis, isoelectric focusing.

Unit – V

Basics of radioactive isotopes and radioactive decay, sample preparation, counting, Safety precautions during handling, biological applications, Liquid Scintillation counter, HPGe. Introduction to nanobodies, nanobody as a tool for protein structurefunction studies, use of nanobodies for molecular imaging. Microarray, Theory, principle and applications of PSA cum Zeta sizer, CRISPR-CAS, DSC-TGA etc.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Biostatistics and Bioinformatics**	**MBM2-522**

Course Objective:-

The objectives of this course are to provide basic knowledge about biostatistics and bioinformatics.

Course learning outcomes (CLO):-

The students should be able to: -

1. Develop an understanding of the basics of biostatistics, data analysis tools and bioinformatics tools;

2. Gain working knowledge of these bioinformatics tools and methods.

3. Appreciate their relevance for investigating specific contemporary biological questions.

4. Critically analyze and interpret results of their study.

Unit - I

Introduction Concept of variables in biological systems. Collection, classification, tabulation graphical and diagrammatic representation of numerical data. Measures of central tendency: mean, median and mode and their relationship, measures of dispersion: Range, quartile deviation, mean deviation, standard deviation. Coefficient of variation, skew ness and kurtosis. Probability: Random experiment, events, sample space, mutually exclusive events, independent and dependent events. Various definitions of probability, addition and multiplication theorems of probability (only statement), Random variables (discrete and continuous). Probability density functions and its properties.

Unit – II

Sample Some probability distributions such as binomial, Poisson and normal (Basic idea about these distributions) and their applications. Concept of populations and sample. Simple random sampling without replacement. Definition of simple random sample. Chi-square (X2), student's t and f-distributions (derivations not required) their properties and uses. Concept of standard error. Correlation and Regression, linear and quadratic regression Analysis of variance: One- way and two-way classifications with single observation per cell.

Unit – III

Introduction to Bioinformatics

Definition, role, scope and limitation of Bioinformatics. Different branches of Bioinformatics. Terminologies: Internet Browser, Software, hardware, database, Network NicNet, Inflibnet, EMBnet, Operating System, algorithm. Biological data & databases: Biological data type, Classification of biological database, sequence database: GenBank, EMBLDDBJ, PIR, SWISS-PROT. Secondary nucleotide and protein sequence databases: ExInt, TIGR, EPD, CUTG, GOBASE, PROSITE, PRINTS, BLOCKS, Pfam, PRODOME. Structure database: PDB, CSD, CATH, SCOP, FSSP, Specialized Database: KEGG, ENZYME, REBASE. Study odf data entry formats: GenBank, EMBL, DDBJ, Swiss-Port, PIR, PDB, FASTA, MSA, PHYLIP

Unit – IV

Sequence Analysis Introduction, methods (HMM & ANN) and significance. Nucleic acid sequence analysis: Principle and software tools. Protein Sequence Analysis: Principle and software tools. Sequence Comparison: Pair wise algorithms-Introduction and significance. Methods of alignment: Dot matrix, Dynamic Programming, Heuristic algorithm (FASTA & BLAST). Scoring matrix: PAM and BLOSUM, Concept of Gap penalty. Multiple Sequence Alignment Introduction, Significance and various algorithms. Phylogenetic Analysis: Introduction & Importance, Phylogenetic tree, methods of Phylogenetic analysis.

Unit – V

Structural Bioinformatics Introduction & Importance. Experimental Structure determination: X-ray, NMR and electron microscopy. Coordinate systems. Visualization & presentation of structure. Geometric Analysis of structure. Structure comparison. Protein structure prediction: secondary structure prediction, tertiary structure prediction. Protein folding. Nucleic acid structure: RNA structure prediction: principle and tools: DNA structural polymorphism. Molecular modelling and dynamics, computer aided drug designing

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - I**	**MBM2-523**

Course Objective:-

The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better. This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life- sciences.

Course learning outcomes (CLO):-

The course contents of the course students should be able to: -

1. To learn history, theoretical basis and applications of latest technologies in the advanced area of microbiology.

2. To gain fundamental knowledge about the light spectrum, absorption, fluorescence, NMR, mass spectroscopy

3. To acquire knowledge on the different. Chromatographic methods for the separation of biological products.

List of Practicals

1. Study of different morphological and surface features using atomic force microscopy

2. Study of the crystalline information of the sample (either solid or thin film) using Xray diffraction.

3. Quantification of the metal ion concentrations in aqueous samples using atomic

absorption spectroscopy (AAS)/inductively coupled plasma mass spectrometry (ICPMS).

4. Study of the spectrum of pure and complex samples using mass spectroscopy.

5. Study of the variation of properties of substance with heat using differential scanning

calorimetry (DSC) and thermogravimetric analysis (TGA).

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - II**	**MBM2-524**

Course Objective:-

The objectives of this course are to provide basic knowledge about biostatistics and bioinformatics.

Course learning outcomes (CLO):-

The students should be able to: -

1.Develop an understanding of the basics of biostatistics, data analysis tools and bioinformatics tools;

2. Gain working knowledge of these bioinformatics tools and methods.

3. Appreciate their relevance for investigating specific contemporary biological questions.

4. Critically analyze and interpret results of their study.

List of Practical

1. Using NCBI and Uniprot web resources.

2. Introduction and use of various genome databases.

3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.

4. Similarity searches using tools like BLAST and interpretation of results.

5. Multiple sequence alignment using Clustal W.

6. Phylogenetic analysis of protein and nucleotide sequences.

7. Use of gene prediction methods (GRAIL, Gen scan, Glimmer).

8. Using RNA structure prediction tools.

9. Use of various primer designing and restriction site prediction tools.

10. Use of different protein structure prediction databases (PDB, SCOP, CATH).

11. Construction and study of protein structures using Deep view/Py Mol

M.Sc. Microbiology III Semester

S.No	Course Code	Course Name	Total Mark	Credit (s)	End Semester Exam Marks		Internal Marks	
					Max	Min.	Max	Min.
1.	MBM2-531	Immunology & Immunodiagnostics	100	6	60	24	40	16
2.	MBM2-532	Molecular Biology and Recombinant DNA Technology	100	6	60	24	40	16
3.	MBM2-533	Practical - I	100	4	60	24	40	16
4.	MBM2-534	Practical – II	100	4	60	24	40	16
5.	MBM2-535	Internship/Seminar /Field Project	100	2	-	-	100	40
		Grand Total	500	22				

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Immunology & Immunodiagnostics**	**MBM2-531**

Course Objective:-

The objectives of this course are to acquaint students to understand about the infection, immune system, immune response, antigen, antibody, hypersensitivity, Transplantation immunology and autoimmunity its mechanisms and related immunodeficiency disorders and diseases.

Course learning outcomes (CLO):-

Students should understand Immunology and immunodiagnostics.

1. Learn about infection, Antigen, Antibody, MHC and Immune response

2. Understand transplantation immunology, Tumour immunology and Immuno deficiency diseases.

Unit - I

Defense from the germs, elimination of germs by Sunrays. contribution of Dhanvantri. Immunology Components of innate and acquired immunity; Important organs and cells of immune responses, complement and inflammatory responses; Pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); Interferon, Inflammation, ADCC, Acute Phase protein, Innate immune response; Mucosal immunity; Immune dysfunction and its consequences; Antigens - immunogens, Haptens, adjuvant; Antigenic determinants.

Immunoglobulins: Structure of IgG (b) , various classes of antibodies, theories of generation of antibodies, Diversity, molecular mechanisms of antibody diversity, monoclonal antibodies (hybridoma technology) , recombinant antibodies, antigen- antibody interaction, class-switching.

Unit - II

Complement System Classical and alternate pathways, Role of Complement in immune response- Immunity to bacteria, fungi, protozoa & worms. complement deficiencies Major Histo-compatibility Complex, recognition of antigens by T & B cells, T – cell receptor complex, B – cells receptor complex. Dendritic cells and N cells.

Immunological Responses: Cell mediated immune response, cellular interactions in the immune response – antigen recognition and presentation, cytokines, immunological tolerance, hypersensitivity, antiimmune diseases & AIDS.

Unit – III

Autoimmunity and Vaccines Mechanism and therapeutic approaches, immunodeficiency syndrome and their diagnosis, vaccines-active and passive immunization, whole organism vaccines, macromolecules as vaccines, recombinant vector vaccines, synthetic peptide vaccines and subunit vaccines, DNA vaccines, Immunodiagnostic: precipitation techniques, agglutination, fluorescence Molecular mechanism of antibody diversity, Antibody Engineering, Monoclonal antibodies: Production, characterization and application in diagnosis therapy and basic research.

Unit – IV

Immunodiagnostics for detection of infectious agents: fungi, bacteria, viruses and protozoan, cancer (malignant and non malignant) and autoimmune diseases; Immunosensors.

Unit – V

Immuno fluorescence microscopy; Immuno electronmicroscopy; principle and application. Immunohistochemistry, Immunoblotting technique; principle and applications.

Therapeutic monoclonal antibodies: principle and applications, Biological response modifiers (immunostimulators and immunosuppressant), Recombinant vaccines-vector, DNA, synthetic peptide.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Molecular Biology and Recombinant DNA Technology**	**MBM2-532**

Course Objective:-

The objectives of this course are to acquaint students with various approaches of molecular biology and recombinant DNA technology and their applications in biological research / industries.

Course learning outcomes (CLO):-

Upon completion of this course, students should be:

1. Understand core techniques and essential enzyme used in molecular biology & recombinant DNA Technology (rDNA Technology).

2. Understanding and learn cloning strategies.

3. Learn about DNA sequencing methods for DNA.

4. Learn about application of r-DNA Technology.

5. Endowed with strong theoretical knowledge of molecular biology & recombinant DNA technology and its applications in the genetic manipulation of organisms for the agriculture, industrial, and pharmaceutical industries.

6. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit – I

Origin of Molecules and Atoms in Vedas. The Nature of Genetic Material: DNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Different forms of DNA, Forces stabilizing nucleic acid structure, Super coiled DNA, Properties of DNA, Renaturation and denaturation of DNA. Tm and Cot curves, Structure of RNA.

Organization of prokaryotic and eukaryotic genomes, chromatin arrangement, nucleosome formation, satellite DNA. DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, Models of replication, Prokaryotic and eukaryotic replication mechanism, relationship between DNA replication and cell cycle, DNA copy number maintenance. Replication in phages, Reverse transcription.

Unit – II

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, Structure and assembly of prokaryotic and eukaryotic RNA polymerases, promoters and enhancers, Transcription factors as activators and repressor, Transcription- Initiation, Elongation and Termination, Effect of chromatin structure, Regulation of transcription.

Post-transcriptional Processes: Co- and post-transcriptional modifications, Post-transcriptional processing of tRNA, rRNA and mRNA (5' capping, 3' polyadenylation and splicing), mRNA flow through nuclear envelop into cytoplasm, RNA Editing; RNAi and miRNAs, Antisense RNA, Posttranscriptional gene regulation, RNA as an enzyme- Ribozyme.

Unit – III

Genetic code: Genetic code, General features, Deciphering of genetic code, Wobble hypothesis, Mitochondrial genetic code.

Translation: Translational mechanism in prokaryotes and eukaryotes. Ribosome composition and assembly, Regulation of translation, RNA instability, Antibiotic inhibitors and translation, stringent response in bacteria, Non ribosomal polypeptide synthesis.

Post-translational Processes: Post translational modification, transport, folding, chaperones. Protein targeting, The Signal Hypothesis. DNA Binding Protein Motifs: Zinc finger, leucine zipper, helix-turn-helix and other motifs.

Unit – IV

Introduction and Tools of Recombinant DNA Technology (RDT) : Impact of RDT in modern society; General requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south- western and farwestern and colony hybridization, fluorescence in situ hybridization.

Cloning and Expression Vectors: Vehicles for gene cloning, Plasmids, Bacteriophages, Cosmids and Phagemids as vectors, P1 vectors, F- factor based vectors, Plant and animal viruses as vector, Artificial chromosomes as vectors (YAC, BAC, PAC and MAC vectors), Expression vectors- use of promoters and expression cassettes, Baculovirus and Pichia vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, Binary and shuttle vectors.

Unit – V

PCR Techniques: Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR, cloning of PCR products; T- vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; Sequencing Techniques: Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; automated DNA

sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP, Next Generation sequencing methods: 454 FLX Roche genome analyzer platform, Illumina Solexagenome analyzer platform. Whole genome sequencing and functional genomics (a brief account), Applications of genomics and Proteomics with special reference to E.coli, Phage lambda and SV40. Gene Silencing and Genome Editing Technologies: principle and application of gene silencing; Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; gene knockouts and gene therapy.

Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; Genome editing by CRISPR-Cas with specific emphasis on Chinese and American clinical trials.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - I**	**MBM2-533**

Course Objective:-

The objectives of this course are to acquaint students to understand about the infection, immune system, immune response, antigen, antibody, hypersensitivity, Transplantation immunology and autoimmunity its mechanisms and related immunodeficiency disorders and diseases.

Course learning outcomes (CLO):-

Students should understand Immunology and immunodiagnostics.

1. Learn about infection, Antigen, Antibody, MHC and Immune response

2. Understand transplantation immunology, Tumour immunology and Immuno deficiency diseases.

List of Practicals

1. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.

2. Antibody titre by ELISA method.

3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.

4. Complement fixation test.

5. Isolation and purification of IgG from serum or IgY from chicken egg.

6. Immunoblotting, Dotblotassays.

7. Blood smear identification of leucocytesby Giemsa stain.

8. Separation of leucocytes by the dextran method.

9. Demonstration of Phagocytosis of latex beads and their cryopreservation.

10. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.

11. Demonstration of ELISPOT.

12. Demonstration of FACS.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical - II**	**MBM2-534**

Course Objective:-

The objectives of this course are to acquaint students with various approaches of molecular biology and recombinant DNA technology and their applications in biological research / industries.

Course learning outcomes (CLO):-

Upon completion of this course, students should be:

1. Understand core techniques and essential enzyme used in molecular biology & recombinant DNA Technology (rDNA Technology).

2. Understanding and learn cloning strategies.

3. Learn about DNA sequencing methods for DNA.

4. Learn about application of r-DNA Technology.

5. Endowed with strong theoretical knowledge of molecular biology & recombinant DNA technology and its applications in the genetic manipulation of organisms for the agriculture, industrial, and pharmaceutical industries.

6. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

List of Practical

1. Isolation of genomic DNA.

2. DNA fingerprinting by RAPD.

3. Restriction analysis of genomic DNA.

4. Southern blotting analysis.

5. Determination of molecular size of DNA.

6. Amplification of gene by PCR.

7. Isolation of RNA and AGE analysis.

8. cDNA synthesis by RT-PCR.

9. Isolation of plasmids and Electrophoretic analysis.

10. Ligation of DNA into plasmid vectors.

11. Transformation of plasmids.

12. Selection of recombinant clones by blue – White screening.

13. Identification of gene by Colony PCR.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Internship/Seminar/Field Project**	MBM2-535

Project /Dissertation work (Six weeksP) in the form of small thesis based upon the topic related to the M.Sc. Microbiology syllabus . The topics of the dissertation with synopsis will be decided by the

Departmental Research Advisory Committee (DRAC).

M.Sc. Microbiology IV Semester

S.No	Course Code	Course Name	Total Mark	Credit (s)	End Semester Exam Marks		Internal Marks	
					Max	Min.	Max	Min.
1.	MBM2-541	Microbial Enzyme and Fermentation Technology	100	6	60	24	40	16
2.	MBM2-542	Applied Microbiology	100	6	60	24	40	16
3.	MBM2-543	Practical - I	100	4	60	24	40	16
4.	MBM2-544	Practical – II	100	4	60	24	40	16
5.	MBM2-545	Value-added course (VAC) from /MOOCS, SWAYAM, on quality control & assurance .	100	2	-	-	100	40
		Grand Total	500	22				

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Microbial Enzymes and Fermentation Technology**	MBM2-541

Course Objective:-

The objectives of this course are to educate students about the fundamental concepts and its related Microbial Enzymes and Fermentation Technology applications, thus preparing them to meet the challenges of the new and emerging areas of fermentation industry.

Course learning outcomes (CLO):-

The content of the course, students should be able to: -

1. Understand the general features and characteristics of enzymes regulation.

2. Know about the application of industrially important enzymes.

3. Develop strong fundamental knowledge that can be applicable to fermentation industries.

4. Identify major categories of microorganisms and analyze their classification, diversity, andubiquity;

5. Evaluate factors that contribute in enhancement of cell and product formation.

Unit – I

Regulatory Enzymes: Allosteric enzymes, Sequential and symmetry models, covalently regulated enzymes.

Enzyme Technology: Large scale production of enzymes, Uses of isolated enzymes in food and chemical industries, Therapeutic & medicinal use of enzymes.

Unit – II

Enzymes: commercial applications; production of Amylases; Glucose Isomerase; L Asparaginase Proteases Renin; Penicillin acylases; Lactases; Pectinases; Lipases; Structure and biosynthesis Nucleosides Nucleotides and related compounds.

Unit – III

Introduction to Fermentation Technology: Fermentation- Overview, Introduction to fermentation processes, industrially important microorganisms-Isolation, screening, and preservation of industrially important microorganisms, Strain improvement for increased yield and other desirable characteristics; Principles of overproduction of primary and secondary metabolites with relevant examples, Culture collection, cataloguing of cultures.

Fermentation Systems: Batch and Continuous system, Fed batch culture, multistage systems, Feedback systems, Solid substrate fermentation. Instrumentation and control of fermentation processes, Monod kinetics of microbial growth, growth and non-growth associated product formation, product formation kinetics.

Unit – IV

Fermentation Upstream Processing: Media for industrial fermentation, Criteria used in media formulation, fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

Downstream Processing: Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: Liquid-liquid extractions, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Unit – V

Hygiene and safety in fermentation industries. Microbial production of vaccines. Microbial production of polymers: Dextran and xanthan. Microbial transformation: steroid and biotransformation.

Waste Treatment: Waste Treatment systems, Aerobic and anaerobic waste treatment systems for waste treatment in fermentation industry, Treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters).

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Applied Microbiology**	MBM2-542

Course Objective:-

The objectives of this course are to introduce the field of food, environment medical microbiology with special emphasis on applied importance microbes in this field.

Course learning outcomes (CLO):-

After successful completion of this course, students will be able to:

1. Comprehend knowledge regarding fermented food products, food spoilage and infection.

2. Learn about general methods and techniques of water treatment, environmental, bioremediation and medical microbiology.

Unit – I

Occurrence of germs in water & soil according to Vedas. Agnihotra- on plant and microbial health. Soil and Water Microbiology: Importance of soil microorganisms, Distribution of various groups of microorganisms in soil, such as bacteria, fungi, protozoa, algae and viruses,nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

Microbial transformation, microbial interaction in soil, microbial control by bioinoculants.

Unit – II

Fermented Food Products: Microorganisms involved in food fermentations, Starter Cultures, Fermented meats and sausages; Fermented milk products- Acidophilus and Bulgarian milk, yoghurt, cheese, Kefir, Koumiss; Fermented grains and vegetable products - Sauerkraut, Soy sauce, Tempeh, Miso, Olive, and Kimchi, Nutraceuticals &Nanonutraceuticals.

Protein Engineering: Protein engineering in food technology-objectives, methods, targets, potential applications in food industry and limitations. Food Safety and Quality Assurance in Foods: Microbial testing of foodstraditional methodology and new approaches: Microbiological, Physical, Chemical methods, Immunological methods, Use of gene probes and PCR, bioluminescence, BAX system, Riboprinter and Real Time PCR based approaches, Biosensors in food. Concept of HACCP for quality assurance and food safety in food industry.

Unit – III

Environmental Microbiology: Development ofmicrobial ecology andemergenceoffield of environmental microbiology, significant applications of microbes in solving environmental pollution problems.

Bioremediation of Environmental Pollutants: Biological indicators of soil health. Biodegradation of pesticides& xenobiotic compounds, Heavy metals etc. Phytoremediation, Role of microorganisms in sustainable agriculture and organic farming, use of biosensors for their detection. Biomass Waste Management of Plant Residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production. Challenges in waste management.

Unit – IV

Medical Microbiology: Process of infection-Types, stages of infection, Establishment of pathogenic microorganisms: Entry, spread and tissue damage. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Aggresssins and toxins.

Pathogenic microbes: Morphological characteristics, pathogenesis and laboratory diagnosis including rapid methods of pathogenic bacteria, fungai, protozoa.

Viral diseases: Structure, cultivation, pathogenicity, lab diagnostics, prevention and control of viral diseases-Hepatitis, Herpes, Measles, Rabies, Polio, Rubella, Rotaviruses, Japanese Encephalitis, HIV, SARS, Ebola, Avian Flu, Swine Flu, Covid-19 and future pandemics.

Unit – V

Nanoparticle in microorganisms: Introduction - history and recent developments - sources of nanoparticles - microbial producers of nanoparticles -advantages of microbial nanoparticles – applications. Use of bacteria, fungi and actinomycetes for nanoparticle synthesis, magnetotactic bacteria, and viruses Nanotoxicity, nanocomposite biomaterials, carbon nanotubes in health care, nanomedicine and cancer therapy.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical-I**	MBM2-543

Course Objective:-

The objectives of this course are to educate students about the fundamental concepts and its related Microbial Enzymes and Fermentation Technology applications, thus preparing them to meet the challenges of the new and emerging areas of fermentation industry.

Course learning outcomes (CLO):-

The content of the course, students should be able to: -

1. Understand the general features and characteristics of enzymes regulation.

2. Know about the application of industrially important enzymes.

3. Develop strong fundamental knowledge that can be applicable to fermentation industries.

4. Identify major categories of microorganisms and analyze their classification, diversity, andubiquity;

5. Evaluate factors that contribute in enhancement of cell and product formation.

List of Practicals

1. Introduction to Microbiology laboratory – GLP, Biosafety

2. Preparation and sterilization of culture media

3. Isolation, screening, selection of industrially important microorganisms, and their Preservation.

4. Strain improvement using different mutagenic agents.

5. Aseptic Transfer Techniques

6. Assessment of sterility of glassware and nutritional media (Hot air oven and Autoclave).

7. Sterilization by membrane filtration and sterility assessment Fermentation

8. Measurement of microbial growth

9. Turbidimetric studies for bacterial growth

10. Determination of viable count and CFU

11. Isolation of industrially important microorganisms

12. Characterization of metabolites of industrial purpose, qualitative and quantitative Assays.

BRANCH	Subject	Subject Code
M.Sc. (Microbiology)	**Practical-II**	MBM2-544

Course Objective:-

The objectives of this course are to introduce the field of food, environment medical microbiology with special emphasis on applied importance microbes in this field.

Course learning outcomes (CLO):-

After successful completion of this course, students will be able to:

1. Comprehend knowledge regarding fermented food products, food spoilage and infection.

2. Learn about general methods and techniques of water treatment, environmental, bioremediation and medical microbiology.

List of Practical

1. Bacteriological tests for potability of water

a. MPN, confirmed and completed test.

b. Membrane filter technique (Demonstration)

2. Enumeration of microbial population in soil

3. Measurement of microbial Cell load

4. Cultivation of Anaerobic Microorganisms

5. Maintenance and preservation of microbes