

M.Sc. Microbiology

Department of Biotechnology

Effective from July, 2018

Scheme

I Semester

S. No.	Subject Code	Subject Name	L	T	P	Credit
1	56MB101	General Microbiology	4	0	-	4
2	56MB102	Microbial Diversity and Taxonomy	3	0	-	3
3	56MB103	Advanced Biochemistry	4	0	-	4
4	56MB104	Microbial Genetics and Molecular Biology	4	0	-	4
5	56MB105	Bioinformatics and Biostatistics	3	0	-	3
6	56MB106	Bioinstrumentation	3	0	-	3
1	56MB151	Lab-1 General Microbiology, Microbial Diversity and Taxonomy, Biochemistry	-	-	3	2
2	56MB152	Lab-2 Microbial Genetics and Molecular Biology, Bioinformatics and Biostatistics Bioinstrumentation	-	-	3	2
						25

II Semester

S. No.	Subject Code	Subject Name	L	T	P	C
1	56MB201	Microbial Physiology and Metabolism	4	0	-	4
2	56MB202	Enzyme Technology	4	0	-	4
3	56MB203	Immunology	4	0	-	4
4	56MB204	Environmental Microbiology	4	0	-	4
5	56MB205	Recent Trends in Virology and Mycology	3	0	-	3
6	56MB206	Genetic Engineering and Genomics	3	0	-	3
1	56MB251	Lab-1 Microbial Physiology and Metabolism, Enzyme Technology, Immunology	-	-	3	2
2	56MB252	Lab-2 Environmental Microbiology, Recent Trends in Virology and Mycology, Genetic Engineering and Genomics	-	-	3	2
						26

III Semester

S. No.	Subject Code	Subject Name	L	T	P	C
1	56MB301	Medical Microbiology	4	0	-	4
2	56MB302	Food and Dairy Microbiology	4	0	-	4
3	56MB303	Industrial Microbiology and Fermentation Technology	4	0	-	4
4	56MB304	Scientific Writing and Patenting Process	4	0	-	4
5	56MB305	Clinical Diagnosis of Microorganisms	3	0	-	3
6	56MB306	Pharmaceutical Microbiology	3	0	-	3
1	56MB351	Lab-1 Medical Microbiology, Food and Dairy Microbiology, Industrial Microbiology and Fermentation Technology	-	-	3	2
2	56MB352	Lab-2 Scientific Writing and Patenting Process, Clinical Diagnosis of Microorganisms, Pharmaceutical Microbiology	-	-	3	2
						26

IV Semester

	Subject Code	Title	L	T	P	C
1	56MB451	Six months Dissertation or Project on any Microbiology related aspect	0	-	16	16

M.Sc. Microbiology
Semester-II
Subject- Microbial Physiology and Metabolism
Subject Code-

[L:4; T:0]

Unit-I

Bioenergetics and metabolism: Basic concepts. First and second law of thermodynamics, concept of free energy, entropy and enthalpy. High energy phosphate compounds, role of ATP, ATP cycle, structural basis of free energy change during hydrolysis of ATP. Biological redox reactions, Biological reducing power and its role in biological system.

Unit-II

Carbohydrate metabolism: glycolysis and its regulation, Feeder pathway of glycolysis and carbohydrate –homo and heterolactic fermentation, Glycogenesis, Glycogenolysis and regulation, Gluconeogenesis. Pentose phosphate pathway, E-D pathway, Kreb's cycle and glyoxalate pathway. Electron transport system in Mitochondria, Electron carriers and multienzyme complex I to IV. ATP synthesis: substrate level and oxidative phosphorylation and un-couplers, inhibitors of oxidative phosphorylation.

Unit-III

Photosynthesis: Oxygenic and an-oxygenic microorganisms, structure of chloroplast, light reaction, photolysis of water and photophosphorylation, C₃ and C₄ pathway of carbon fixation. Nutritional classification of microorganisms, Energy generation in cyanobacteria, green bacteria, purple sulphur bacteria and chemolithotrops.

Lipid biosynthesis: Biosynthesis of lipids and fatty acids, triglycerol and phospholipids and their regulation, Lipid Metabolism: Degradation of Lipids, oxidation of unsaturated, saturated, even and odd chain fatty acids, ketone bodies.

Unit-IV

Amino acid metabolism: Biosynthetic families of amino acids: Outlines. Catabolism of amino acids: Breakdown of amino acids into six common intermediates and urea cycle and relationship with TCA cycle: Outlines.

Nucleotide metabolism: Biosynthesis of purines and pyrimidines nucleotides by de novo and salvage pathways. Degradation of Purines and Pyrimidines nucleotides.

Unit-V

Nitrification, denitrification, Nitrate and ammonia assimilation pathways, Nitrogen cycle. Diazotrophs and Biochemistry of nitrogen fixation, Structure of nitrogenase complex. Regulation of nitrogenase complex by oxygen and combined nitrogen sources. *Nif* genes and their regulation.

Reference Books:

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc.,2008
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008.
3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
4. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002
5. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.
6. Genetic Analysis, Griffiths et al., W. H. Freeman

M.Sc. Microbiology
Semester-II
Enzyme Technology
Subject Code-

[L:4; T:0]

Unit-I

Introduction to enzymes, enzyme classification and nomenclature, Characteristics of enzymes. Mode of action and kinetics of enzyme catalyzed reactions (K_m , V_{max}). Types and Mechanism of enzyme inhibition, Biotechnological importance of enzymes

Unit-II

Microbial sources of enzymes. Primary and secondary screening of microorganisms for enzyme production. Qualitative and quantitative assay of enzyme activity Enzymes units Amylases, Cellulases, Hemicellulases, Proteases. Natural and synthetic substrates for enzyme assay,

Unit-III

Microbial enzyme production: submerged and solid state fermentation (SSF). Important parameters in enzyme production. Enzyme purification Techniques- Precipitation, chromatographic separation-gel filtration, anion and cation exchange, zymography.

Unit-IV

Techniques used in characterization of enzymes- determination of molecular weight (SDS PAGE, Gel filtration), Isoelectric point, pH & temperature optima and stability, Inhibition pattern, Product analysis of enzyme action using TLC, HPLC, and MALDI-TOF

Unit-V

Molecular biology of enzymes- amino acid sequencing, structure and function relationship. Protein engineering & directed evolution. Cloning and over expression of microbial enzymes in heterologous host.

Reference Books:

1. Fersht A. 1985. Enzyme Structure and Mechanism. 2nd ed. W.H. Freeman and Co., New York.
2. Gutfruend H. 1972. Enzyme: Physical Principles. Wiley-Intescience, New York.
3. Price N.C., Stevens L. 1982. Fundamentals of Enzymology. Oxford University Press, Oxford.
4. Sumner J.B., Somers G.F. 1953. Chemistry and Methods of Enzymes. Academic Press, Inc., New York

M.Sc. Microbiology
Semester: II
Subject: Immunology
Subject Code-

[L:4; T:0]

Unit-I

Introduction, Phylogeny of immune system, Immunity- Innate and acquired. Organisation and structure of lymphoid organs, cells of immune system, hematopoiesis.

Unit-II

Antigen- properties and types, super antigen, heptane carrier system, structure, classes and function of immunoglobulin, antibody engineering, hybridoma secreting monoclonal antibodies, antigen antibody interaction, complement system.

Unit-III

Regulation of immune response- generation of humoral and cell mediated immune system, activation of B & T lymphocytes, cytokines and it's function, regulation of B & T cell, structure and function of MHC molecules.

Unit-IV

Hypersensitivity- Delayed and immediate hypersensitivity
Autoimmunity- types of autoimmune diseases, mechanism of CD-4+ T-cell, MHC and TCR in autoimmunity, AIDS and immuno deficiency disorder.

Unit-V

Immunity to infection and tumours, Vaccinology- Active and passive immunization, live, killed, subunit vaccine, recombinant and protein based vaccine and plant based vaccine. Immuno assay- RIA, ELISA, ELISPOT assay, western blotting and immunofluorescence.

Reference Books:

- Roitt I.M, Brostoff, J., Male D.K., Immunology (Illustrated Publisher, Mosby).
- T. J. Kindt, R.A. G. B. A. Osborne, J. Kuby. Immunology (W.H. Freeman and Company, New York).
- Paul, W.E. (2008). Fundamental immunology (Lippincott Williams & Wilkins).
- T.G. Parslow, D.P. Stites, A.I. Terr. Medical immunology (Lange Medical Books/McGraw-Hill).

M.Sc. Microbiology
Semester-II
Subject-Environmental Microbiology
Subject Code-

[L:4; T:0]

Unit-I

Microbial ecology: basic concepts, types and microbial habitats, factors affecting microbial population. Microbial interactions: competition, commensalism, parasitism, mutualism, commensalisms, synergism. Population ecology: characteristics of population, population growth curves(r and k selection) population regulation. Conservation and management of microbial diversity: biodeterioration and biodegradation.

Unit-II

Microbiology of air: microorganism of air, enumeration of air micro flora. Significance of air micro flora. Brief account of air borne transmission of bacteria, fungi, pollens and viruses. Air borne diseases and their prevention.

Unit-III

Soil microbiology: microflora of soil: soil microorganisms associated with plants: rhizosphere, mycorrhizae. Role of microorganisms in organic matter decomposition (cellulose, hemi cellulose, lignin). Bioleaching; introduction, application of bacterial leaching leaching techniques, properties of bioleaching. Microbial degradation of xenobiotics, petroleum and oil spills in environmental decay behaviours and degradative plasmid.

Unit-IV

Water microbiology: aquatic microorganisms; fresh water and sea water microflora. Microorganisms and water quality, water pollution. Water purity test and indicator organisms, method used in environmental studies –BOD, COD, DO. Common water born disease and their control measure. Water purification: flocculation, chlorination and purification.

Unit-V

Microbiology of waste water and effluent treatments, aerobic process: primary, secondary and tertiary treatment : trickle filter ,oxidation ponds and stabilization ponds , principle of aerobic digestion. Bioremediation of contaminations. Extremophiles –acidophilic, alkalophilic, thermophilic microbes with adaptation and application in ecosystem. Microbial biofilms: physiology, morphology, biochemistry of microbial biofilms, mechanism of microbial adherence, beneficial and harmful role of biofilms.

Reference Books:

1. Microbial Ecology: Fundamentals and applications, Ronals M, Atlas, fourth edition, Animprint of Addison Wesley Longman. Inc, California
2. Environemental chemistry, A.K. De, Wiley Eastern Ltd., New Delhi
3. Environemtal Science, Physical Principles and applications; Egbert Boeker et. al.
4. Comprehensive Biotechnology, vol.4, M.moo-young (Ed-in-chief), Pergmon Press, Oxford.
5. Wastewater Treatment for Pollution Control By Soli J Arceivala, Second Edition, Tata McGraw- Hill Publishing Company Limited.

M.Sc. Microbiology
Semester-II
Subject: Recent Trends in Virology and Mycology
Subject Code-

[L:3; T:0]

Unit- I

Brief outline on discovery and origin of viruses. General properties of viruses, morphology and ultra structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents-viroids and prions. Classification and general properties of major families of viruses including detail account of their mode of replication.

Unit-II

Cultivation of viruses- in embryonated eggs, experimental animals and cell lines; primary and secondary cell lines, diploid cell culture. Assay of viruses: physical and chemical methods, plaque method, pock counting and end point method. Serological methods: hemagglutination, hemagglutination inhibition, neutralization test, complement fixation, ELISA, RIA. Purification of viruses: gradient centrifuge, electrophoresis, and chromatography.

Unit-III

Plant viruses: recent advance in classification of plant viruses. Structure and pathogenicity of TMV. Transmission of plant viruses with vector (insect, nematods and fungi) and without vector (contact, seed and pollens). Biochemical changes induced by virus in plant cell. Animal viruses: nomenclature and classification of animal viruses. General idea about Cyanophage, and Mycophage.

Unit-IV

Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. Brief account of M13, Mu, T4, Ø x174 and lambda phage

Unit-V

Structure, reproduction and classification of fungi, general characteristics of Zygomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes. Cultivation of fungi, culture media for fungal growth, effects of environment on growth, isolation, identification and preservation of fungi. Dimorphic fungi, yeast morphology, general characteristics and reproduction. Lichens, Mycorrhiza, and Actinomycetes. Ecology of fungi: concept of fungistatic, fungicidal.

Reference Books:

1. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company, USA
2. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.
3. Textbook of Microbiology by Ananthnarayanan and Paniker's, eighth edition, Universities Press .
4. Microbiology; Lansing M Prescott, John P. Harley, Donald A Klein, Sixth edition, Mc Graw Hill Higher education.
5. Introductory Mycology, Alexopoulos, C.Jr : , Second edition, Wiley, New York.

M.Sc. Microbiology
Semester-II
Subject: Genetic Engineering and Genomics
Subject Code-

[L:3; T:0]

Unit-I

Enzymes used in DNA technology: Restriction and modification enzymes, nucleases, polymerases, ligase, kinases and phosphatases. Linkers and adapters. Cloning vectors: Plasmids, Phages (Lambda and M13) Phagmids, Cosmids and Expression vectors. Cloning vectors for Yeast (shuttle vector and YAC) and cloning vector for animal cells: SV 40, Vaccinia and Retroviruses. Cloning techniques: DNA isolation (Bacteria, Fungi, Plant and animal), Insert preparation, Ligation, Transformation methods (chemical methods, Electroporation and microinjection), Transfection.

Unit-II

Genomic and cDNA library. Screening of clones from libraries: Expression based screening, Interaction based screening. Gene Expression: Expression vectors, factors affecting expression of cloned gene in *E. coli*. Mutagenesis: Site directed mutagenesis, Transposon mutagenesis.

Unit-III

DNA Sequencing: Sangers method, Maxam Gilbert method, Thermo cycle sequencing and Pyrosequencing Principles of hybridization and hybridization based techniques: Colony, plaque, in-situ Hybridization, Southern, Northern, Western blotting. Oligonucleotide synthesis, Restriction mapping, S1 nuclease and RNase mapping. Polymerase Chain Reaction (PCR): Principle, Types and variants of PCR (Touch -Down PCR, Hot start PCR, Inverse PCR, RT-PCR, multiplex PCR, nested PCR), Real time PCR.

Unit- IV

Molecular typing: RFLP (Ribotyping, IS based), RAPD, AFLP, VNTR, SNP, Whole genome sequence: GIS Promoter characterization: promoter analysis through reporter genes, electrophoretic mobility, shift assay, DNA foot-printing & DNA fingerprinting. Transgenic animals: Strategies and methods. Construction of knockout mutants.

Unit-V

Applications of Recombinant DNA Technology in Medicine, Molecular diagnostics, recombinant and DNA vaccines. Gene therapy: somatic and germ line gene therapy. Applications of Recombinant DNA Technology in Agriculture and Industry. Biosafety & ethical considerations for GMOs.

Reference Books:

1. Molecular Biotechnology. Glick BR, Pasternak JJ. ASM Press Washington D.C. Principles of Gene Manipulation. Old and Primrose. Blackwell Scientific Publication.
2. Gene Cloning. T. A. Brown, Blackwell Publishing.
3. Molecular cloning- A laboratory manual, Sambrook, Fritsch and Miniatis, Cold Spring Harbor Laboratory Press.
4. Molecular Biotechnology 2nd Edition by S.B. Primrose. Blackwell Scientific Publishers, Oxford.
5. Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes by S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.
6. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.), Stockton Press.
7. Genes and Genomes: A Changing Perspective; Maxine Singer and Paul Berg. University Science Books, Mill Valley, CA, 1991

M.Sc. Microbiology
Semester-II

Lab-1 Microbial Physiology and Metabolism, Enzyme Technology, Immunology

1. To study catalase activity of given microbial culture.
2. To study oxidase activity of given microbial culture.
3. To study ability of microorganisms to hydrolyse casein
5. To demonstrate phenylalanine deaminase activity of given bacterial culture.
6. To demonstrate L-lysine decarboxylase activity of bacterial culture.
7. To demonstrate carbohydrate metabolism (oxidation and fermentation of Glucose) in microorganisms.
8. To demonstrate Fat hydrolysis (lipase activity) by bacteria
9. To study ability of microorganisms to hydrolyze gelatin
10. Primary screening of α -amylase and protease on solid media.
11. Quantitative estimation of microbial enzymes.
12. Major steps of enzyme purification- precipitation, ion exchange chromatography, gel filtration
13. Zymography- visualization of enzymes on gels.
14. To prepare serum and plasma from blood.
15. To precipitate immunoglobulins by ammonium sulphate from and to determine total protein contents.
16. To determine Blood group and Rh factor by slide agglutination test
17. To determine Total Leukocyte Count (TLC) and determine Differential Leukocyte Count (DLC) for given blood sample.
18. To perform Widal agglutination test (slide and tube) for diagnosis of typhoid.
19. To perform Radial immuno-diffusion test for detection of antigen and antibody reaction and for quantification of antigens.
20. To perform ELISA for assay of antibodies in serum sample against given antigen.

M.Sc. Microbiology

Semester-II

Lab-2 Environmental Microbiology, Recent Trends in Virology and Mycology, Genetic Engineering and Genomics

1. Determination of Total Dissolve Solids (TDS) of given water sample
2. Determination of chemical oxygen demand (COD), Determination of BOD and Determination of Dissolved oxygen (DO) of given water sample
3. Determination of total bacterial population by standard plate count technique
4. Determination of the most probable number (MPN) of coliform bacteria in water
5. Microbiological analysis of water by membrane filter method
6. Microbiological analysis of air for presence of pathogenic microorganisms in air
7. Microbiological analysis of water for presence of pathogenic microorganisms
8. Inoculation and cultivation of viruses in embryonated eggs.
9. Isolation of bacteriophage (coli phages) from sewage.
10. Enumeration of bacteriophage by plaque forming unit method
11. Determination of one step growth curve of bacteriophage
12. Isolation cultivation and morphological studies of fungi
13. Isolation cultivation and morphological studies of Actinomycetes
14. Preparation of LB broth, LB Agar with antibiotic for culture and maintenance of Host E.coli and E.coli with plasmid vector
15. Isolation of plasmid DNA (or plasmid vector DNA)
16. Restriction digestion of given DNA with suitable restriction enzymes.
17. Ligation of insert (gene) and vector DNA
18. Preparation of competent cells
19. Transformation of host E. coli with recombinant DNA and selection of recombinants.
20. To perform PCR for amplification of target DNA segment (or gene)