

North Maharashtra University, Jalgaon



'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of syllabus for

M. Sc. Part I

Microbiology

[2018-19]

M. Sc. Part: I Microbiology

Prelude

The need for trained and skilled human resource is a prerequisite in the higher education. This coerces the necessity to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods of the subject. On this streak, the present syllabus of M.Sc. part I in the subject Microbiology has been prepared as per the guidelines of UGC and cultivate a theoretical and practical know how of different fields of Microbiology. The contents of syllabus have been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Microbiology and to complement the needs of various applied sectors of Microbiology. Beside this, the graduate students will be enlightened with knowledge in the newer areas of Microbial Systematic, Bioinstrumentations, Biomolecules, Microbial Genetics, Immune response, etc. Post graduate students will surely have an urge to endure research studies in Microbiology and contribute significantly in the development.

The present syllabus is restructured to cater the present and future needs of Microbiology in research field, Industrial Sector, Environmental Sector, etc., with more emphasis on imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The extensive appendix is furnished for each course to support know how and suffice the inquisitive of the students. The detailed syllabus of each paper is appended with a list of suggested readings.

Learning objectives

To acquaint students with:

- Basic concepts, principles and methods of Microbial Diversity, microbial Systematics and Bioinstruments used in isolation and identification of microbes and structural determination of biomolecules.
- Basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses.
- Causes, mechanisms and consequences of defect in gene/genome of microorganisms.
- Basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes.
- Biotechnological significance of enzymes of extremophiles in agriculture, environment, medicine and industry.
- Concepts and significance of enzymes in non-aqueous environment.

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

- Basic and applied aspects of microbial diversity and systematic.
- Physiology, biochemistry and applications of basic and applied aspects of microbial diversity and systematic.
- Principles, working and application of bioinstruments used in isolation and identification of microbes and structural determination of biomolecules.
- Characteristics and significance of Extremophiles, Algae, Fungi, Viruses.
- Impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development.
- Structure, properties, pathways and significance of biomolecules.
- Applications of microbial biomolecules in various fields.
- Basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses.
- Causes, mechanisms and consequences of defect in gene/genome of microorganisms.
- Basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes.
- Biotechnological significance of enzymes from extremophiles in agriculture, environment, medicine and industry.
- Enzyme function in non-aqueous environment

Course structure

Duration: The duration of M.Sc. (Microbiology) degree program shall be TWO years.

Medium of instruction: The medium of instruction for the course shall be English.

Structure of Syllabus for M.Sc. (Part- I) Microbiology

Subject Code	Title of the Paper	Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
Semester I : Theory Courses				
MB-101	Microbial Taxonomy and Diversity	04	100	03
MB-102	Microbial Biochemistry	04	100	03
MB-103	Bioanalytical Techniques	04	100	03
Semester I : Practical Courses				
MB-104	Methods in Microbiology	04+04	100	06
MB-105	Methods in Biochemistry	04+04	100	06
Semester II : Theory Courses				
MB-201	Microbial Genetics	04	100	03
MB-202	Microbial Enzymology	04	100	03
MB-203	Immunology	04	100	03
Semester II : Practical Courses				
MB-204	Methods in Enzymology	04+04	100	06
MB-205	Methods in Molecular Biology and Immunology	04+04	100	06

- Each theory and practical course has to complete in 50 lectures, respectively of 60 min duration,
- Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.
- **Theory examination** (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
 - **Question 1** (12 marks): 6 sub-questions, each of 3 marks; answerable in brief and based on entire syllabus, attempt any 4 out of 6 questions.
 - **Question 2, 3 and 4** (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4.
 - **Question 5** (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.
- **Internal examination** (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination
- **Equivalence** for M.Sc. (Microbiology) is given below:

Old Syllabus (w. e. f. AY 2015-2016) Semester I (Pattern 60:40)	New Syllabus (w. e. f. AY 2018 -19) Semester I (Pattern 60:40)
MB 101 : Microbial Diversity	MB 101 - Microbial Taxonomy and Diversity
MB 102 : Microbial Biochemistry	MB 102 - Microbial Biochemistry
MB 103 : Bioinstrumentation	MB 103 - Bioanalytical Microbiology
MB 104 : Methods in Microbiology	MB 104 - Methods in Microbiology
MB 105 : Methods in Biochemistry	MB 105 - Methods in Biochemistry
Semester II (Pattern 60:40)	Semester II (Pattern 60:40)
MB 201 : Microbial Genetics	MB 201 - Microbial Genetics
MB 202 : Microbial Enzymology	MB 202 - Microbial Enzymology
MB 203 : Immunology	MB 203 - Immunology
MB 204 : Methods in Enzymology	MB 204 : Methods in Enzymology
MB 205 : Methods in Molecular Biology	MB 205 : Methods in Molecular Biology and Immunology

MB 101: Microbial Taxonomy and Diversity

Unit I	Microbial Systematics <ul style="list-style-type: none"> • Introduction to Bergey's Manual of Systematic Bacteriology 9th Edition. • Polyphasic identification approaches: 16S rRNA Ribotyping, Cell wall Fatty Acid Methyl Ester Analysis (FAME), BIOLOG, DNA fingerprinting, Randomly Amplified Polymorphic DNA (RAPD), Metagenomics concept • Culturable and Non-culturable biodiversity • Microbial metabolic diversity and Conservation of microbial diversity • Culture collection centers in India 	10 L
Unit II	Extremophile bacteria (Archaea) <ul style="list-style-type: none"> • Types and properties of Archaea: Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkalophile, radiation resistant bacteria, Metanogens • Biochemistry and physiology of adaptation to extreme environment • Methods/Techniques for cultivation of Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkalophile, Xerophiles, Endoliths. • Applications of extremophiles in Agricultural, Pharmaceutical and Environment 	10 L
Unit III	Algae <ul style="list-style-type: none"> • Ultrastructure of algal cell (Flagella, Cell Wall, Cell Membrane, Plastids) • Nutrition: Physical and chemical requirements, Types based on nutrition • Significance of algae in biogeochemical Cycle, food, Animal feed, fertilizers, cosmetics, therapeutic supplements, extracts (Agar, Alginate, Carrageenan), Biopigments. • Algal farming for biodiesel • BGA : General characteristics, cultivation and significance • Prochlorons and cyanelles 	10 L
Unit IV	Fungi <ul style="list-style-type: none"> • Characteristics: Fungi (Yeast, moulds and dimorphic fungi), mycorrhizal fungi • Ultrastructure: Fungal hyphae, Flagella, Cell wall, Cell membrane Nucleus. • Endophytic fungi: General characteristics, Growth, Cultivation and Significance. • Ecological significance and applications of fungi: Biogeochemical role, Medical significance (Mycoses), Industrial and Biotechnological applications 	10 L
Unit V	Virus <ul style="list-style-type: none"> • Structure and classification of virus on the basis of genome • Structure of virus - Virus proteins, Capsids, Virion membranes, Ultrastructure of Animal Virus (NIPA), Plant virus (TMV) and Bacterial virus (T4 phage). • Cultivation of viruses –Basic and advance methods. • Detection/Enumeration of viruses - Plaque formation, cytopathic effect. • Emerging viruses: Zika and NIPA Virus, Soybean Vein Necrosis Virus (SVNV), Viral Haemorrhagic fever. • Viruses in Oncogenesis : Oncogenic viruses, Source and causes of viral induced oncogenesis, Mechanism of viral induced oncogenesis, Prevention of virus-induced cancers, Diagnosis and treatment. 	10 L

Suggested readings:

1. Carter, John B and Saunders, Venetia A. (2007) **Virology** : Principles and applications, John Wiley & Sons Ltd., London
2. Wagner, E. K. and Hewlett, M. J (2004) Basic Virology, 2nd Edn., Blackwell Publications, Oxford, UK.
3. Conrat, H.F. Kimball, P.C. and Levy, J. A (1994) Virology, 3rd Edn., Prentice Hall, Eaglewood Cliff, New Jersey, USA
4. Hull, R. (2002) Matthew's Plant Virology, 4th Edn., Academic Press, London Dimmock, N. J. Easton, A. J. and Leppard, K. N. (2001) Introduction to Modern Virology, 5th Edn., Blackwell Science, London
5. Laura Barsanti, and Paolo Gualtieri (2006) Algae: Anatomy, Biochemistry and Biotechnology, Taylor & Francis Group, UK

6. Becker, E. W. (1994) *Microalgae- Biotechnology and Microbiology*, Cambridge University Press, UK. Burnett, J. H.
7. Kevin Kavanagh (2005) *Fungi: Biology and Applications*, John Wiley & Sons Ltd., West Sussex,
8. Jim Deacon (2006) *Fungal Biology*, 4th Ed. Blackwell Publishing Ltd., West Sussex
9. Alexopoulos, C. J. and Mims, C. W. (1979) *Introduction to Mycology*, Wiley Eastern Ltd., New Delhi
10. Griffin, D. H. (1994) *Fungal Physiology*, Wiley-Liss, New York
11. Kathy Talaro and Barry Chess (2012) *Foundations in Microbiology*, 8th Edn., The McGraw-Hill Companies, Inc., New Delhi
12. Tortora, Funke and Case (2010) *Microbiology*, 10th Edn., Benjamin Cummings Inc. California
13. Moselio Schaechter (2009) 2nd Ed, *Desk encyclopaedia of Microbiology*, Elsevier
14. Prescott, Harley and Klein's (2002) *Microbiology*, 5th Ed. The McGraw-Hill Companies, Inc.,
15. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2011) *Foundations in Microbiology*, 7th Edn., Nirali Prakashan, Pune
16. Fred A. Rainey and Aharon Oren (2006) *Extremophiles, Methods in Microbiology*, Volume 35 Elsevier and Academic Press,
17. Martin Dworkin (Editor) (2006) *The Prokaryotes A Handbook on the Biology of Bacteria Volume 2, Ecophysiology and Biochemistry*, Springer-Verlag New York.
18. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark, (2009) *Brock Biology of Microorganism*, Benjamin Cummings, California, USA.
19. *Bergey's Manual of Systematic Bacteriology* (2001) Editor-in-chief: Garrity, George M. Boone,
20. David R.; Castenholz, Richard W. (Eds.), (4 Volumes) Springer/ Williams and Wilkins, USA
21. Kushner, D.J. eds. (1978) *Microbial life in extreme environments*. Academic Press, London.
22. Horikoshi, K., Grant, W.D. eds. (1998) *Extremophiles, Microbial life in extreme environments*. Wiley-Liss Publishers, New York.

MB 102: Microbial Biochemistry

Unit I	Biomolecules <ul style="list-style-type: none"> • Classification, Structure and Significance of carbohydrates, lipids, proteins and nucleic acids. • Chemical bond formation in carbohydrates, lipids, proteins and nucleic acids • Structural organization of proteins: Primary, secondary, Tertiary and Quaternary structure; Ramachandran plot, cot value • Vitamins of microbial origin: Structure, properties and Functions. 	10 L
Unit II	Transport and energy metabolism <ul style="list-style-type: none"> • Ultrastructure of cell membrane and structural features • Transport of molecules: Types of transport – (a) Active, (b) Passive, (c) Facilitated, (d) Translocation. Na/K+ ATPase.,(e) Ionophores and siderophores • Energy metabolism : Free energy, bacterial and mitochondrial ETC, ATP Synthase complex, inhibitors of oxidative phosphorylation, Energetics of ETC. 	10 L
Unit III	Metabolism of carbohydrates <ul style="list-style-type: none"> • Metabolic pathway, EMP, HMP, TCA, Glyoxylate pathway, C₃ and C₄ pathway, bioenergetics and regulation. • Alternative glycolytic pathways 	10 L
Unit IV	Metabolism of Lipids Metabolic pathway, Bioenergetics and regulation of: Fatty acid synthesis, Catabolism of lipids FAS Complex	10 L
Unit V	Amino acid and Nucleotide metabolism <ul style="list-style-type: none"> • Metabolic pathway, Bioenergetics and regulation of: amino acid degradation and biosynthesis • Transamination, Deamination, Stickland Reaction. • Metabolic pathway, Bioenergetics and regulation : Purines and Pyrimidine biosynthesis: De novo pathway and Salvage pathway, Ribonucleotide reductase and inhibitors of nucleic acid biosynthesis 	10 L

Suggested readings:

1. White, D. (2000) *The Physiology and Biochemistry of Prokaryotes*, Oxford University Press, New York, USA
2. Gottschalle, G (2004) *Bacterial Metabolism*, Springer, Weinheim

- Moat, A. G. and Foster, J. (1988) Microbial Physiology, Wiley Interscience Publ., New York
- Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi
- Stryer, L. (1992) Biochemistry, 4th Edn., W.H. Freeman and Co., New York, USA
- Price, N.C. and Stevens, L. (2000) Fundamentals of Enzymology, 3rd edn., Oxford University, Press, NY, USA.
- Voet, D., Voet, J.G. and Pratt C.W. (1999) Fundamentals of Biochemistry. John Wiley & Sons, Inc., Chichester, UK
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2003) Harper's Biochemistry. Appleton and Lange, Stamford, Connecticut.
- Jain, J.L., Jain, S. and Jain, N. (2009) Fundamentals of Biochemistry, S Chand, New Delhi
- Das, H. K. (2005) Text book of Biotechnology, 2nd Edn. Wiley Deramlech India Pvt. Ltd., New, Delhi.
- Doelle, H.W. (1975) Microbial Metabolism, 2nd Edn, Academic Press, London

MB 103: Bioanalytical Techniques

Unit I	Separation Techniques <ul style="list-style-type: none"> • Chromatography: Principle, design and applications of HPTLC, GC, HPLC, Gel filtration, Affinity chromatography. • Electrophoresis and electrofocusing: Principle, design and applications of Agarose gel, PAGE and Iso-electric focusing. • Centrifugation and Ultracentrifugation 	10 L
Unit II	Biophysical methods of analysis of biomolecules <ul style="list-style-type: none"> • Spectrophotometry: UV-visible spectrophotometer, fluorescence, Circular dichroism, • Spectroscopy: IR, NMR and ESR spectroscopy, • Structure determination: X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry. 	10 L
Unit III	Radiolabeling techniques <ul style="list-style-type: none"> • Properties of different types of radioisotopes used in biology, detection and measurement of radioactivity using GM scintillation counters, tracer techniques. • Radiolabelling of biological tissues and cells. • Safety guidelines for use and disposal of radioisotopes. 	10 L
Unit IV	Microscopic techniques <ul style="list-style-type: none"> • Electron microscopes (Scanning and Transmission) – Principle, Working and Construction and application in microbiology • Smear preparation for electron microscope. • Staining techniques for electron microscope, freeze-etch and freeze-fracture methods for electron microscope. • Image processing for electron microscope. 	10 L
Unit V	<ul style="list-style-type: none"> • Biosensors – Principle, Working, Types and Applications • Nano-biosensors • Biomarkers and Bioreporter 	10 L

Suggested readings:

- Upadhyay, A., Upadhyay, K. and Nath, N. (2000) Biophysical Chemistry, Himalaya Publisher, Nagpur.
- Friefelder A, D. (1993) Physical Biochemistry, 2nd Edn. W. H. Freeman & Co., USA.
- Van Holde, K. E. (1985) Physical Biochemistry, 2nd Edn., Prentice Hall Inc. New Jersey.
- Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando.
- Wilson, K. and Walker, J. (2000) Practical Biochemistry: Principles and techniques, 5th Edn., ambridge University Press, Cambridge.
- Willard, H.H. and Merrit, Jr. L.L. (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi.
- Wilson, K. and Goulding, K.H. Biologists Guide to Principle and Techniques of Practical Biochemistry, ELBS Publications, London.
- Mikkelsen, S.R. and Corton, E. (2004) Bioanalytical Chemistry, Wiley Interscience, New York, USA,

9. Sivasankar, B. (2005) Bioseparations Principles and Techniques, Printice Hall of India Pvt. Ltd., New Delhi.
10. Bengt Nölting (2009) Methods in Modern Biophysics, 3rd Edn., Springer, Berlin.

MB 104: Methods in Microbiology

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.
2	Growth Curve of yeast by Turbidity (Spectrophotometer/ Nephelometer) and Dry mass (Centrifugation) measurement
3	Isolation and cultivation of cyanobacteria/ Algae.
4	Isolation and cultural characterization of Actinomycetes.
5	Isolation and enumeration of Bacteriophages by plaque Titer Method
6	Cultivation of algae/ Endophytic fungi
7	Isolation of Acidophile/ Alkalophile/ Halophile/ Thermophile/ Psychrophile bacteria from extreme environments.
8	SDS PAGE of protein
9	Agarose gel electrophoresis of DNA
10	Column chromatography – Sepharose/Agarose/XAD/Octyl/CM Cellulose/DEAE Cellulose
11	16S r-RNA gene sequence analysis using BLAST and preparation of phylogenetic tree
12	Demonstration of HPLC/ GC/AAS

Suggested readings:

1. Norris, J. R. and Ribbons, D. W. (Ed) (1969) Methods in Microbiology, Vol 1, Academic Press Inc. Ltd., London
2. Harley, J. P., Lansing, M. Prescott, (2002) Laboratory Exercises in Microbiology, 5th Edn., The McGraw–Hill Companies, New York
3. Benson, H. (2001) Microbiological Applications Lab Manual, 8th Edn. The McGraw Hill Co., New York
4. Aneja, K.R. (1996) Experiments in Microbiology, 3rd Edn., Wishwa Prakashan, New Delhi.
5. Parija, S.C. (2005) Text Book of Practical Microbiology, Ahuja Publishing House, New Delhi.
6. Patil, Ulhas and Muskan, Kalyani (2009) Essential of Biotechnology, IK International, New Delhi
7. Dubey, R.C. and Maheshwari, D.K. (2004) Practical Microbiology, S. Chand and Co. New Delhi.

MB 105: Methods in Biochemistry

1	Basic biochemical techniques: Use of hand glove, Use of pipette aid, Preparation of standard solutions and buffers, Dilution approaches and Calibration of glass wares (pipet, volumetric flask)
2	Preparation of buffers of various pH and determination of pKa of a buffer system
3	Quantitative analysis reducing sugar by DNSA method.
4	Quantitative estimation of Total carbohydrate - Phenol sulphuric acid method.
5	Quantitative estimation of - Folin-Ciocalteu method/Biuret Method.
6	Quantitative estimation of amino acids by ninhydrin method.
7	Quantitative estimation of fatty acids by titration
8	Quantitative estimation of DNA by Diphenyl amine method.
9	Quantitative estimation of RNA by Orcinol method.
10	Quantitative estimation of lipids - Determination of Iodine and acid number.
11	Study of biomolecules using RasMol/ SPDBV software.
12	Qualitative analysis of biomolecules by Thin Layer Chromatography: Sugars and amino acids

Suggested readings:

1. Thomas, G.M. and Shalkhammer, (2004) Analytical Biotechnology, Springer, New Delhi
1. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
2. Plummer, D.T. (2001) An Introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. New Delhi
3. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.

- Jayramann, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi.
- Schmauder, H.P, Schweizer, M. and Schewizer, L.M. (2003) Methods in Biotechnology, Taylor and Francis Ltd., London

MB 201: Microbial Genetics

Unit I	Genome organization <ul style="list-style-type: none"> • General features of genome: Bacteria, Viruses, Algae and Fungi. • Genome: <i>E. coli</i>, Phage (T4, T7, ϕX174), Algae (BGA/<i>Spirulina</i>) and Fungi (<i>Neurospora</i>). • Genome vocabulary: Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, allele, transposons. 	10 L
Unit II	Virus Genome replication <ul style="list-style-type: none"> • General aspects of viral genome replication: Gapped, Segmented, Positive, strands of DNA, Negative strands of DNA, Positive strands of RNA, Negative strands of RNA. • Replication: DNA replication (Initiation, elongation and termination), Double stranded RNA replication, Single-stranded RNA replication. • Mechanism of reverse transcription and viral interference 	10 L
Unit III	DNA Damage and Repair <ul style="list-style-type: none"> • Mutation: Spontaneous and induced (Physical and Chemical mutagens), • Effects of mutation on the gene product: loss of the function of mutants (null, leaky mutations), gain of function of mutants, random or adaptive mutations, • Significance of mutants: Uses of bacterial and fungal mutants in strain improvement, Bacteriophage mutants in viral genetics, Plasmids in emergence of Multiple Drug Resistance. • DNA protection and repair: Role of restriction-modification system in DNA protection and repair. 	10 L
Unit IV	Plasmid biology <ul style="list-style-type: none"> • Characteristics and Features of bacterial plasmid: Size, Conformation, origin of replication, replication proteins, regulation of plasmid copy number, amplification, segregation and compatibility. Curing of plasmids and plasmid incompatibility. • Types of plasmid in: Bacteria (R, F, Ti, Vi, Ri, Deg, Col) and <i>Saccharomyces</i> (Snapfast). • Plasmid segregation: Random diffusion, par regions, post-segregational killing. • Plasmid isolation: Isolation and purification techniques for bacterial plasmids 	10 L
Unit V	Gene regulations <ul style="list-style-type: none"> • Gene regulation in bacteria and Viruses: His and Lac operon, Quorum sensing, Riboswitch, gene regulation by repressor in Lysogenic cycle of bacteriophage • Gene regulation in eukaryotes: DNA Rearrangements, Chromatin Modification, Cis-acting site, RNA Silencing. 	10 L

Suggested readings:

- Streips, U. N. and Yasbin, R. E. (2002) Modern Microbial Genetics, 2nd Edn., Wiley-Liss, New York
- Maloy, S. and Freifelder, D. (1994) Microbial Genetics, Jones and Barlett Publishers, London
- Dale, J. W. (1994) Molecular Genetics, John Wiley and Sons, Hoboken, NJ, USA
- Upadhyay, A., and Upadhyay, K. (2005) Molbio: Fundamentals of Molecular Biology, Himalya Publication House, Mumbai
- Trun, Nancy Jo and Trempey, J. E.(2006) Fundamental Bacterial Genetics, Blackwell Publishers, New York
- Verma, P.S. and Agrawal, V.K. (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S Chand and Co., New Delhi
- Gupta, P.K. (2008) Cell and Molecular Biology, Rastogi Publications, Meerut
- Rastogi, V. B. (2008) Fundamentals of Molecular Biology, Ane Books, New Delhi
- Larry, Snyder and Wendy, Champness (2007) Molecular Genetics of Bacteria, 3rd Edn, ASM Press, Washington, USA.

8. Malacinski, G.M. (2005) Freifelder's Essentials of Molecular Biology, 4th Edn., Narosa Publishing House, New Delhi

MB 202: Advanced Enzymology

Unit I	Concepts in Enzymology <ul style="list-style-type: none"> • General characteristics of enzyme, Ribozyme, Abzyme and Coenzymes • Enzyme Nomenclature, classes of enzymes, enzyme activity, Specific activity, catal, Substrate specificity, turn over number. • Enzyme active site • Effect of pH, temperature, substrate concentration, activator on enzyme activity • Enzyme turnover: Concept and significance. • Isoenzyme: Concept, properties e.g. LDH • Multienzyme complexes- pyruvate dehydrogenase (PDH) and fatty acid synthetase, advantages of multienzyme complex 	10 L
Unit II	Enzyme Kinetics <ul style="list-style-type: none"> • Elementary reactions, Reversible reactions, Rates of reactions, Transition state theory • The Michaelis–Menten Equation, Concept of Km and Vmax, Double reciprocal plot and Brigg's Haldane plot, Analysis of Kinetic Data. • Enzyme Inhibition : Competitive Inhibition, Non-competitive, Uncompetitive Inhibition and Mixed Inhibition, • Bi-substrate kinetics and Oligomeric enzymes 	10 L
Unit III	Mechanism and regulation of enzyme catalysis <ul style="list-style-type: none"> • Acid–Base Catalysis: Covalent Catalysis, Metal Ion Catalysis, Electrostatic Catalysis, Catalysis through Proximity and Orientation Effects, Catalysis by Preferential Transition State Binding • Serine Proteases : Kinetics and Catalytic Groups, X-Ray Structures, Catalytic mechanism, Testing Catalytic Mechanism, Zymogens • Enzyme regulation: Feedback inhibition, enzyme repression, induction and degradation, enzyme regulation by cAMP, covalent modification, allosteric regulation of enzymes (ATCase) 	10 L
Unit IV	Industrial applications of enzymes <ul style="list-style-type: none"> • Perspective of use of enzyme in industry • 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), Asperaginase 	10 L
Unit V	Extremozymes <ul style="list-style-type: none"> • Microbial source, characteristics and biotechnological significance of extremozymes from thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles. Solvent resistant enzymes. • Non aqueous enzymology and Biosurfactants 	10 L

Suggested readings

1. Stryer, L. (2004) Biochemistry, 5th Edn., W. H. Freeman and Co., New York
1. Palmer, T. (2004) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Affiliated East-West Press Pvt. Ltd., New Delhi
2. Price, N. C. and Stevens, L. (2000) Fundamentals of Enzymology, Oxford University Press, New York.
3. Dixon, M. Webb, E. C., Throne, C.J.R. and Tipton, K. F., Enzymes, Academic Press, New York
4. Pandey, A., Webb, C., Soccol, C.R, and Larroche, C. (2005). Enzyme Technology, Asiatech Publishers Inc., New Delhi
5. Cook, Paul, F. and Cleland, W.W. (2007) Enzyme Kinetics and Mechanism, Garland Science, New York.
6. Nooralabettu, K. P. (2011) Enzyme Technology Pacemaker of Biotechnology, PHI Learning Pvt. Ltd., New Dehli
8. Shanmugam, S. and Sathishkumar, T. (2009) Enzyme Technology, I K International, New Delhi
9. Satyanaryana, T. (1999) Biochemistry, Books and Allied Pvt. Ltd., Calcutta

10. Jain, J.L, Jain, S, and Jain, N (2005) Fundamental Biochemistry, S. Chand and Co., New Delhi
 7. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi.

MB 203: Immunology

Unit I	Overview of the Immune System <ul style="list-style-type: none"> • Morphology and functions of organs of the immune system. • Morphology, formation and functions of cells of immune system. • Antibody diversity - Somatic gene recombination, Genesis of light and heavy chain diversity. • Major Histocompatibility Complex: Structure, Properties and distribution. • Graft rejection: Mechanisms, HLA typing. 	10 L
Unit II	Mechanisms of immune response <ul style="list-style-type: none"> • 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 	10 L
Unit III	Hyper immune response <ul style="list-style-type: none"> • Hypersensitivity: Types (I-IV) and mechanism of each type. • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organspecific and systemic, Treatment of autoimmune diseases. 	10 L
Unit IV	Immune response to infections and diseases <ul style="list-style-type: none"> • Immunity against bacterial, viral, Fungal and protozoal infections. • Tumor immunology: Types of tumors, oncogenesis and tumor antigens (TATAs, TSTA), Immune response to tumors. • Immunodeficiency diseases (e.g. SCID, CVI, AIDS) 	10 L
Unit V	Histochemical and immunotechniques <ul style="list-style-type: none"> • Production and applications of monoclonal antibodies • Detection of Ag/Ab - ELISA, RIA, Western blot, Immunoprecipitation, immunofluorescence and Flow Cytometry. • <i>in situ</i> localization by FISH and GISH 	10 L

Suggested readings:

1. Goldsby, R.A., Kindt, T.J. and Osborne, B. and Kuby, A. (2003) Immunology, 5th edn., W. H. Freeman and Company, New York.
2. Roitt, I. (2000) Essentials of Immunology, 5th edn., Blackwell ELBS Science Publication, Oxford.
3. Paul, W. E (2003) Fundamental Immunology, 5th edn., Lippincott Williams and Wilkins Publishers, USA
4. Tizard, I. R. (1995) Immunology: An Introduction, Saunders College Publishing, Philadelphia
5. Banerjee, A. K. and Banerjee, N. (2006) Fundamentals of Microbiology and Immunology, New Central Book Agency (Pvt.) Ltd., Kolkata
6. Coleman, R.M., Lombard, M.F. and Sicard, R.E. (2000) Fundamental Immunology, 4th edn., WmC Publications, London
7. Rao, C. V. (2007) Immunology, Narosa Publishing House, New Delhi
8. Shastri, N.V. (2005) Principal of Immunology, Himalya Publication House, Mumbai
9. Barrett, James T. (1998) Microbiology and Immunology Concepts, Lippincott Williams & Wilkins, Philadelphia, PA
10. Janeway, Charles, Travers, Paul, Walport, Mark and Shlomchik, Mark (2004) Immunobiology, Garland Science.

MB 204: Methods in Enzymology

1	Screening and Detection of enzyme from microbial source
2	Quantitative estimation of enzyme (Enzyme activity, specific activity, IU)
3	Effect of pH and temperature on enzyme activity

4	Effect of activator on enzyme activity and determination of kinetic parameters
5	Screening and evaluation of inhibitor on enzyme and determination of K_i and V_{max}
6	Purification of enzyme by salting out and dialysis/gel permeation and determination of purification fold and yield parameters
7	Detection of enzyme by zymography: Substrate gel electrophoresis
8	Electrophoretic determination of Molecular weight of enzyme by PAGE: SDS, Native
9	Enzyme stabilization by immobilization technique (Gel entrapment/ Crosslinking)
10	Production of maltodextrin using amylase (% conversion method/Degree of hydrolysis method)
11	Determination of enzyme kinetics using suitable software (Sigma Plot)
12	Determination of enzyme activity in organic solvent media
13	Demonstration of Structural prediction of suitable enzyme with ExPasy server

NB: Use any ONE enzyme from the following:

- | | | | |
|------------|---------------------------|-------------|--------------|
| 1) Amylase | 2) Protease | 3) Phytase | 4) Laccase |
| 5) Lipase | 6) β -Galactosidase | 7) Xylanase | 8) Cellulase |

Suggested readings:

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

MB 205: Methods in Molecular Biology and Immunology

1	Bacterial transformation.
2	Detection of transformants.
3	Bacterial conjugation.
4	Isolation and detection of bacterial/ Fungal DNA.
5	Isolation and curing of plasmid.
6	Restriction digestion by endonucleases.
7	PCR amplification of DNA.
8	Effect of physical/Chemical mutagen on growth of bacteria
9	Immuno-diffusion by Ouchterlony double diffusion
10	Immuno-electrophoresis
11	Bacterial gene expression using IPTG /X-gal
12	ELISA (Sandwich method)/ Western/Southern/Northern blot

Suggested readings:

1. Schmauder, H. P., Schweizer, M. and Schweizer, L. M. (2003) Methods in Biotechnology, Taylor and Francis, London
2. Joe Sambrook (2001) Molecular Cloning: A Laboratory Manual, 3rd Edn., (3 volume set) Cold Spring Harbor Laboratory Press,
3. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
4. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
5. Davis, L.G., Dibner, M.D. and Battey, J.F. (1986) Basic Methods in Molecular Biology, Appleton and Lange, Norwalk.