

M.Sc. MICROBIOLOGY- SEMESTER SYSTEM

(EFFECTIVE FROM THE ACADEMIC YEAR 2009-10)
SCHEME OF INSTRUCTION AND EXAMINATION

| Paper No. | Title of the Paper | Periods/ Week | Duration of Exam (Hours) | Maximum Marks | Credits |
|--|--|------------------|--------------------------------|------------------|------------|
| I Semester | | | | | |
| MB 101 | General Microbiology | 4 | 3 | 100 | 4 |
| MB 102 | Virology | 4 | 3 | 100 | 4 |
| MB 103 | Bio-molecules | 4 | 3 | 100 | 4 |
| MB 104 | Analytical Techniques | 4 | 3 | 100 | 4 |
| Practical | | | | | |
| MBP 105 | Microbiological methods & Virology | 12 | 6 | 100 | 4 |
| MBP 106 | Analytical Techniques | 12 | 6 | 100 | 4 |
| Total Marks and Credits for I Semester | | | | 600 | 24 |
| II Semester | | | | | |
| MB 201 | Microbial Physiology & Metabolism | 4 | 3 | 100 | 4 |
| MB 202 | Enzymology & Cell Biology | 4 | 3 | 100 | 4 |
| MB 203 | Molecular & Microbial Genetics | 4 | 3 | 100 | 4 |
| MB 204 | Immunology | 4 | 3 | 100 | 4 |
| Practical | | | | | |
| MBP 205 | Enzymology & Immunology | 12 | 6 | 100 | 4 |
| MBP 206 | Microbial Physiology & Genetics | 12 | 6 | 100 | 4 |
| MB: 207 | Principles of Microbiology (Non-Core) | 4 | 3 | 100 | 4 |
| Total Marks and Credits for II Semester | | | | 700 | 28 |
| III Semester | | | | | |
| MB 301 | Molecular Biology | 4 | 3 | 100 | 4 |
| MB 302 | Medical Microbiology | 4 | 3 | 100 | 4 |
| MB 303 | Bio-statistics & Bio-informatics | 4 | 3 | 100 | 4 |
| MB 304 | Molecular Biotechnology | 4 | 3 | 100 | 4 |
| Practical | | | | | |
| MBP 305 | Molecular Biology & Molecular Biotechnology. | 12 | 6 | 100 | 4 |
| MBP 306 | Medical Microbiology & Bio-informatics. | 12 | 6 | 100 | 4 |
| MB 307 | Applied Microbiology (Non-Core) | 4 | 3 | 100 | 4 |
| Total Marks and Credits for III Semester | | | | 700 | 28 |
| IV Semester | | | | | |
| MB 401 | Fermentation Technology & Industrial Microbiology | 4 | 3 | 100 | 4 |
| MB 402 | Environmental Microbiology | 4 | 3 | 100 | 4 |
| MB 403 | Food Microbiology & Agriculture Microbiology | 4 | 3 | 100 | 4 |
| MB 404 | Pharmaceutical Microbiology | 4 | 3 | 100 | 4 |
| Practical | | | | | |
| MBP 405 | Industrial Microbiology & Environmental Microbiology | 12 | 6 | 100 | 4 |
| MBP 406 | Food, Agriculture & Pharmaceutical Microbiology | 12 | 6 | 100 | 4 |
| Total Marks and Credits for IV Semester | | | | 600 | 24 |
| Project Work/Dissertation and Credits | | | | 100 | 4 |
| Grand Total Marks and Credits for 4 Semesters | | | | 2700 | 108 |

- Out of 100 Theory and 100 Practical Marks for each paper, 15 marks for internal assessment and 85 marks for semester-end examinations.
- Out of 85 Marks of each practical examination, 15 marks should be allotted for viva-voce and 10 marks for Record.

I SEMESTER

MB 101: GENERAL MICROBIOLOGY

UNIT – I:

History and scope of Microbiology . Recent trends and developments in modern microbiology. Identification, characterization and classification of microorganisms- Principles of bacterial taxonomy and classification: - Bergy's manual and its importance,

Concepts, nomenclature and taxonomic ranks: general properties of bacterial groups. Major characteristics used in Taxonomy-morphological, physiological and metabolic, ecological, numerical taxonomy, genetic and molecular classification systems; the kingdoms of organisms and phylogenetic trees. Distinguishing characteristics between prokaryotic and eukaryotic cells Structure and function of Cell wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolosomes.

UNIT- II:

Methods of sterilization: Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment facility, sterilization at industrial level.

Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development.

Microscopic identification characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods

Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media

Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method.

UNIT -III:

.Bacterial nutrition and growth kinetics- synchronous, stock, batch and continuous cultures. Growth measurement methods –Metabolic diversity, measurements of NAD, ATP, DNA, and Protein, CO₂ liberated O₂ consumed, extra cellular enzymes. Cultivation of aerobes and anaerobes, Reproduction in bacteria and spore formation.

Morphology, Ultra structure and chemical composition of bacteria, actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae – TRIC agents and LGV Archaeobacteria

UNIT- IV:

Eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi. Classification, structure, composition, reproduction and other characteristics of fungal divisions-Zygomycota, Ascomycota, Basidiomycota, Deuteromycota and slime & water molds

Structure, reproduction and other characteristics of algal divisions. Distribution of algae. Characteristics of – blue green algae, dinoflagellates, thallus organization, products of algae and their economic importance. Algal SCP, emphasis on *Spirulina*

Characteristics of Virious protozoa-Morphology, nutritional reuirements, reproduction. Morphology, Life cycle and Pathology of *Entamoeba histolytica*, *Plasmodium*, Free Living Pathogenic Amoeba *Naglaria* & *Acanthamoeba*.

RECOMMENDED BOOKS FOR MB 101:

1. Bergey's Manual of Systematic Bacteriology (9th edition) volumes I to VI
2. Methods for General and Molecular Bacteriology (2nd edition) by GERHARDT (Editor-in-Chief)
3. Microbiology (5th edition) PELCZAR, CHAN & KRIEG.
4. Brock Biology of Microorganism (9th edition) by MADIGAN, MARTINKO & PARKER.
5. Introduction to Microbiology by ROSS.
6. Basic Microbiology by VOLK & WHEELER.
7. Fundamental Principles of Bacteriology by SALLE.
8. General Microbiology by Stainier, Deudroff and Adelberg
9. Structure and Reproduction of Algae, Vol. I & II by Fritsch, F.E.
10. Introduction to Algae by Morris, I.
11. Products and Properties of Algae by Zizac.

12. Fresh water algae of the United States by Smith, GM.
13. Introductory Mycology, by Alexopolus, C.J.
14. Dispersal in Fungi by Ingold, CT.
15. Principles of Microbiology, by R.M. Atlas, Wm.C. Brown Publications.
16. Foundations in Microbiology, K. Talaro and A. Talaro. Wm.C. Brown Publications.
17. Fundamentals of Microbiology by D.E. Alcamo, Jones and Bartlett, Boston.
18. Microbiology – Principles & Applications by J.G. Black, John Wiley & Sons, New York.
19. Microbiology by G.J. Tortora, B.R. Funke and C.L. Case, Addison Wesley Longman Inc., San Francisco.
20. The Biology of the Protozoa by M.A. Sleigh, American Elsevier, New York.

MB 102: VIROLOGY

UNIT-I:

History and Discovery of Viruses, Nature, origin and evolution of viruses, New emerging and reemerging, viruses, viruses in human welfare.

Nomenclature, classification and structure of viruses – criteria used for naming, classification of viruses, recent ICTV classification of viruses infecting animals, humans, plants, bacteria, algae, fungi. Major characteristics of different virus families/genera/groups- Poxviridae, Hepadnaviridae, Baculoviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae, Flaviviridae, Potyviridae, Tobamoviridae, Bromoviridae, Bunyaviridae, Geminiviridae, Caulimoviridae.

Algal, Fungal and Bacterial viruses- Phycodnaviridae, Cyanophages, Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids, Viroids, Prions.

UNIT-II:

Properties of Viruses- Biological properties of viruses – host range, transmission-vector, non-vector; Physical properties of viruses – morphology, structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical characteristics – chemical composition of viruses, proteins, nucleic acids, envelope, enzymes, lipids, carbohydrates, polyamines, cations, Antigenic nature of viruses.

Isolation, cultivation, assay and maintenances of viruses – Animal, Plant and Bacterial Viruses: biassay tissue culture – organ culture, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines, embryonated eggs; experimental plant tissue cultures.

UNIT – III:

Viral replication and genome expression – viral genomes- structure and complexity of viral genomes, diversity among viral genomes – DNA and RNA genomes- linear, circular, double and single stranded; positive and negative sense of RNA genomes, mono, bi tri and multipartite of genomes. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses and regulation of viral genome expression- Baltimore strategies.

Virus – host interactions – cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection –interference, immunological responses of the host,

UNIT – IV:

Transmission of viruses – Vertical (Direct) transmission – contact, mechanical, transplacental, transovarial, sexual, fecal, oral, respiratory, seed and pollen. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthropods, virus and vector relationship. Multiple host infections – viral zoonosis.

Diagnosis of viral diseases – chemical symptoms, immuno diagnosis, molecular methods used in viral diagnosis, prevation and control of viruses: prevation – sanitation, vector control, vaccines and immunization control – chemoprophylaxis, chemotherapy – anti viral drugs, interferon therapy, efficacy of infection control.

REFERENCE BOOKS FOR MB 102:

1. Virology: 1994. 3rd Edition. Frankel-Conrat . Prentice-Hall

2. Principles of Virology: 2004 Second Edition by S.J.Flint et al., ASM press
3. Introduction to Modern Virology: 2001.5th edition. Dimmock et al., Blackwell Sci.Publ
4. Principles of Molecular Virology, 2001, 3rd edition A.Cann. Academic Press
5. Basic Virology, 1999, by Waginer and Hewelett, Black Well Science Publ
6. Medical Virology, 1994, 4th edition. D.O.White and F.J.Fenner, Academic Press.
7. Plant Virology, 2001, 4th edition by R.Hull, Academic Pres.
8. Fundamental Virology, 4th edition 2001, D.M.Knipe and P.M.Howley.
9. Veterinary Virology. 3rd edition 1999, Murphy et al., Academic press.
10. Encyclopedia of Virology. 1994. R.G.Webster and Allan Granoff Vol I, II, III, Academic Press.
11. Plant viruses.2006.M.V.Nayudu. Prentice Hall Publication.

MB 103: BIOMOLECULES

UNIT – I:

Major Biomolecules: Carbohydrates – Classification, chemistry, properties, and function – mono, di, oligo and polysaccharides.bacterial cell wall polysaccharides. Conjugated polysaccharides– glycoproteins, muriens and lipopolysaccharides. Lipids – classification, chemistry, properties and function – free fatty acids, triglycerides, phospholipids, glycolipids & waxes. Conjugated lipids – lipoproteins. Major steroids of biological importance – prostaglandins.

UNIT –II:

Amino acids and proteins – classification, structure and function. Essential amino acids & amphoteric nature of amino acids and reactions and functions of carboxyl and amino groups and side chains. Peptide structure. Ramachandran's plot. Methods for isolation and characterization of proteins. Structural levels of proteins – primary,

secondary, tertiary and quaternary, denaturation of proteins. Hydrolysis of proteins. Protein sequencing using various methods.

UNIT – III:

Nucleic acids – structure, function and their properties. Structural polymorphism of DNA, RNA. Structural characteristics of RNA.

Sources, Chemistry and biochemical functions of water-soluble vitamins. Chemistry of Porphyrins – Heme, Cytochromes, Chlorophylls, xanthophylls, Bacteriochlorophylls & algal pigments, Carotenoids.

UNIT-IV:

Biological oxidation, Biological redox carriers, biological membranes, electron transport, oxidative phosphorylation and mechanism. Bacterial photosynthesis, photosynthetic electron transport

Mineral metabolism – phosphorus, potassium, calcium and Trace elements – molybdenum, zinc, manganese, cobalt and copper. Influence of minerals on the production of toxins. Role of trace elements on microbial enzymes.

RECOMMENDED BOOKS FOR MB 103:

1. Biochemistry (2nd edition) by VOET & VOET.
2. Outlines of Biochemistry (5th edition) CONN, STUMPF, BRUENING & DOI.
3. Biochemistry (3rd edition) by STRYER.
4. Biochemistry by ZUBAY.
5. Principles of Biochemistry by LEHNINGER, NELSON & COX.
6. Harper's Review of Biochemistry by MARTIN, MAYER & RODWELL
7. Principles of Biochemistry: General aspects by SMITH, HILL, LEHMAN, LEFKOWITZ, HANDLER & WHITE
8. Biochemistry of Nucleic acids by Davidson
9. Microbial Physiology and Metabolism, by D.R.Caldwell. Wm.C.Brown Publications.
10. Biochemistry of Nucleic acids by P.L.P. Adams, J.T. Knowler and D.P. Leader, Chapman & Hall, London.
11. Text Book of Biochemistry by E.S.West. W.R. Tood, H.S.Mason and J.T.V. Bruggen, Oxford & IBM Publishing Company Private Limited, New Delhi.

MB 104: ANALYTICAL TECHNIQUES

UNIT – I:

Microscopy – Principles of light, phase, fluorescent & electron microscopes; Microtomy – sectioning. Microscopic techniques: Basic principles and applications of phase – contrast microscopy (phase annulus, phase plate, specimen preparations), fluorescent microscopy (filters, dark field condenser, complex optical system, sample preparations) and electron microscopy (Magnetic lenses, electron beams, condensers, types of electron microscopy – scanning and transmission, sample preparations - fixing of specimens, preparation of blocks, microtomy and staining, negative staining techniques of biological samples), cytometry and flow cytometry.

UNIT – II:

Principles of Centrifugation – Centrifugation techniques-preparative and analytical methods, density gradient centrifugation.

General principles and applications of chromatography – Paper, Column, Thin layer, Gas, Ion exchange, Affinity chromatography, HPLC, FPLC and Gel filtration.

Electrophoresis – moving boundary, zone (Paper Gel) electrophoresis. Immunoelectrophoresis. Immunoblotting. Isoelectric focusing, 2-D electrophoresis

UNIT – III:

Principles, Laws of absorption and radiation. Visible, ultraviolet, infrared and mass spectrophotometry. Absorption spectra, fluorescence flame photometry, NMR, ESR, Principles of colorimetry, Turbidometry, Viscometry. Determination of size, shape and molecular weight of macromolecules – osmotic pressure, flow birefringence, optical rotatory dispersion. light scattering, diffusion, sedimentation and X-ray diffraction.

UNIT-IV:

Radio isotopic tracers – methodology, problems of experimental design, radiometric analysis, stable and radioactive isotopes, preparation, labeling, detection and measurement of isotopes. RIA. Kinetics of radioactive disintegration.

Manometric techniques. Freeze drying and its application in biological systems.

RECOMMENDED BOOKS FOR MB 104:

1. Instrumental Methods of Chemical Analysis by CHATWAL & ANANAD.
2. Practical Biochemistry: Principles and techniques by WILSON & WALKER.

3. Physical Biochemistry: Application to Biochemistry and Molecular biology (2nd edition) by FREIFELDER.
4. Biochemical methods (2nd edition) by SADASIVAM & MANICKAM.
5. Biophysical Chemistry: Principles and techniques by UPADHYAY, UPADHYAY & NATH.
6. HAWK'S Physiological Chemistry by OSER.
7. Modern Experimental Biochemistry, by R.F.Boyer, Benjamin Cummings Publ. Company
8. Manometric and Biochemical Techniques by Umbtict, Burris and Staffer, Burgross.
9. A Biologist's Guide to Principles and Techniques of Practical Biochemistry by B.D. Williams and K. Wilson.

MBP 105: MICROBIOLIGAL METHODS & VIROLOGY

1. Isolation methods – Pour plate, Streak plate and Dilution methods.
2. Staining methods – Gram's stain. Capsule staining. Cell wall staining. Indian Ink Method or Hiss's method. Demonstration of granules in bacterial cells – Albert's method, Neisser's method. Acid-fast staining by Ziehl-Neelsen's method. Flagella and spore stain. Negative stain.
3. Detection of motility by hanging drop method,
4. Selective and indicator media – Crystal violet blood agar, Potassium tellurite blood agar, Neomycin blood agar, Salt nutrient agar, Mannitol salt agar, Phenolphthalein phosphate nutrient agar and Aesculin bile medium.
5. Enumeration of bacteria – Quantitative estimation of microorganisms – total and viable counts.
6. Growth curves, Bacterial growth measurement, viable count by spread plate method, colony count. Enumeration by dry weight and turbidometric methods,
7. Culturing of anaerobic microorganisms
8. Metabolic (Biochemical) tests – Catalase and Oxidase tests. Indole reaction. Methyl red and Voges-Proskauer reactions, citrate utilization, starch and gelatin hydrolysis; H₂S production.
9. Isolation & Identification of known & unknown bacteria.
10. Isolation of phage from soil, Cultivation and preservation of phages, Quantitation of phages

11. Growth phages of phage and burst size
12. Cultivation of animal viruses by different routes in embryonated chicken/duck eggs Yolksac, Allantoic and Chorio allantoic membrane (CAM) routes.
13. Animal cell culture-Sheep kidney cell culture, chicken embryo fibroblast cell culture
14. Mechanical inoculation of plant viruses – Tobacco mosaic virus or cucumber mosaic virus and graft transmission of plant viruses.
15. Measurement of size of spores and cells.
16. Isolation and culturing of fungi (yeasts and molds) and algae
17. Observation of specimen and permanent slides

RECOMMENDED BOOKS FOR MBP 105:

1. Microbiology: A laboratory manual by CAPPUCCINO & SHERMAN
2. Laboratory Experiments in Microbiology by Gopal Reddy, M.N.Reddy, D.V.R. Sai Gopal and K.V.Mallaiah,
3. Microbiology -Practical Manual by Reddy S.M. & Reddy S.R., Books Selection Centre, Hyderabad.
4. Laboratory Exercises in Organismal and Molecular Microbiology by S.K. Alexander, D.Strete and M.J. Mily, Mc. Graw Hill, USA.
5. Microbiology – A Laboratory Manual by J.G. Cappunico and N.Sherman, 4th Edition, Addison Welsley Longman Inc., England.
6. Practical Microbiology – Principles and Techniques by V.Kale and K.Bhusari, Himalaya Publishing House, New Delhi.
7. Laboratory Manual in Microbiology by P.Gunashekarana, New Age International Private Limited Publishers, New Delhi.
8. Laboratory Manual in General Microbiology by N. Kannan, Panima Publishing Cooperation, New Delhi.
9. Practical Microbiology by R.C. Dubey and D.K. Maheswari, S.Chand & Company Limited, New Delhi.
10. Bergy's Manual of Determinative Bacteriology By J.G.Holt, N.R.Krieg, P.H.A. Sneath, J.T. Staley and S.T. Williams, Lippincott Williams & Wilkins, Philadelphia.
11. Microbiology Laboratory Exercises BY Barnett, Mc. Graw Hill, U.S.A.
12. Microbiology applications: a Laboratory Manual in General Microbiology by Benson, Mc. Graw Hill, U.S.A.
13. Laboratory Exercises in Microbiology by Chan, Mc. Graw Hill, U.S.A.

MBP 106: ANALYTICAL TECHNIQUES

1. Qualitative tests of carbohydrates, lipids, amino acids, proteins & nucleic acids.
2. Estimation of reducing sugar-Anthrone method

3. Estimation of sugar by titration method –Benedict's method
4. Estimation of Ninhydrin method, Micro kjeldhal method, Ultraviolet spectroscopy of proteins.
5. Determination of pKa and pI values of amino acids.
6. Quantitation of glycine by formol titration
7. Paper Chromatography of amino acids, sugars, and purine and pyrimidine bases.
8. Colorimetric determination of any one amino acid.
9. Separation of pigments by adsorption chromatography
10. Thin Layer chromatography separation – sugars & lipids
11. Molecular weight determination of enzymes / proteins by Gel filtration, SDS-PAGE.
12. Determination of saponification value of fats
13. Determination of iodine number of oils
14. Determination of acid value of fats
15. Demonstration of GM counter.
16. Determination of molar absorption coefficient of amino acid/protein and estimation of its concentration

RECOMMENDED BOOKS FOR MBP 106:

1. Experimental Biochemistry – A student comparison by B. Shashidhara Rao & Vijay Deshpande – I.K. International Private Limited, New Delhi.
2. Practical Biochemistry - Principles and Techniques by K. Wilson and J. Walker, Cambridge University Press.
3. An Introduction to Practical Biochemistry by D.T. Plummer, Tata Mc. Graw Hill Publishing Company Limited, New Delhi.
4. Practical Biochemistry – A Basic Course by A. Rameshwar, Kalyani Publishers, Ludhiana.

5. Laboratory Manual in Biochemistry by Jayaraman, Wiley Eastern Limited.
6. Hawk's Physiological Chemistry by Oser, Mc. Graw Hill, U.S.A.

II SEMESTER

MB 201: MICROBIAL PHYSIOLOGY & METABOLISM

UNIT- I:

Nutritional types – autotrophic bacteria, chemosynthetic and photo synthetic microorganisms. Heterotrophic bacteria – saprophytes, parasites and mixotrophs. Respiration in bacteria – aerobic and anaerobic types of respiration, obligate aerobes, facultative anaerobes and obligate anaerobes. Toxic effect of oxygen on anaerobes. Bioluminescence in microorganisms. Energy yields. Microbial growth: The concept of growth and definition, Cell cycle in microbes and generation time
Growth phases of bacteria –survival of microbial cells. Importance of each growth phase. Synchronous cultures – methods of synchronous culturing
Continuous culturing methods, factors effecting growth. Methods of growth measurement. Physiology and biochemistry of sporulation and germination of spores

UNIT-II:

Carbohydrate metabolism in microbes – synthesis of carbohydrates in photosynthetic, chemosynthetic and heterotrophic microbes. Fermentation of carbohydrates by microorganisms – Embden-Meyerhof-Parnas pathway, Entner-Doudoroff (ED) pathway, C2-C4 split pathway. Kreb's cycle, glyoxylate cycle, hexose monophosphate shunt (HMP), gluconeogenesis, anaplerotic reactions, synthesis of peptidoglycans and glycoproteins. Anaerobic respiration - Fermentation, Biochemical

mechanisms of lactic acid, ethanol, butanol and citric acid fermentations. Nitrate and sulphate respiration.

UNIT-III:

Metabolism of amino acids –Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine by microorganisms

Protein metabolism - Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Urea cycle . Signal transduction with reference to nitrogen metabolism. Catabolism of amino acids, transamination, decarboxylation and oxidative deamination. Porphyrin biosynthesis and catabolism.

UNIT –IV:

Lipid metabolism - Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and aliphatic hydrocarbons (camphor, 2,4-D and toluene) with emphasis on the role of monooxygenase and dioxygenase in the ring cleavage (*ortho*, *meta* and *gentisate* cleavage) and reductive catabolism.

Nucleotide metabolism - Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis, catabolism of purine and pyrimidines.

Secondary metabolism - Utilization of secondary metabolites for production of vitamins, toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).

RECOMMENDED BOOKS FOR MB 201:

1. Microbial physiology by Moat and Foster.
2. An introduction to bacterial physiology by Price and Stevens.
3. An introduction to bacterial physiology by Oginsky and Umbreit.

4. Bacterial metabolism by Gottschalk.
5. Growth of bacterial cell by Ingraham, Lod and Neichardt.
6. Microbial energetic by Dawes.
7. Principles of Biochemistry by Lehninger, Nelson and Cox.
8. Biochemistry by Zubay.
9. Biochemistry by Stryer.
10. Biochemistry by Garrett and Grisham.
11. Textbook of Microbiology by M.Burrows.
12. Microbial physiology and Metabolism by D.R.Caldwell, Wm.C.Brown Publ.
13. Foundations in Microbiology by K.Talaro and A. Talaro Wm.C.Brown Publ.
14. Microbiology by Prescott *et al.* Wm.C.Brown Publ.
15. Molecular Cell Biology by Lodish *et al.*
16. General Microbiology by Stainer, Macmillan educational Ltd.
17. Brock Biology of microorganisms by Madigan M.T., Martinko J.M., and Parker J. Prentice-Hall.
18. Textbook of Biochemistry by West E.S and Tood, Oxford and IBM Publishing Co. Pvt. Ltd.
19. Biochemistry by Donald Voet, Judith G.voet, John Wiley & Sons.
20. Biochemistry by Harper, Mc.Graw Hill.
21. Principles of Biochemistry by Cohn and Stumph, John Wiley and Sons, Inc.
22. Biochemistry of Nucleic acids by Davidson.
23. Biological chemistry by Mullar and Cords.
24. Biochemistry by White Handler and Smith.
25. Bacterial metabolism by Dwelley.

MB 202: CELL BIOLOGY & ENZYMOLOGY

UNIT-I:

Organellar Biology: Structure, function & biogenesis of chloroplast and mitochondria, mesosomes, lysosomes and cytoskeletal system. Photosynthesis in bacteria and plants: Organization, apparatus, electron donors & acceptors, energetics. Physico-chemical properties of bacteria – intracellular osmotic pressure, permeability of the bacterial cell. Nutrient transport – simple diffusion, active, passive and facilitated diffusion. Purple green photosynthetic bacteria Photosynthesis - Oxygenic and anoxygenic photosynthesis, structure of synthetic pigments, primary photochemistry of PS I and PS II, and photosynthetic electron transport, CO₂ fixation, halo bacterial photosynthesis.

UNIT-II:

Signal transduction in eukaryotes: Protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, etc. Cyclic nucleotides, G proteins. Mechanisms of protein translocation across membranes in prokaryotes and eukaryotes, coated vesicles, membrane receptors.

UNIT-III:

Outlines of enzyme classification, nomenclature, assay of enzymes and kinetics of enzyme catalyzed reactions – Michaelis – Menton equation, determination of K_m, V_{max} and k_{cat} values. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes

UNIT-IV:

Enzyme inhibitors, competitive and noncompetitive inhibition. Active site determination. Mechanism of action of ribonuclease, lysozyme and chymotrypsin. Isoenzymes, Regulatory enzymes – covalent modification, zymogen activation, Allosteric enzymes – ATCase, Glutamine synthetase. Hemoglobin & Myoglobin. Enzyme purification - Methods of isolation, purification. Recovery and yield of enzymes. Criteria for testing purity of enzyme preparations. Immobilised enzymes - Methods of immobilisation. Comparison of kinetics of immobilised and free enzymes. Application of immobilized enzymes.

RECOMMENDED BOOKS FOR MB 202:

1. Cell and Molecular Biology by E.B.P. De Robertis, Lippincott Williams & Wilkins.

2. Molecular Cell Biology by Lodish & Baltimore.
3. Fundamentals of Enzymology, Nicholas C. Price, Lewis Stevens, Oxford University Press.
4. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Harward Publishing Limited.
5. Biochemistry by Lehninger.
6. Principles of Biochemistry by Lehninger, Nelson and Cox.
7. Biochemistry by Lubert Stryer.
8. Biochemistry by Zubay.
9. Biochemistry by White Handler and Smith.
10. Enzymes by Dixon and Webb.
11. Introduction to Experimental Cell Biology by Ahern, Mc. Graw Hill, USA.
12. The Chemical reactions of Living Cells, Vol 1 and 2, by Metzler
13. Cell Biology by Alberts, Bay Johnson.

MB 203: MOLECULAR & MICROBIAL GENETICS

UNIT-I:

Molecular organization of chromosomes in Prokaryotes and Eukaryotes. Centromeres and telomeres. Recombination at molecular level, heteroduplex analysis. Fine Structure analysis. Organisation of genomes – Repeated sequences - C value – cot curves” Multigene families; Molecular markers(RFLP and RAPD) Polymorphisms. Yeast & Drosophila as model organisms. Complementation and functional allelism.

UNIT-II:

Plasmids – types, plasmid DNA properties. Sex plasmid F and its derivatives, drug resistance (R) plasmids. The Ti plasmid of *Agrobacterium*. Hybridization in yeast, control of mating type loci in yeast. Transposable elements – transposition. Types of bacterial transposons, duplication of target sequence at an insertion site. Deletion and inversion caused by transposons. Transposable elements in yeast and drosophila. Retroposons.

UNIT-III:

Mutations – Terminology, types of mutations, Molecular basis of mutations, isolation & analysis of mutants. Mutagenesis – base analogue mutagens, chemical mutagens, intercalating substances, mutator genes. Site directed mutagenesis, mutational hot spots, Reversion, second site revertants, frame shift mutations, carcinogens, screening of mutants. UV damage of DNA and repair.

UNIT-IV:

Bacterial genetics – Inheritance of characteristics and variability. Phenotypic changes due to environmental alterations. Genotypic changes. Bacterial recombination. Bacterial conjugation. Transduction – Generalized and specialized transductions. Bacterial transformation. Tetrad analysis in eukaryotic microbes – Neurospora and yeast.

Mapping of bacterial chromosome by interrupted mating and transduction.

Recombination in bacteriophages. Benzer's studies on r-II locus of T4 bacteriophage.

Complementation test.

RECOMMENDED BOOKS FOR MB 203:

1. Cell and Molecular Biology by E.B.P. De Robertis, Lippincott Williams & Wilkins.
2. Molecular Cell Biology by Lodish & Baltimore.
3. Molecular Biology of the Gene by Watson Roberts, Steitx Wainer, The Benjamin/Cummings Publishing Company Inc.
4. Microbial Genetics by Stanley R. Maloy, John E Cronan Jr., David Freifelder Jones and Bartleh Publishers Inc.
5. Genes – VII by Benjamin Lewen.
6. Essentials of Genetics by Russell.
7. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, A.S.M. Press.
8. Genetics by Gardener.
9. Genetics by Tamrin.
10. Genetics by Strickberger.
11. Molecular Genetics of Bacteria, 3rd Edition. 1998, J.W. Dale, Wiley Publ.
12. Modern Genetic Analysis by Griffith.
13. Bacterial and Bacteriophage genetics by E.A. Birge Springer.

MB 204: IMMUNOLOGY

UNIT-I:

History and scope of immunology cells involved in immune system – T-lymphocytes, B- lymphocytes, monocytes, macrophages, APC, Neutrophils, mast cells. Types of immunity - Adaptive immunity, innate immunity. lymphoid organs, Thymus, bone marrow, spleen, lymph nodes. Antigen-Antibody reactions - Ag-Ab binding, agglutination, blood groups, immunofluorescence, and important immunological diagnostic tests - ELISA, RIA, immuno blot, Immunodiffusion, Immunoelectrophoresis, Complement fixation test (CFT).

UNIT-II:

Nature of antigens; antibody structure, classification of antibodies, functions of IgG, IgA, IgM, IgD and IgE; primary and secondary immune response; serological analysis of antibodies – isotypes, allotypes and idiotypes. Antibody diversity, antigen receptors on B and T lymphocytes. Phagocytosis, opsonin, Opsonins and polyclonal and (monoclonal antibody production) (Hybridoma techniques) – Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment. The complement system - components of classical and alternative complement pathways, complement receptors, biological, consequences of complement activation.

UNIT-III:

Humoral and cell-mediated immunity, ontogeny of B and T lymphocytes, generation of memory B cells and affinity maturation. T and B cell interactions, cytokines, lymphocyte-mediated cytotoxicity (CTL). Antibody-dependent cell-mediated cytotoxicity. Reactions of immunity – antitoxins, neutralization of toxin with antitoxin. Immune response to infectious diseases: viral infections, bacterial infections, and protozoan diseases.

UNIT-IV:

Graft versus host reactions - Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction, Hypersensitive reactions – Auto immunity, transplantation immunity, Tumor immunology, immunological tolerance and immunosuppression. Immunodeficiency diseases - Primary immunodeficiency (genetic) diseases due to B-cell and T-cell and combined defects (hypogammaglobulinemia, thymic aplasia, SCID). Secondary immunodeficiency (acquired). Vaccines – development and production, vaccine expression system. Production of DNA vaccines. Immunotherapy of infectious diseases; Principles of immunization; vaccinoprophylaxis, vaccinotherapy, serotherapy.

RECOMMENDED BOOKS FOR MB 204:

1. Immunology and Immunopathology by Stewart.
2. Cellular and Molecular Immunology by Abul K. Abbas *et al.*
3. Textbook of Immunology by Barret.
4. Essential Immunology by Roitt, Brostoff, Male, Harcourt Brace & Company (5th Edition), Mosby (6th Edition)
5. Immunology by J.Kuby, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Freeman & Company Mosby publishers. 2009.
6. Immunobiology – The immune system in Health disease by Janeway and Travers. 1994.
7. Immunology – An introduction by Tizard.
8. Text book of Immunology by Unani and Benacerraf
9. Fundamentals of Immunology by Paul.
10. Immunology – A short course by Benjaini, Sunshine and Lesrowitz.
11. Basic and Clinical Immunology by Stites, Terr and Parslow.
12. Immunology by Herman N. Eosen.
13. Molecular Basis of Immunology by Constantin Bena.

14. Immunology – The science of self-Non-self discrimination by Jan Klein.
15. Fundamental Immunology by R.M.Coleman, M.F. Lombard and R.E. Sicard.
Wm.C.Brown Publishers.
16. Immunology by R.M. Hyde, B.I. Waverly Pvt. Ltd.
17. Viruses that affect Immune system by H.Y.Fan, I.S.Y.Chen, N. Rosenberg and
W. Sugden, American society for Microbiology

MBP 205: ENZYMOLOGY AND IMMUNOLOGY

- 1) Assay of microbial enzymes (any two) – Amylase, protease, catalase, urease
and pectinase.
- 2) Production, isolation, purification and assay of any one of the above enzymes
- 3) Enzyme Kinetics: (any one of the above enzymes):
 - a) Effect of substrate and enzyme concentration on enzyme activity;
Determination of K_M and V_{max} values.
 - b) Effect of pH, temperature and inhibitors on enzyme activity.
- 4) Enzyme and Whole cell immobilization.
- 5) Separation of Serum - Immuno electrophoresis.
- 6) Ouchterlony double diffusion.
- 7) Radial immunodiffusion.
- 8) Immunoprecipitation and precipitin curve.
- 9) ELISA.
- 10) Western blotting.
- 11) Agglutination inhibition test.
- 12) Blood grouping, Rh typing, VDRL, WIDAL
- 13) Complementation test in bacteria.

14) Bacterial conjugation

15) Raising antiserum.

RECOMMENDED BOOKS FOR MBP 205:

1. Practical Immunology by Hudson and Hay.
2. Antibodies: A Laboratory manual by Harlow and Lane.
3. Manual of Clinical Immunology by Rose and Friedman.
4. Immunochemistry in Practice by Johnstone and Thrope.
5. Handbook of Experimental Immunology, Vol I and II by Weir.
6. An Introduction to Practical Biochemistry by Plummer.
7. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd.
8. Methods in enzymology series, Academic Press.

MBP 206: MICROBIAL PHYSIOLOGY AND GENETICS

1. Estimation of proteins by Biuret method and Folin Ciocalteu method.
2. Estimation of DNA by Diphenyl amine method.
3. Estimation of RNA by Orcinol method
4. Estimation of Inorganic and organic phosphates by Fiske-SubbaRow method.
5. Estimation of Ammonical nitrogen and nitrates.
6. Strain improvement using chemical mutagens.
7. Isolation of mutants using EMS.
8. UV Survival curve of *E.coli.* or any other bacteria.
9. Study of the repair mechanism for the damage caused by UV radiation.
10. Demonstration of Ames test.

11. Protoplast preparation and regeneration.
12. Observation of mitosis in Onion root tips.
13. Observation of meiosis in Flower buds.
14. Chromosome isolation, banding and Karyotyping.

RECOMMENDED BOOKS FOR MBP 206:

1. A short course in bacterial genetics – A laboratory manual and Handbook for Eschericia coli and related Bacteria – Jeffrey H Miller, Cold spring Harbor Laboratory press
2. Introductory practical Biochemistry –S.K. Sawhney and Randhir Singh.
3. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology – K.R.Aneja, New age international Publishers.
4. Recombinant DNA Laboratory Manual by T.W. Zyskind and S.I. Bern stein, Academic press.
5. Microbiological Applications (A Laboratory manual in General Microbiology) Benson, H.J. WCB: WM C. Brown Publishers.
6. Microbiology – A Laboratory Manual, Capuccino, J.G. and Sherman, N. Addison Wesley.
7. Laboratory Manual in General Microbiology by N. Kannan, Panima Publishing Corporation.
8. Practical Microbiology – R.C. Dubey and D.K. Maheswari, S.Chand and Company Limited.
9. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K. International Pvt. Ltd.

II SEMESTER

NON-CORE PAPER: MB 207: PRINCIPLES OF MICROBIOLOGY

UNIT-I - SCOPE AND HISTORY OF MICROBIOLOGY

Scope and History of Microbiology. Microscopy and staining. Characteristics of Prokaryotic and Eukaryotic cells. Growth and culturing of bacteria. An introduction to taxonomy – General characters of Bacteria, Viruses, Algae Fungi and Protists Microbiologists and their contributions. Principles of sterilization and Disinfection.

UNIT-II - INFECTIOUS DISEASES OF HUMAN ORGAN SYSTEMS

Diseases of the skin and eyes; wounds and bites. Diseases of the skin-bacterial, viral, fungal and other skin diseases. Diseases of the eyes – bacterial, viral and parasitic eye disease. Wound and bites – wound infection, , anaerobic infections, anthropod bites and diseases. Urological and sexually transmitted diseases – urological diseases usually not transmitted sexually – bacterial and parasitic urogenital diseases. Sexually transmitted diseases – Aquired Immune Deficiency Syndrome (AIDS), bacterial and viral sexually transmitted diseases.

UNIT- III - ANTIMICROBIAL THEROPY AND BASIC PRINCIPLES OF IMMUNOLOGY

General properties of antimicrobial agents ‘Determining microbial sensitivities to antimicrobial agents. Antibacterial, antifungal, antiviral, antiprotozoan, antihelminthic agents. Host microbe relations – symbiosis Koch’s posulates. Epidemeology and Nosocomial infections. Basic principles of specific immunity and immunization. Types of immunity Characters of immune system.

UNIT-IV - MEDICAL MICROBIOLOGY

Laboratory diagnosis of common infective syndromes and parasitic manifestations. Methods of transmission and role of vectors – biology of vectors. 1) House fly, 2) Mosquitoes 3) sand fly Principles of chemotheraphy. Problems of drug resistance and drug sensitivity. Drug resistance to bacteria. Description and pathology of diseases caused by *Aspergillus*, *Penicillium*, *Epidermophyton*.. Description and pathology of diseases caused by bacteria – *Streptococcus*, *Solmonella*, *Vibrio cholera*.

III SEMESTER

MB 301: MOLECULAR BIOLOGY

UNIT-I:

Proof of DNA & RNA as genetic material; Transformation experiments, Blenders experiments, properties of genetic material. Modern concept of gene structure. Overlapping genes, split genes, constitutive genes, jumping genes, Oncogenes. Types of tumors, physical, chemical and biological Carcinogens, chromosomal changes induced by Carcinogens.

UNIT-II:

DNA replication –various modes of replication, Meselson-Stahl's studies on replication. Enzymes and Proteins involved in replication Mechanism of replication – Initiation, polymerization and termination. Topoisomerases, DNA ligases. Prokaryotic and Eucaryotic promoters. Mechanism of transcription and transcriptional activators. Posttranscriptional modifications.

UNIT-III:

The genetic code: Deciphering the genetic code; theory of triplet code, elucidation of base composition of codons. Identification of stop and start codons, universality of the code, redundancy of the code, the decoding system.

Protein synthesis: Mechanism and role of various factors involved in Initiation, elongation and termination of Protein Synthesis Inhibitors of protein synthesis. Post translational processing of proteins, protein channeling, role of RNA in protein synthesis.

Unit-4:

Regulation of gene expression at the levels of transcription and translation. Operon concept; Regulatory genes, structural genes and repressors. Negative and Positive regulation. Regulation of lac, ara and trp operons. Catabolite repression. Regulation of gene expression in lambda and nif operon. Regulation of gene expression in eucaryotes.

RECOMMENDED BOOKS FOR MB 301:

1. Molecular Biology of the Cell (1983) by B.alberts, D Bray, J.Lewis, M.Raff, K.Roberts and J.D. Watson, Garland Publishing Inc., New York.
2. Molecular Biology of the Gene (1976) 3rd Edition, by J.D. Watson, W.A. Benjamin Inc., New York.

3. Genetics: from genes to Genomes (2000) by hartwell, L., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. and Veres, R.C.1st Edition WCB –Mc Graw Hill.
4. Molecular Cell Biology (2000) by Lodith.H., Berk.A., Zipursky, S.I.Matsudira.P., Baltimore, D and Darnell, J 4th Edition, W.H. Truman & Co.
5. Lehinger: Principles of Biochemistry (2000) by Nelson D.L. and Cox, M.M., 3rd Edition, Worth Publishers.
6. Biochemistry (2002) Styer, 5th Edition, W.H. Freeman and Co.
7. Molecular Biology (1999) by Robert F.Weaver. 1st Edition. WCB –Mc Graw Hill.
8. Molecular Biotechnology Principles and Applications of Recombinant DNA (2001) by Glick and Pasternak, ASM Press.
9. Recombinant DNA Watson Gilman, Scientific American Books.
10. A Passion for DNA Genes, Genomes and Society by James D Watson, CSHL Press.
11. Cell and Molecular Biology by Cooper, ASM Press.
12. Molecular Biology by Friefelder.

MB 302: MEDICAL MICROBIOLOGY

UNIT-I:

Normal microbial flora of human body, host microbe interactions. Infection and infection process- routes of transmission of microbes in the body. Description and pathology of diseases caused by bacteria; *Streptococcus*, *Pneumococcus*, *Gonococcus*, Enterobacteriaceae, *E. coli*, *Salmonella*, *Shigella*, *Pseudomonas*, *Klebsiella*, *Proteus*, *Vibrio cholera*. *Brucella*, *Haemophilus*, *influenzae*; pathogenic anaerobes, Tetanus, Clostridia, Conynebacteria, Mycobacteria, Spirochaetes.

UNIT-II:

Description and pathology of diseases caused by Aspergillus, Penicillium, Mucomycosis, Blastomycosis, Microsporosis, Rhinosporidium, Epidermophyscosis. Description and pathology of diseases caused by hemoflagellates; *Leishmania donavani*, *L.tropica*, *Trypanosoma gambiense*; intestinal flagellates; Trichomonas, Giardia, *Entamoeba histolytica*, malarial parasites, Helminthes; *Ascaris lumbricoides*, Hook worm, pinworm, Filarial parasites.

UNIT-III:

Laboratory diagnosis of Common infective syndromes and parasitic manifestations; Methods of transmission and role of vectors- biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly. Need and significance of epidemiological studies. Epidemiological investigations to identify a disease, Principles of chemotherapy, Mode of antibiotics. - Penicillin, streptomycin, sulfonamides and Polymyxins. Antifungal drugs (Nystatin), Antiviral agents. (Robovirin) Problems of drug resistance and drug sensitivity. Drug resistance in bacteria.

UNIT-IV:

Viral diseases: Description, pathology and lab diagnosis of diseases caused by pox viruses; herpes virus (chicken pox- zoster); orthomyxo and paramyxo viruses; adenovirus, other respiratory viruses, (Influenza, Rhyno) viruses affecting nervous system (ex: Polio virus, Rabies virus), enterovirus, reovirus, viral hepatitis, HIV. Interferon – Nomenclature, types & classification, Induction of interferon, types of inducers.

RECOMMENDED BOOKS FOR MB 302:

1. Medical Microbiology by MIMS, Play Fair, Roitt & Mosby Publishers, 2nd edition.
2. Parasitology by Elmer R.Noble & Lea & Fibiger Publishers, 5th edition.
3. Medical Virology by D.O. White & F.J. Fenner, Academic press, 4th Edition, 1994.
4. Medical Microbiology by Melnick.
5. Textbook of Microbiology by Ananthanarayan, C.K.J.Panikar, Oreint Longman Ltd., 2000, 6th Edition.
6. Mackie & Mc. Caurety: Practical Medical Microbiology (14th Edition), edited by J.G.Gollee, Published by: Churchill Livingstone.
7. Textbook of Medical Parasitology by Subish.C.Panija, published by 'All India Publishers and distributors'.
8. Textbook of Medical Parasitology by C.K.Jaya Ram Paniker, Published by 'Jaypee Brothers', 4th Edition.
9. Textbook of Diagnostic Microbiology by Coloratlas (5th Edition), edited by Eimer.W. Koneman, published by Lippinett.
10. Diagnostic Microbiology by Bailey and Swotts, 10th Edition, published by Mosby.
11. Medical Microbiology by David Greenwood, Richard C.B.Slack, John.F.Peutherer, 16th Edition.
12. Medical Microbiology – A Clinical perspective by J.B.Sharma, paras publishing.
13. Medical Microbiology by Patrick R.Murray, Ken.S.Rosenthal, George.S.Kobayashi, Michael A.Ptaller, 3rd Edition.
14. Medical Microbiology by Jawetz.

MB 303: BIostatISTICS & BIOINFORMATICS

UNIT-I:

Biostatistics: Measures of Central tendency and distribution – mean, median, mode, range, standard deviation, variance. Basic principles of probability theory, Bayes theorem, Normal distribution, statistical inference – Types of errors and levels of significance. Comparison of variance (F-test), small sample test, t-test for comparison of means chi square test. Analysis of variance – one way and two way, multiple comparisons. Correlation and Linear regression. Introduction to hidden Markov models.

UNIT-II:

Sequence Analysis: Introduction to biological databases: NCBI, EMBL, EXPASY, PIR, Pfam. Concept of World Wide Web: HTML, HTTP. Similarity measures - Euclidean, Mahalanobis distance, Edit distance, similarity matrices (PAM, BLOSUM) Searching sequence databases using BLAST. Pairwise sequence alignment using dynamic programming (Needleman – Wunsch & Smith – Waterman algorithms.) Multiple sequence alignment – progressive alignment – profiles – multidimensional dynamic programming.

UNIT-III:

Genomics and proteomics: Molecular phylogenetics: Construction of of phylogenetic trees using parsimony method and branch & bound method. Clustering methods – UPGMA & neighbor- joining, Analysis of gene expression data by clustering.

Gene prediction – Statistical approaches – Similarity based approaches gene annotation. Fragment assembly, peptide sequencing using mass and spectroscopy data. Comparative genomics.

UNIT-IV

Modeling: Protein secondary structure prediction – Chou Fasman rules – neural networks – discriminant analysis. Prediction of transmembrane segments in membrane

proteins. Protein 3D structure prediction – homology – threading – potential energy functions – energy minimization – molecular dynamics – simulated annealing.

RECOMMENDED BOOKS FOR MB 303:

1. Biostatistics by Daniel. 2006 Eighth Edition. John Wiley and sons.
2. Biological sequence analysis by Durbin, Eddy, Krogh, Mithison
3. Introduction of Bioinformatics, 2001 by T.A. Attwood and D.J. parry – smith.
4. Bioinformatics: A practical guide to the analysis of genes and proteins, 1998. A.D.Baxevaris (Edited) B.F.Publication.
5. Bio-informatics by D.Mount.

MB 304: MOLECULAR BIOTECHNOLOGY

UNIT-I:

r-DNA technology- Isolation of nucleic acids, DNA sequencing, maxam-Gilbert and Di-deoxy methods. Restriction endonucleases, restriction maps, Southern, Northern blotting and western blotting. DNA finger printing, PCR- principle, types, application.

UNIT-II:

Cloning vectors- Plasmids, Cosmids and bacteriophages. Ligases- DNA ligases, ligation of fragments with cohesive ends & blunt ends; homopolymer tailing, Cloning strategies – shot gun experiments, gene libraries. Isolation of poly mRNA, synthesis of c-DNA, cloning of c-DNA in bacteria. Isolation of cloned genes, identification of recombinants, structural and functional analysis of recombinants.

UNIT-III

Gene expression- expression of cloned genes in bacteria, yeast, plant and animal cells. Application of recombinant DNA technology in biology, plant, medicine,

genetic diseases, gene therapy. Genetically engineered microorganisms and intellectual property rights.

UNIT-IV

Nucleic acid probe technology, DNA micro array – printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expression using fluorescent-labelled c-DNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips. Protein micro array, advantages and disadvantages of DNA and protein micro arrays.

RECOMMENDED BOOKS FOR MB 304:

1. Molecular Biotechnology by Glick & Palturah, 2003, 3rd Edition.
2. Modern Biotechnology by Primrose.
3. Molecular Cell Biology by Lodish et al.
4. Advanced Molecular Biology: A concise reference by R.Twyman.
5. Principles of Gene Manipulation: An introduction to genetic engineering by Old & Primrose.
6. Recombinant DNA by J.D. Watson et al.
7. Molecular Biology & Biotechnology by J.M. Walker.
8. Recombinant DNA & Biotechnology by H. Krenzer.
9. DNA micro arrays by M.Schena.
10. Molecular Biology by David & Freifelder.
11. Molecular Biology of Gene by Watson.
12. Immobilized cells: Principles and Applications by Tampion & Tampion.

MBP 305: MOLECULAR BIOLOGY & MOLECULAR BIOTECHNOLOGY.

1. Isolation of genomic DNA (from bacteria/fungi/plants)
2. Isolation of plasmid DNA.
3. Isolation of RNA.
4. Restriction Enzyme digestion – ligation of lambda DNA.

5. Transformation and Induction of β -galactosidase in *E.coli*
6. Bacteriophage titration – Plaque forming Units (PFU)
7. Polymerase Chain Reaction (PCR).
8. Recovery of DNA from gels – Electro elution and extraction of DNA from low melting gels.
9. Southern blotting.

RECOMMENDED BOOKS FOR MB 305:

1. Molecular Cloning – A Laboratory Manual, 3rd Edition, Volumes I to III by Sambrook and Russell, CSHL Press.
2. Current Protocols in molecular biology, 2000 by Ausbel et al.
3. Genome analysis, 2000, 4 volumes, ESHL Press.

MBP 306: MEDICAL MICROBIOLOGY AND BIOINFORMATICS

1. Preparation of different media used in diagnostics Microbiology.
2. Laboratory examination of sputum: collection of sputum. Microbiological examination of sputum for pus cells and predominant bacteria. Ziehl-Neelson staining to detect AFB culturing the specimen.
3. Collection of throat swabs – culturing the specimen.
4. Laboratory examination of pus and skin specimens for *staphylococcus aureus*, *streptococcus pyogenes* and *Pseudomonas aeruginosa*.
5. Examination of urine for pathogenic microorganisms –collection of urine, microscopic examination of urine, comparison of normal specimen with urinary tract infection sample. The Enterobacteriaceae – *Escherichia coli*, *Klebsiella pneumonia* and *proteus mirabilis*. Urine cultures, single colonies, seeding in peptone water and Christensen's urea medium. Examination of blood agar, nutrient agar and Mac conkey plate cultures.
6. Mycology – Laboratory diagnosis of fungal diseases. Direct microscopy – cultures using Sabouraud's Dextrose agar medium – Fungi pathogenic for humans – Filamentous fungi, yeasts, yeast like fungi and dimorphic fungi. *Aspergillus niger*, *Nocardia*, *candida albicans*.

7. Medical Parasitology – E. histolytica, G. lamblia, Trypanosomas, Leishmania and Plasmodium (Permanent Slide Observation)
8. Laboratory diagnosis of common helminthes infections (permanent slide observations of helminthes)
9. Serological Tests: Hemoglobin estimation, RBC Count, WBC Count, Bleeding time, Clotting tie, Erythrocyte Sedimentation Rate (ESR), Packed Cell Volume (PCV)

RECOMMENDED BOOKS FOR MB 306:

1. Practical Medical Microbiology by Mackie.
2. Practical Medical Microbiology Vol-II by Cruichshank et al.
3. Microbiology: A laboratory manual, 4th Edition, by J.G. Cappuccinno and H. Sherman.
4. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 3rd Edition, by K.R. Aneja.
5. Laboratory Manual in Microbiology by Alcamo.

III- SEMESTER

NON-CORE PAPER: MB 307: APPLIED MICROBIOLOGY

UNIT-I - MOLECULAR BIOLOGY

Molecular nature of Microbial genes – Genetic elements in prokaryotes – genetic elements in viruses, phenotypic changes in bacteria, transcription, translation, replication of prokaryotes, replication of viruses and bacteriophages : gene transfer in prokaryotes. Operon concept. Regulation of gene expression in prokaryotes and Eukaryotes.

UNIT- II - FERMENTATION TECHNOLOGY

An introduction to fermentation processes – the range of fermentation processes – Types of fermentors, Microbial growth kinetics, batch culture, continuous culture, fed batch culture and dual or multiple fermentations. Production of ethyl alcohol. Microbial leaching – role of microorganisms in the recovery of minerals (uranium, copper) from ores.

UNIT – III - ENVIRONMENTAL MICROBIOLOGY

Basic concepts of Ecology and Environment. Ecosystem concepts, components, food chains, food webs and trophic levels. **Aquatic environment**, Freshwater microorganisms, their zonation and characters. Marine microorganisms and their zonation and characteristics. **Atmospheric Environment**. Dispersal of airborne microorganisms. Diurnal periodicity patterns. Bioremediation - Biofouling.

UNIT – IV - FOOD AND AGRICULTURAL MICROBIOLOGY

Microbiology of foods – Microbial flora of fresh foods, grains, fruits, vegetables, milk, meat, eggs and fish and their infestation by bacteria, fungi and viruses. Methods of food preservation. Microorganisms as food – single cell protein, yeast, algae and fungal biomass production. Biofertilizers – Algal biofertilizers, Bacterial biofertilizers, mycorrhizae - Biopesticides.

IV SEMESTER

MB 401: FERMENTATION TECHNOLOGY & INDUSTRIAL MICROBIOLOGY

UNIT-I:

An introduction to fermentation processes – the range of fermentation processes.

Microorganisms used in industrial microbiological processes – the isolation, preservation and strain improvement of industrially important microorganisms, screening methods, isolation of autotrophic mutants. Media and materials required for industrial microbiological processes – Antifoams.

UNIT-II:

Microbial growth kinetics, batch culture, continuous culture, fed batch culture and Dual or multiple fermentations. Inoculum development for large-scale processes. Design of fermentor: Construction and maintenance of aseptic conditions. Control of various parameters. Sterilization of media. Types of fermentors. Computer application

in fermentation technology. Recovery and purification of fermentation products.
Fermentation Economics.

UNIT-III:

Production of ethyl alcohol, beer & wine. Enzyme probe biosensors, biochips, biofilms, biosurfactants, Biotransformation, Petroleum Microbiology. Microbial leaching- role of microorganisms in the recovery of minerals (uranium, copper) from ores.

UNIT-IV:

Microbial products from genetically modified (cloned) organisms ex: insulin.
Microbial groups involved in biogas production, design of digester.
Patenting: Concept and its composition & protection of right and their limitation, intellectual property rights (IPR); patenting biotechnology inventions.

RECOMMENDED BOOKS FOR MB 401:

1. Solid State fermentation in Biotechnology by Pandey.
2. Industrial Microbiology by Waiter.
3. Fermentation Microbiology and Biotechnology by Mansi.
4. Industrial Microbiology by Patel.
5. Biotechnology: A text book of Industrial Microbiology by Greger
6. Principles of Fermentation technology by Whitaker.
7. Industrial Microbiology by Prescott & Dunn.
8. Microbial Technology by J.H. Pepler & D. Perlman.
9. Industrial Microbiology by L.E.Casida.
10. Industrial Microbiology by B.M. Miller & W.Litsky.
11. Economic Microbiology by Rose, Vol-I to V.
12. Advances in Applied Microbiology by Ed.Pperlman, Series of volumes.

MB 402: ENVIRONMENTAL MICROBIOLOGY

UNIT-I:

Basic concepts of Ecology and Environment – Biological spectrum at levels of organization & realm of ecology. Ecosystem – Concept, components, food chains, food webs and trophic levels. Energy transfer efficiencies between trophic levels. Biological factors influencing the growth and survival of microorganisms- interactions of microbial population and community dynamics – Growth in closed environments and in open environments. The kinetic properties of competition between microbial populations. Kinetic principles of prey-predator relationship.

UNIT-II:

Aquatic environment: Fresh water microorganisms, their zonation and characteristics. Salt water, oceans, estuaries, microorganism their zonation and characteristics. Faecal pollution of waters – water borne diseases, indicator organisms. IMVIC test, sanitary examination of water.

Atmospheric Environment: Dispersal of airborne microorganisms. Air Sampling principles and techniques. Air spora: Concepts and components, indoor and outdoor air spora. Diurnal periodicity patterns. Seasonal periodicity patterns. Vertical profiles.

UNIT-III:

Microorganisms and pollution: Microbial production of methyl mercury, trimethyl arsine, hydrogen sulphide, acid rain water, carbon monoxide, ammonia, nitrate, nitrogen oxides, nitrosamines, Eutrophication, algal toxins.

Microorganisms and sewage treatment: COD, BOD & DO, trickling filters, activated sludge process, oxidation ponds; sludge treatment (anaerobic digestion).

UNIT-IV:

Bioremediation Technology – Microbial degradation of oil spills, pesticides and detergents, Biofouling; Fate of genetically engineered microorganisms in the environment. Environmental impact assessment studies.

Deterioration of materials – paper, textiles, painted surfaces, prevention of microbial deterioration.

RECOMMENDED BOOKS FOR MB 402:

1. Extremophiles by B.N.Johri, 2000, Springer Verlag, New York.

2. Microbial Diversity by D.Cdwd, 1999, Academic press.
3. Manual at Environmental Microbiology, 2nd edition, by C.J. Hurst, Editor in Chief, 2002, ASM Press.
4. Microbial Ecology: Fundamentals and Applications, 1998, Atlas, RM & Barta, R.
5. Aerobiology, 1997, by Tilak.
6. Environmental Microbiology by Ralph Mitechell.
7. Bioremediation principles by Eweis.
8. Techniques in Microbial Ecology by Buruage.
9. Environmental Microbiology, 1981, by W.P. Grant and P.E. Long.

MB 403: FOOD MICROBIOLOGY & AGRICULTURAL MICROBIOLOGY

UNIT-I:

Microbiology of foods – Microbial flora of fresh foods, grains, fruits, vegetables, milk, meat, eggs and fish and their infestation by bacteria, fungi and viruses. Microbiological examination of foods- microscopic techniques and cultural techniques. Direct microscopic examination, total colony counts and differential enumeration. Identification of specific groups – Bacteria, Viruses, Fungi and Protozoa. Microbial spoilage of milk, food, types of spoilage organisms, food poisoning, mycotoxins and bacterial toxins.

UNIT-II:

Food processing & preservation: Methods of food preservation, Aseptic handling, pasteurization of milk, refrigeration and freezing, dehydration, osmotic pressure, chemicals – organic acids, nitrates, nitrites and cresols; Radiation – UV light, Y-irradiation.

Fermented foods – preparation of Yogurt, streptococcus species, Lactobacillus bulgaricus; Manufacture of cheese; Pencillium roqueforti. Fermented soybean products.

Microorganisms as food – single cell protein, yeast, algae and fungal biomass production.

UNIT-III:

Soil Environment- Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins)

Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulphur, iron and phosphorus cycles. Rhizosphere – Rhizosphere Microorganisms, Biochelators (Siderophores).

UNIT-IV:

Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- Rhizobium, Azatobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae, Mycorrhiza, Biopesticides – toxins from Bacillus thuringiensis, Pseudomonas syringae, Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

RECOMMENDED BOOKS FOR MB 403:

1. Food Microbiology: Fundamentals & Frontiers, 2nd edition, by M.P. Dayle et al, ASM press, 2001.
2. Food Microbiology by Adams, M.R. and Moss M.O. (1995), Royal Society of Chemistry Publication, Cambridge.
3. Food Microbiology by Frazier W.C. and West haff D.C. (1988), Tata Mc.Graw Hill Publishing Company Limited, New Delhi.
4. Principles of Fermentation Technology by Stantury, P.F., Whitekar, A. and Hall, S.J. (1995).
5. Basic Food Microbiology by Banwart, GJ (1989), CBS Publishers and Distributors, Delhi
6. Food Poisoning and Food Hygiene by Hobbs BC and Roberts.D, (1993), Edward Arnold (A division at Hodder and Strong hton) London.
7. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
8. Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. Subba Rao.
9. Soil Microbiology and Plant Growth, 1995, by N.S. Subba Rao.

MB 404: PHARMACEUTICAL MICROBIOLOGY

UNIT-I:

Chemical disinfectants, antiseptics and preservatives. Types of Antibiotics-B-lactam antibiotics, tetracycline group Rifamycin, aminoglycoside antibiotics, macrolides, polypeptide antibiotics, glycopeptide antibiotics, miscellaneous antibacterial antibiotics and antifungal antibiotics. Production of antibiotics – Penicillin, Streptomycin, Erythromycin, bacitracin and tetracycline.

UNIT-II:

Mechanism of action of antibiotics – the bacterial cell wall, protein synthesis, chromosome function & replication, folate antagonis, the cytoplasmic membrane. Bacterial resistance to antibiotics - Intrinsic & acquired resistance, biochemical mechanism of resistance. Assay of antibiotics – Penicillin, Streptomycin.

UNIT-III:

Industrial Production of Enzymes – amylases, Proteases, organic acids- lactic acid, citric acid, vinegar, aminoacids – L-lysine, L-glutamic acid; Food supplements and hormones. Production of Vitamin B₁₂; Microbial transformation of steroids and nonsteroids. Analytical Microbiology – microbiological assays of Vitamins (Riboflavin, B₁₂), amino acids (lysine, tryptophan).

UNIT-IV:

Ecology of Microorganisms as it effects the pharmaceutical industry; Microbial spoilage & preservation of medicines using antimicrobial agents; quality assurance and the control of microbial risk in medicines. Contamination of non-sterile pharmaceuticals in hospital & community environments.

RECOMMENDED BOOKS FOR MB 404:

1. Pharmaceutical Microbiology edited by W.B. Hugo & A.D. Russell, 6th Edition, Black well science.
2. Microbiology in clinical practice by Shanson D.C., 2nd edition, London; Wright.
3. Topics in Antibiotic chemistry Vol I to V Sammes Ellis Horwood.
4. Biotechnology – A textbook of Industrial Microbiology – Wulf Crueger, 2nd Edition.
5. Industrial Microbiology – A.H. Patel, Macmilan India Limited, 1984.
6. Molecular mechanisms of drug action by Coulson C.J., London; Taylor and Francis.
7. Guide to microbiological control in Pharmaceuticals by Denyes S.P. & Baird R.M. Chichester, Ellis Horwood.

MBP 405: INDUSTRIAL MICROBIOLOGY & ENVIRONMENTAL MICROBIOLOGY

1. Production of citric acid by *A.niger*. Recovery & Fermentation.
2. Estimation of Ethanol by dichromate method.
3. Production of Ethanol by fermentation and recovery.
4. Preparation of Wine from grapes by fermentation.
5. Production of glutamic acid by fermentation.
6. Estimation of bacteria, actinomycetes and fungi in soil by dilution – Plating method.
7. Observation of air-borne microflora by petriplate exposure.
8. Effect of pesticides on pure cultures of bacteria.
9. DO Estimation.
10. BOD Estimation.
11. COD Estimation

RECOMMENDED BOOKS FOR MB 405:

1. Handbook of milk Microbiology by Srivastava.
2. Manual of Industrial Microbiology and Biotechnology by Demain.
3. Experiments in Microbiology, Plant Pathology, Tissue Culture & Mushroom production technology by Aneja.
4. Fermentation: A practical Approach by Mc. Niel & L.H. Harvey.
5. Manual of Environmental Microbiology, 2nd Edition by C.J. Hurst.
6. Experimental Microbial Ecology by Burns & Slater.
7. Environmental Microbiology: A Laboratory manual by Pepler, Gerba & Brendecks.

MBP 406: FOOD, AGRICULTURAL & PHARMACEUTICAL MICROBIOLOGY

1. Microbiological examination of milk & milk products.
2. Preparation of Yoghurt
3. Microbiological examination of fresh & canned foods.
4. Microbiological quality testing of milk (MBRT test)
5. Isolation of yeasts from grapes.
6. Culturing of Mushrooms.
7. Isolation of Rhizobium from root nodules.
8. Isolation of Azotobacter from soil.
9. Microbiological Assay of antibiotics.
10. Microbiological Assay of Vitamin B₁₂.

RECOMMENDED BOOKS FOR MB 406:

1. Handbook of Milk Microbiology by Srivastava.
2. Laboratory methods in Food Microbiology by W.F. Harrigan.
3. Manual of Environmental Microbiology, 2nd Edition by C.J. Hurst.
4. Experiments in Microbiology, Plant Pathology, Tissue Culture & Mushroom production technology by Aneja.
