M.SC. MICROBIOLOGY- SEMESTER SYSTEM

ANDHRA UNIVERSITY **(EFFECTIVE FROM THE ACADEMIC YEAR 2015 -16) 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 &	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 &	4	3	100	4
MB 202	Enzymology & Cell Biology	4	3	100	4
MB 203	Molecular & Microbial	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 *	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-	4	3	100	4
MB 304	Molecular Biotechnology	4	3	100	4
Practical					
MBP 305	Molecular Biology & Molecular	12	6	100	4
MBP 306	Medical Microbiology & Bio-informatics.	12	6	100	4
MB 307	Applied Microbiology *	4	3	100	4
Total Marks and Credits for III Semester				**700**	**28**
IV Semester					
MB 401	Fermentation Technology & Industrial	4	3	100	4

MB 402	Environmental Microbiology	4	3	100	4
MB 403	Food Microbiology & Agriculture	4	3	100	4
MB 404	Pharmaceutical Microbiology	4	3	100	4
Practical					
MBP 405	Industrial Microbiology & Environmental	12	6	100	4
MBP 406	Food, Agriculture & Pharmaceutical	12	6	100	4
			Total Marks and Credits for IV	**600**	**24**
			Project Work/Dissertation	**100**	**4**
			Grand Total Marks and Credits for 4	**2700**	**108**

- Out of 100 Theory and 100 Practical Marks for each paper, 20 marks for internal assessment and 80 marks for semester-end examinations.
- Out of 80 Marks of each practical examination, 15 marks should be allotted for viva-voce and 10 marks for Record.

* Choice based credit system – for the students of other Departments.

I SEMESTER
MB 101: GENERAL MICROBIOLOGY

UNIT – I:

History, discovery, evolution, development and recent trends in Microbiology. Contributions of Van Leeuwenhock, Joseph Lister, Pasteur, Koch, Jenner, Winogradsky and Beijerinck.Nobel laureates in Microbiology.

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 phycobolisomes.
Concepts, nomenclature and taxonomic ranks.general properties of bacterial groups. Major characteristics used in Taxonomy-morphological, nutritional(cultural), chemical, biochemical, physiological, metabolic, ecological, immunological, pathogenic properties. Numerical taxonomy, genetic and molecular classification systems; phylogenetic trees.
Identification, characterization and classification of microorganisms- Principles of bacterial taxonomy and classification: - Bergey's manual and its importance, concept of kingdom - Haeckel's three kingdom concept-Whittaker's five kingdom concept-three domain concept of Carl Woese.

UNIT- II:
Methods of sterilization: Physical methods – Dry heat, moist heat, radiation methods,filtration methods, Chemical methods and their application.
Microbial cultures: Concept of pure culture, Methods of pure culture isolation,Enrichment culturing techniques, single cell isolation, and pure culture development.
Chemical structure of peptidoglycon, protoplasts, spheroplasts, microsomes and ribosomal RNAs, Nuclear material/nucleus.
Microscopic identification, characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods.
Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic and prototrophic 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 (cryo) preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method

UNIT –III
Types of cultures- stock, batch, continuous and synchronous cultures. Growth measurement methods –Direct methods: viable plate counts, membrane filtration, microscopic counts, electronic counters, most probable number; Indirect methods: metabolic activity (measurements of NAD, ATP, DNA, and Protein, CO_2 liberated O_2 consumed, extra cellular enzymes), dry weight, turbidity. 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, Cyanobacteria, Archaebacteria

UNIT- IV
Eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi. Classification, structure, composition, reproduction and other characteristics of fungal divisions-Zygomycota, Ascomycota, Basidomycota, Deuteromycota and slime & water molds
Structure, reproduction and other characteristics of algal divisions, Distribution of algae.Classification of algae by Fritsch.Characteristics of - dinoflagellates, thallus organization, products of algae and their economic importance. Algal SCP, emphasis on *Spirulina.*

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

RECOMMENDED BOOKS FOR MB 101:

1. **Microbiology,** 8th Edition International Student Version Jacquelyn G. Black (Marymount University) April 2012, ©2011, Wiley publication.
2. **Understanding Microbes: An Introduction to a Small World**. Jeremy W. Dale December 2012, Wiley-Blackwell
3. **Brock Biology of Microorganisms :Global Edition, 13th Edition, Michael Madigan, John Martinko, David Stahl, David Clark Apr 2011, Paperback, 1152 pages**
4. **William Barry Whitman**, 2004, Bergey's Manual of Systematic Bacteriology (2nd edition) volumes I to VI, American Society of Microbiology. George M. Garrity, Julia A Bell, Timothy G.Lilburn.
5. **GERHARDT**, Methods for General and Molecular Bacteriology (2nd edition).
6. **PELCZAR, CHAN & KRIEG,** Microbiology (5th edition) M.C.Graw Hills.
7. **MADIGAN, MARTINKO &PARKER,** Brock Biology of Microorganism (9th edition) by Introduction to Microbiology by ROSS, Wasley Eductional publisher,1986
8. **VOLK & WHEELER,** Basic Microbiology, Edition 3,Publisher Lippincott
9. **SALLE**, Fundamental Principles of Bacteriology, Mc Grawhills.
10. **Stainier, Deudroff and Adelberg,** General Microbiology
11. **Fritsch, F.E,** Structure and Reproduction of Algae, Vol. I & II, Cambridge University Press.
12. **Morris, I, Hutchon,** Introduction to Algae, Pub 1967.
13. **Zizac,** Products and Properties of Algae.
14. **Smith, GM.**, Fresh water algae of the United States.
15. **Alexopolus, C.J,** Introductory Mycology,Wiley scientific.
16. **Ingold, CT,** Dispersal in Fungi, Oxford university press
17. **R.M.Atlas,** Principles of Microbiology, Wm.C Brown Publications.
18. **K.Talaro and A.Talaro,** Foundations in Microbiology, Wm.C.Brown Publications, 2nd edition.
19. **D.E. Alcamo, Jones and Bartiett, Boston,** Fundementals of Microbiology.
20. **J.G.Black,** Microbiology – Principles & Applications, John Wiley & Sons, New york.
21. **G.J.Tortora, B.R.Funke and C.L. Case,** Microbiology Addison Wesley Longman Inc., 7th edition Pub. Daryl Fox
22. **M.A. Sleigh,** The Biology of the Protozoa, American Elsevier, Newyork.

MB 102: VIROLOGY

UNIT–I:

History and Discovery of Viruses, Nature, origin and evolution of viruses, New emergingand re-emerging viruses, viruses in human welfare.
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-II:

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 – 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-arthopods, virus and vector relationship.Multiple host infections – viral zoonosis.
Diagnosis of viral diseases – clinical symptoms, immuno diagnosis, molecular methods used in viral diagnosis, prevention and control of viral diseases, sanitation, vector control, vaccines and immunization control – chemoprophylaxis, chemotherapy – anti viral drugs,interferon therapy, efficacy of infection control.

REFERENCE BOOKS FOR MB 102:

1. **John B Carter.2013** Virology: Principles and Applications Reviews , John Wiley & Sons, Limited, 2013 - 400 page
2. **Nicholas H. Acheson**, 2011. Fundamentals of Molecular Virology, 2nd Edition, McGill Univ., Canada.
3. **John Carter, Venetia A. Saunders,** 2007,Virology: Principles and Applications.., John Wiley and Sons.
4. **Frankel-Conrat**, 1994, Virology: 3rd Edition. Prentice-Hall
5. Principles of Virology: 2004 Second Edition, ASM press
6. **S.J.Flint et al.,** 2001, Introduction to Modern Virology:.5th edition. Dimmock et al., Blackwell Sci.Publ.

7. **A.Cann**, 2001, Principles of Molecular Virology, 3rd edition Academic Press
8. **Waginer and Hewelett,** 2004, Basic Virology, Black Well Science Publ
9. **D.O.White and F.J.Fenner,** 1994, Medical Virology, 4th edition. Academic Press.
10. **R.Hull,** 2001, Plant Virology, 4th edition by Academic Pres.
11. **D.M.Knipe and P.M.Howley,** 2001, Fundemental Virology, 4th edition, Lippiacott Williams and Wilkins.
12. **Murphy et al.,** 1999, Veterinary Virology. 3rd edition, Academic press.
13. **R.G.Webster and Allan Granoff,** 1994, Encyclopedia of Virology. Vol I, II, III,
14. **M.V.Nayudu,** 2006, Plant viruses. Prentice Hall Publication.

MB 103: BIOMOLECULES

UNIT – I:

Major Biomolecules: Carbohydrates – Classification, chemistry, properties, and function– mono, di, oligo and polysaccharides. Conjugated polysaccharides– glycoproteins, mureins 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 andsidechains.Peptidestructure.Ramachandran'splot.Methods for isolation and characterizationof 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, Carotenoides.

UNIT-IV:

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

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. **VOET & VOET,** Biochemistry (2nd edition) John Wiley and sons.
2. **CONN, STUMPF, BRUENING & DOI,** Outlines of Biochemistry (5th edition) John Wiley and Sons.
3. **STRYER,** Biochemistry (3rd edition), Free man and company.
4. **ZUBAY,** Biochemistry, Brown Publishers

5. **LEHNINGER, NELSON & COX,** Principles of Biochemistry, 4th edithion , lSara Tenney pulishers
6. **MARTIN, MAYER & RODWELL**, Harper's Review of Biochemistry, Large medical publication
7. **SMITH, HILL, LEHMAN, LEFKOWITZ, HANDLER & WHITE,** Principles of Biochemistry: General aspects, 6th edition , Tata McGraw Hill Publishers.
8. **Davidson,** Biochemistry of Nucleic acids, Wiley scientific publishers
9. **D.R.Caldwell,** Microbial Physiology and Metabolism, Wm.C.Brown Publications.
10. **P.L.P. Adams, J.T. Knowler and D.P. Leader,** Biochemistry of Nucleic acids, Chapman&Hall, London.
11. **E.S.West. W.R. Tood, H.S.Mason and J.T.V. Bruggen,** Text Book of Biochemistry, 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 – contrastmicroscopy (phase annulus, phase plate, specimen preparations), fluorescent microscopy (filters,dark field condensor, complex optical system, sample preparations) and electron microscopy(Magnetic lenses, electron beams, condensors, types of electron microscopy – scanning andtransmission, sample preparations - fixing of specimens, preparation of blocks, microtomyandstaining, 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, GCMS 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 ofmacromolecules – osmotic pressure, flow birefringence, optical rotatory dispersion.Lightscattering, diffusion, sedimentation and X-ray diffraction.

UNIT-IV:

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

RECOMMENDED BOOKS FOR MB 104:

1. **CHATWAL & ANANAD,** Instrumental Methods of Chemical Analysis, 5th edition revised Himalaya Publishers.
2. **WILSON & WALKER,** Practical Biochemistry: Principles and techniques, Academic publishers

3. **David M Freifelder,** Physical Biochemistry: Application to Biochemistry and Molecular biology (2nd edition) by. Publisher: W. H. Freeman; 2nd Revised edition (6 January 1983)
4. **SADASIVAM & MANICKAM,** Biochemical methods (2nd edition), New age inte.(p)Ltd.
5. **UPADHYAY, UPADHYAY &NATH,** Biophysical Chemistry: Principles and techniques, Himalaya Publishers
6. **OSER,** HAWK'S Physiological Chemistry, Mc Graw Hill Book company.
7. **R.F.Boyer,** Modern Experimental Biochemistry, Benjamin Cummings Publ. Company
8. **Umbtict, Burris and Staffer,** Manometric and Biochemical Techniques, Burgross.
9. **B.D. Williams and K. Wilson,** A Biologist's Guide to Principles and Techniques of Practical Biochemistry.

MBP 105: MICROBIOLIGAL METHODS & VIROLOGY

1. Isolation methods – Enrichment culturing, Pour plate, Spread plate, Streak plate and Dilution methods.
2. Staining methods – Gram's stain, Capsule staining, Cell wall staining. Indian Ink Methodor 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. Calibration of Microscope, Measurement of size of spores and cells
4. Detection of motility by hanging drop method
5. 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 Esculin bile medium.
6. Enumeration of bacteria – Quantitative estimation of microorganisms – total and viable counts.
7. Growth curves, Bacterial growth measurement, viable count by spread plate method. Measurement by dry weight and turbidometric methods
8. Culturing of anaerobic microorganisms-Pyrogallol tube method, anaerobic jar,thioglycollate media.
9. Metabolic (Biochemical) tests – Catalase and Oxidase tests. Indole reaction. Methyl redand Voges-Proskauer reactions, citrate utilization, starch and gelatin hydrolysis; H_2S production.
10. Isolation & Identification of known & unknown bacteria.
11. Isolation of phage from soil/sewage. Cultivation and preservation of phages, Quantitation of phages by plaque assay.
12. Growth phases of phage and burst size
13. Cultivation of animal viruses by different routes in embryonated chicken/duck eggsYolksac, Allantoic and Chorioallantoic membrane (CAM) routes.
14. Animal cell culture-Sheep kidney cell culture, chicken embryo fibroblast cell culture
15. Mechanical inoculation of plant viruses – Tobacco mosaic virus or cucumber mosaic virus and graft transmission of plant viruses.
16. Isolation and culturing of fungi (yeasts and molds) and algae.
17. Observation of specimen and permanent slides.
    - Fungi: *Aspergillus niger*
    - Yeast: *Saccharomyces cerevisiae*
    - Helminth: *Taenia solium, Enterobius vermicularis*

- Protozoa: *Plasmodium falciparium, Giardia lamblia*

RECOMMENDED BOOKS FOR MBP 105:

1. **CAPPUCCINO & SHERMAN,** Microbiology: A laboratory manual, Benjamin cummings Science publishing, 5th edition.
2. **Gopal Reddy, M.N.Reddy, D.V.R. SaiGopal and K.V.Mallaiah,** Laboratory Experiments in Microbiology, Himalaya Publishing House.
3. **Reddy S.M. & Reddy S.R.,** Microbiology -Practical Manual, Books Selection Centre,Hyderabad.
4. **S.K. Alexander,D.Strete and M.J. Mily,** Laboratory Exercises in Organismal and Molecular Microbiology, Mc. Graw Hill, USA.
5. **J.G. Cappunico and N.Sherman,** Microbiology – A Laboratory Manual, 4th Edition,AddisonWelsley Longman Inc., England.
6. **V.Kale and K.Bhusari,** Practical Microbiology – Principles and Techniques, Himalaya Publishing House, New Delhi.
7. **P.Gunashekaran,** Laboratory Manual in Microbiology, New Age International PrivateLimited Publishers, New Delhi.
8. **N. Kannan, Panima,** Laboratory Manual in General Microbiology, Publishing Cooperation, New Delhi.
9. **R.C. Dubey and D.K. Maheswari,** Practical Microbiology, S.Chand & Company Limited, New Delhi.
10. **J.G.Holt, N.R.Krieg, P.H.A. Sneath,J.T. Staley and S.T. Williams,** Bergy's Manual of Determinative Bacteriology, Lippincott Williams & Wilkins, Philadelphia.
11. **Barnett,** Microbiology Laboratory Exercises, Mc. Graw Hill, U.S.A.
12. **Benson,** Microbiology applications: a Laboratory Manual in General Microbiology, Mc. Graw Hill, U.S.A.
13. **Chan,** Laboratory Exercises in Microbiology, Mc. Graw Hill, U.S.A.
14. **F.G. Burleson, T.M Chambers, D.L. Wuiedbrauk,** 1992, Virology : A Laboratory Manual.

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 NH_2 group by Ninhydrin method, organic nitrogen in proteins/amino acids by Microkjeldhal 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. **B. Shashidhara Rao &VijayDeshpande – I.K,** Experimental Biochemistry – A student comparison, International Private Limited, New Delhi.
2. **K. Wilson and J. Walker,** Practical Biochemistry - Principles and Techniques, Cambridge University Press.
3. **D.T. Plummer,** An Introduction to Practical Biochemistry, Tata Mc. Graw Hill Publishing Company Limited, New Delhi.
4. **A. Rameshwar, Kalyani,** Practical Biochemistry – A Basic Course, Publishers Ludhiana.
5. **Jayaraman,** Laboratory Manual in Biochemistry, Wiley Eastern Limited.
6. **Oser,** Hawk's Physiological Chemistry, Mc. Graw Hill, U.S.A.

M.Sc Microbiology- II SEMESTER Syllabus

MB 201: MICROBIAL PHYSIOLOGY & METABOLISM

UNIT– I:

Nutritional types –Autotrophy, heterotrophy and prototrophy. Autotrophic bacteria, chemosynthetic and photosynthetic 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. 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 (EMP) pathway, Entner-Doudoroff (ED) pathway, C2-C4 split pathway. Kreb's cycle, glyoxylate cycle, hexose monophosphate (HMP) shunt, 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 gentsiate cleavage) and
reductive catabolism.
Nucleotide metabolism - Biosynthesis of purnine 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. **Moat and Foster,** 2002, Microbial physiology, 4th eidition, Pub. Wiley Liss and son's, Inc.
2. **Price and Stevens,** An introduction to bacterial physiology.
3. **Oginsky and Umbreit,** An introduction to bacterial physiology, Freeman & Company.
4. **Gottschalk,** Bacterial metabolism, University of Texas Medical branch at Galvaston
5. **Ingraham, Lod and Neichardt,** Growth of bacterial cell.
6. **Dawes,** Microbial energetic, Blakie & Sunlted Glasgow.
7. **Lehninger, Nelson and Cox,** Principles of Biochemistry.
8. **Zubay,** Biochemistry, 3rd edition, 1993, Pub. WM.C.Brown Publishers, Melbourne, Australia.
9. Biochemistry by Stryer.
10. **Garrett and Grisham,** 2005, Biochemistry, 3rd edition, Pub. Thomson Brook's and company.
11. **M.Burrows,** Textbook of Microbiology.
12. **D.R.Caldwell,** Microbial physiology and Metabolism, Wm.C.Brown Publ.
13. **K.Talaro and A. Talaro,** Foundations in Microbiology, Wm.C.Brown Publ.
14. **Prescott *et al.*** Microbiology, 7th edition, 2008, Pub. Wm.C.Brown.
15. **Lodish *et al.,*** 1999, Molecular Cell Biology, 4th edition, WH.Greeman and company.
16. **Stainer,** 1958, General Microbiology, Macmillan educational Ltd., 5th edition, Pub. Macmillum Press Ltd..
17. **Madigan M.T., Martinko J.M., and Parker J.,** Prentice Brock Biology of microorganisms,
-Hall, Perarson edition.

18. **West E.S and Tood,** 1974, Textbook of Biochemistry, 4th edition, Oxford and IBM Publishing Co.Pvt. Ltd.,New Delhi.
19. **Donald Voet, Judith G.voet,** Biochemistry, John Wiley & Sons, 1999, Pub. John Willeuy and son's, USA.
20. **Harper,** 2006, Biochemistry, Mc.Graw Hill, 27th edition, Pub. McGraw-Hill companies.
21. **Cohn and Stumph,** Principles of Biochemistry, 4th edition, 2008, W.H. Greeman and company.
22. **Davidson,** Biochemistry of Nucleic acids.
23. **Mullar and Cords,** Biological chemistry.
24. **White Handler and Smith,** Biochemistry, Mc Grahills.
25. **Dwelley,** Bacterial metabolism.

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, passive, facilitated diffusion and active. 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, Carbon dioxide fixation, halo bacterial photosynthesis.

UNIT-II:
Signal transduction in eukaryotes: Protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, Secondry messengers, Cyclic nucleotides, G proteins. 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 Km, Vmax and kcat values.
Enzyme inhibitors, competitive, uncompetitive and noncompetitive inhibition. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes

UNIT-IV:
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. Immobilized enzymes - Methods of Immobilisation. Comparison of kinetics of immobilized and free enzymes. Application of Immobilized enzymes.

RECOMMENDED BOOKS FOR MB 202:

1. **E.B.P. De Robertis,** 2001, Cell and Molecular Biology, 8th edition, Lippincott Williams & Wilkins.
2. **Lodish & Baltimore,** 2000, Molecular Cell Biology, 4th edition, Pub. W.H.Greeman and company.
3. **Nicholas C. Price, Lewis Stevens,** Fundamentals of Enzymology, 3rd edition, 2003, Pub. Oxford University Press.
4. Trevor Palmer, 2004, Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, Pub. Harward Publishing Limited.
5. Lehninger, 2008, Biochemistry, 4th edition, Pub. W.H. Freeman and company.
6. **Lehninger, Nelson and Cox,** 2008, Principles of Biochemistry, 4th edition, Pub. W.H. Freeman and company.
7. **Lubert Stryer,** 2007, Biochemistry, 6th edition, Pub. W.H. Freeman and company.
8. **Zubay,** 1993, Biochemistry, 3rd edition, Pub. WM. C. Brown Co,,unition, Inc.
9. **White Handler and Smith**, 2004, Biochemistry, 6th edition, Pub. Tata McGraw-Hill Ltd.
10. **Dixon and Webb,** Enzymes, Acadamic Press.
11. **Ahern,** Introduction to Experimental Cell Biology, Mc. Graw Hill, USA.
12. **Metzler,** The Chemical reactions of Living Cells, Vol 1 and 2.
13. **Alberts, Bay Johnson**, Cell Biology, American Society of cell biology. Bay city books.

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 test 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, 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 transformation, Bacterial conjugation, Transduction – Generalized and specialized transductions. 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.

RECOMMENDED BOOKS FOR MB 203:

1. **J.D.Watson**. 2004.Molecular Biology of the Gene. 4th Edition. 2004. Pearson Education.
2. **Lodish.** 2003. Molecular Cell Biology. Scientific american books, W.H. Freeman and Company.
3. **E.B.P. De Robertis,** 2001, Cell and Molecular Biology, Lippincott Williams & Wilkins,8th edition,.
4. **Lodish & Baltimore,** 2000, Molecular Cell Biology, 4th edition, Pub Pub. W.H. Freeman and company.
5. **Watson Roberts, Steitx Wainer,** 2004, Molecular Biology of the Gene, The Benjamin/Cummings Publishing Company Inc., 5th edition.
6. **Stanley R. Maloy, John E Cronan Jr.,** 2001, Microbial Genetics, David Freifelder Jones

and Bartleh Publishers Inc., 8th edition
7. **Benjamin Lewen.,** Genes I– VII, 1st edition, Pub. Oxpord University Press, New York.
8. **Russell,** Essentials of Genetics.
9. **Larry Snyder and Wendy Champness,** Molecular Genetics of Bacteria, A.S.M. Press. 3rd edition, 2007.
10. **Gardener,** Genetics, 8th edition, Pub. John Wiley and sons, Inc, 1991.
11. **Tamrin,** 2002, Genetics, 7th edition, Pub. Tata McGraw-Hill Publishing company Ltd,.
12. **Strickberger,** Genetics, 3rd edition, 1985, Pub. Asoke K. Ghosh, prentice Hall jof India Pvt. Ltd.
13. **J.W. Dale,** 1998, Molecular Genetics of Bacteria, 3rd Edition. , Wiley Publ.
14. **Griffith,** Modern Genetic Analysis.
15..**E.A. Birge,** Bacterial and Bacteriophage genetics, Springer.
16. **W.Hays,** Genetics of bacteria and their viruses.

MB 204: IMMUNOLOGY

UNIT-I:
History and scope of Immunology, Cells involved in immune system – T-lymphocytes, Blymphocytes, monocytes, macrophages, APC, Neutrophils, mast cells. Types of immunity -

Adaptive immunity, innate immunity. Lymphoid organs, Thymus, bone marrow, spleen, lymph
nodes. Nature of antigens; antibody structure, classification of antibodies, functions of IgG, IgA, IgM, IgD and IgE; primary and secondary immune response.

UNIT-II:
Antigen-Antibody reactions - Ag-Ab binding, agglutination, blood groups, immunoflourescence, and important immunological diagnostic tests - ELISA, RIA, immuno blot, Immunodiffusion, Immunoelectrophoresis, Complement fixation test (CFT). Serological analysis of antibodies –isotypes, allotypes and idiotypes.
Antibody diversity, antigen receptors on B and T lymphocytes. Phagocytosis, opsination, Opsonins, monoclonal antibody production and polyclonal, 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**. Stewart,** Immunology and Immunopathology, 8th edition, Churchill living stone.
2. **Abul K. Abbas *et al.,*** Cellular and Molecular Immunology, Elsvier publication.
3. **Barret,** 2005, Textbook of Immunology, 5th edition, Pub. Elsevier saunders Inc.
4. **Roitt, Brostoff, Male,** Essential Immunology, Harcourt Brace & Company (4th, 5th Edition), Mosby (6th Edition)
5. **J.Kuby, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne,** Immunology, 4th edition, Freeman & Company Mosby publishers. 2009.
6. **Janeway and Travers,** 1994, Immunobiology – The immune system in Health disease.
7. **Tizard,** 1995, Immunology – An introduction, 4th edition, Pub. Saunders college publishing.
8. **Unani and Benacerraf ,** Text book of Imunology.
9. **Paul,** Fundamentals of Immunology, Lippincott Williams & willeins
10. **Benjaini, Sunshine and Lesrowitz,** Immunology – A short course.

11. **Stites, Terr and Parslow**, Basic and Clinical Immunology.
12. **Herman N. Eosen,** Immunology.
13. **Constantin Bena,** Molecular Basis of Immunology.
14. **Jan Klein,** Immunology – The science of self-Non-self discrimination, John wiley & sons.
15. **R.M.Coleman, M.F. Lombard and R.E. Sicard,** Fundamental Immunology, Wm.C.Brown Publishers.
16. **R.M. Hyde,** Immunology, B.I. Waverly Pvt. Ltd.
17. **H.Y.Fan, I.S.Y.Chen, N. Rosenberg and W.Sugden,**Viruses that affect Immune system by
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 Km and *Vmax* values.
b) Effect of pH, temperature and inhibitors on enzyme activity.
4) Enzyme and Whole cell immobilization.
5) Separation of Serum proteins- Immunoelectrophoresis.
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) Raising antiserum.

RECOMMENDED BOOKS FOR MBP 205:

1. **Hudson and Hay**, Practical Immunology.
2. **Harlow and Lane**, Antibodies: A Laboratory manual.
3. **Rose and Friedman,** Manual of Clinical Immunology.
4. **Johnstone and Thrope**, Immunochemistry in Practice.
5. **Weir,** Handbook of Experimental Immunology, Vol I and II.
6. **Plummer,** An Introduction to Practical Biochemistry, 3rd edition, 1988, Pub. Tata McGraw-Hill publishing company limited.
7. **Beedu Sashidhar Rao and Vijay Deshpande, I.K,** Experimental Biochemistry, International Pvt. Ltd., 2005, Pub. 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 Ciocalteau 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 Find the effectiveness of disinfectants by Phenol coefficient test.
11. Demonstration of Ames test.
12. Protoplast preparation and regeneration.
13. Chromosome isolation, banding and karyotyping.
14. Bacterial conjugation

RECOMMENDED BOOKS FOR MBP 206:

1. **Jeffrey H Miller,** A short course in bacterial genetics – A laboratory manual and Handbook for *Eschericia coli* and related Bacteria, Cold spring Harbor Laboratory press
2. **S.K. Sawhney and Randhir Singh,** 2001, Introductory practical Biochemistry, Pub. N.K. Mehra for Narasa publishing House.
3.**K.R.Aneja,** Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology, New age international Publishers.
4. **T.W. Zyskind and S.I. Bern stein,** Recombinant DNA Laboratory Manual, Academic press.
5. **Benson, H.J. WCB:** Microbiological Applications (A Laboratory manual in General Microbiology) WM C. Brown Publishers.
6. **Capuccino, J.G. and Sherman, N. Addison Wesley,** 2004. Microbiology – A Laboratory Manual, Pub. Pearson Education Private Ltd.
7. **N. Kannan,** Laboratory Manual in General Microbiology, Panima Publishing Corporation.
8. **R.C. Dubey and D.K. Maheswari,** 2002, Practical Microbiology, S.Chand and Company Limited, 1st edition.
9. **Beedu Sashidhar Rao and Vijay Deshpande, I.K,** Experimental Biochemistry, International Pvt. Ltd.

(Non-Core)

II SEMESTER

* 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*, V*ibrio 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 temination. Topoisomerases, DNA ligases. Procaryotic 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. Mechanisms of protein translocation, Post translational processing of proteins, protein channeling, and 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. **B.alberts, D Bray, J.Lewis, M.Raff, K.Roberts and J.D. Watson,** 1983, Molecular Biology of the Cell, Garland Publishing Inc., New York.
2. **J.D. Watson,** 1976, Molecular Biology of the Gene, 3rd Edition, W.A. Benjamin Inc., New York.
3. **Hartwell, L., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. and Veres, R.C,** 2000, Genetics: from genes to Genomes, 1st Edition WCB –Mc Graw Hill.
4. **Lodith.H., Berk.A., Zipursky, S.I.Matsudira.P., Baltimore, D and Darnell. J,** 2000, Molecular Cell Biology, 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. **Styer,** 2002, Biochemistry, 5th Edition, W.H. Freeman and Co.
7. **Robert F.Weaver,** 1999, Molecular Biology,1st Edition. WCB –Mc Graw Hill.
8. **Glick and Pasternak,** 2001, Molecular Biotechnology Principles and Applications of Recombinant DNA, ASM Press.
9. **Watson Gilman,** Recombinant DNA, Scientific American Books.
10. **James D Watson,** A Passion for DNA Genes, Genomes and Society, CSHL Press.
11. **Cooper,** Cell and Molecular Biology, ASM Press.
12. **David Freifelder,** 2008, Molecular Biology, 2nd Edition, Narosa Publishing House.

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, Antibacterial drugs (Penicillin, Streptomycin, Sulfonamides and Polymyxins), Antifungal drugs (Nystatin), and Antiviral agents. (Robovirin) Problems of drug resistance and drug sensitivity. Drug resistance in bacteria.

UNIT-IV:

Viral diseases: 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. **MIMS, Play Fair, Roitt & Mosby**, Medical Microbiology, Publishers, 2nd edition.
2. **Elmer R.Noble & Lea & Fibiger,** Parasitology, Publishers, 5th edition.
3. **D.O. White & F.J. Fenner,** 1994, Medical Virology, Academic press, 4th Edition.
4. **Melnick,** Medical Microbiology.
5. **Ananthanarayan, C.K.J.Panikar**, Textbook of Microbiology, Oreint Longman Ltd., 2000, 6th Edition.
6. **Mackie & Mc. Cauetrey:** Practical Medical Microbiology (14th Edition), edited by J.G.Gollee, Published by: Churchill Livingstone.
7. **Subish.C.Panija,** Textbook of Medical Parasitology, published by 'All India Publishers and distributors'.
8. **C.K.Jaya Ram Paniker,** Textbook of Medical Parasitology, Published by 'Jaypee Brothers', 4th Edition.
9. **Coloratlas,** Textbook of Diagnostic Microbiology (5th Edition), edited by Eimer.W. Koneman, published by Lippinett.
10. **Mosby,** Diagnostic Microbiology by Bailey and Swotts, 10th Edition, published.
11. **David Greenwood, Richard C.B.Slack, John.F.Peutherer,** Medical Microbiology, 16th Edition.
12. **J.B.Sharma,** Medical Microbiology – A Clinical perspective, paras publishing.
13. **Patrick R.Murray, Ken.S.Rosenthal, George.S.Kobayashi, Michael A. Ptaller,** Medical Microbiology, 3rd Edition.
14. **Jawetz, Melnick and Adelberg's,** Medical Microbiology (2004) 23rd Edition, Mc Graw Hill.
15. **W.B. Hugo& A.P. Russell,** Pharmaceutical Microbiology edited, 7th edition, Black well science.

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 comprises. Correlation and Linear regression.

UNIT-II:

Sequence Analysis: Introduction to hidden Markov models. Introduction to biological databases: NCBI, EMBL, EXPASY, PIR, Pfam. Concept of World Wide Web: HTML, HTPP. 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 phytogenetic 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. **Daniel,** 2006 , Biostatistics, Eighth Edition. John Wisley and sons.
2. **Durbin, Eddy, Krogh, Mithison,** Biological sequence analysis.
3. **T.A. Attwood and D.J. parry – smith,** 2001, Introduction of Bioinformatics.
4. **A.D.Baxevaris,** 1998, Bioinformatics: A practical guide to the analysis of genes and proteins, (Edited) B.F.Publication.
5. **David W,** 2005, Bio-informatics ; sequence and Genome Analysis, 2nd Edition by Mount CBS publishers

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. Nanotechnology: Basic Principle and Applications: Biosensors, drug and gene delivery systems, chip technologies, nano imaging, Nanomedicine and Cancer diagnostics and treatment.

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. **Glick & Palturah,** 2003, Molecular Biotechnology, 3rd Edition.
2. **Primrose,** Modern Biotechnology, Black well scientific publication Oxford.
3. **Lodish et al.,** Molecular Cell Biology, Mac Millan education.
4. **R.Twyman,** Advanced Molecular Biology: A concise reference, Springer.
5. **Old & Primrose,** Principles of Gene Manipulation: An introduction to genetic engineering.
6. **J.D. Watson et al.,** Recombinant DNA, Wiley scientific
7. **J.M. Walker,** Molecular Biology &Biotechnology, Roya society of chemistry.
8. **H. Krenzer,** Recombinant DNA & Biotechnology.
9. **M.Schena,** DNA micro arrays.
10. **David Freifelder,** 2008, Molecular Biology, 2nd Edition, Narosa Publishing House.
11. **Watson**, Molecular Biology of Gene.
12. **Tampion &Tampion,** Immobilized cells: Principles and Applications.
13. **David Goodsell,** Nanobiotechnology, John Wiley
14. **Nalwa HS,** 2005, Handbook of Nanostructured biomaterials and their applications in nanobiotechnology, American scientific publishers
15. **Niemeyer CM & Mirkin CA,** 2005, Nanobiotechnology,Wiley Intersci

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.
10. Problems on DNA characteristics.
11. Preparation of Nanosilver By Wet reductionMethod(Chemical),using Neem Extact(plants) &Bacteria(Microbiological)
12. Characterisation of Nanosilver by UV spectrometry and microscopic methods
13. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.

RECOMMENDED BOOKS FOR MB 305:

1. **Sambrook and Russell**, Molecular Cloning – A Laboratory Manual, 3rd Edition, Volumes I to III, CSHL Press.
2. **Ausbel et al.,** 2000, Current Protocols in molecular biology.
3. Genome analysis, 2000, 4 volumes, ESHL Press.
4. **David Goodsell,** Nanobiotechnology, John Wiley
5. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology
6. **Nalwa HS,** 2005, American scientific publishers
7. **Niemeyer CM & Mirkin CA**, 2005 Nanobiotechnology,Wiley Interscience.

MBP 306: MEDICAL MICROBIOLOGY, BIOSTATISTICS AND BIOINFORMATICS

1. Preparation of different media used in diagnostics Microbiology(culture media/observation): Blood Agar, Chacolate Agar,Mannitol salt agar, Blair Parker medium, MacConkey agar, Lowensten-Jension medium,Wilson Blair Bismuth sulphite medium, Biochemical media: TSI,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.
2. Collection of throat swabs – culturing the specimen.Laboratory examination of pus and skin specimens for *staphylococcus aureus, streptococcus pyogenes* and *Pseudomonas aeruginosa*.
3. 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.
4. 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.*
5. Medical Parasitology – *E. histolytica, G. lamblia, Trypanosomas, Leishmania and Plasmodium* (Permanent Slide Observation)

6. Laboratory diagnosis of common helminthes infections (permanent slide observations of helminthes)
7. Microscopic studies of viruses infected materials (demonstration)
8. Examination of blood smear by Leishman stain for Malarial parasites
9. Serological Tests: Hemoglobin estimation, RBC Count, WBC Count, Bleeding time, Clotting tie, Erythrocyte Sedimentation Rate (ESR), Packed Cell Volume (PCV)
10. Immunodiagnostics - Tridot test for HIV, Hepatic test for HBV,
11. Use of Internet/software for sequence analysis of nucleotides and proteins: Studies of public domain databases for nucleic acid and protein sequences.
12. Determination of protein structure (PDB).
13. Genome sequence analysis
14. Problems related to measures of central tendency, dispersion, t-test and chi square test.

RECOMMENDED BOOKS FOR MB 306:

1. **Mackie,** Practical Medical Microbiology.
2. **Cruichshank et al.** Practical Medical Microbiology Vol-II.
3. **J.G.Cappucinno and H.Sherman,** Microbiology: A laboratory manual, 4th Edition.
4. **K.R.Aneja,** Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 3rd Edition.
5. **Alcamo,** Laboratory Manual in Microbiology.
6. **Bailey and Scott,** Diagnostic Microbiology.
7. **Cruckshanak et al.,** Medical Microbiology, Vol I & II
8. **Monica Cheesbrough,** Medical laboratory Manual for tropical countries Vol I & II.
9. **Mitchal hasking ,** Virological Procedures.
10. **Wilson and Topley,** Virologoy.
11. Baxevanis, Bioinformatics-A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition.
12. **Higgis,** Bioinformatics: Seqence, structure and Data Bank: A Practical Approach.
13. **Misener,** Bioformatics Methods and Protocols.
14. www.geneprot.com; www.hybrigenis.com; www.mdsprotemics.com; www.stromix.com; www.syrrx.com.

(Non-Core)

III- SEMESTER

*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 tropic levels. **Aquatic environment**, Freshwater micro organisms, their zonation and characters. Marine microorganisms and their zonation and characteristes. **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. Biofertilizes – 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, maintenance 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 and Containment facility. Types of fermentors and fermentations. Computer application in fermentation technology. Recovery and purification of fermentation products (downstream process). Fermentation Economics.

UNIT-III:

Production of ethyl alcohol, beer & wine. Biofilms, biosurfactants, Biotransformation with reference to steroids and non steroids, 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. **Pandey,** Solid State fermentation in Biotechnology.
2. **Waiter,** Industrial Microbiology.
3. **Mansi,** Fermentation Microbiology and Biotechnology.
4. **Patel,** 2008, Industrial Microbiology.
5. **Greger,** Biotechnology: A text book of Industrial Microbiology.
6. **Whitaker. (Stanbury),** 1997, Principles of Fermentation technology, 2nd Edition.
7. **Prescot & Dunn,** 1982, Industrial Microbiology, 4th Edition., AVI publishing company
8. **J.H. Peppler & D. Perlman,** Microbial Technology.
9. **L.E.Casida.,** 2007, Industrial Microbiology, New age International
10. **B.M. Miller & W.Litsky,** Industrial Microbiology.
11. **Rose,** Economic Microbiology, Vol-I to V.
12. **Ed.Perlman,** Advances in Applied Microbiology, 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 tropic levels. Energy transfer efficiencies between tropic levels. Biological factors influencing the growth and survival of microorganisms- inter reactions 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 preypredator 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, Determination of water potability by MPN and sanitary examination. 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 chemical pollutants: 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:
Bio-magnification and Bioremediation Technology – Microbial degradation of oil spills, pesticides and detergents, Biofouling; Bioplastics PHB, PHA. 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. **B.N.Johri,** 2000, Extremophiles, Springer Verlog, New York.
2. **D.Cdwd,** 1999, Microbial Diversity, Academic press.
3. **C.J. Hurst,** Manual at Environmental Microbiology, 2nd edition, Editor in Chief, 2002, ASM Press.
4. **Atlas, RM & Barta, R,** 1998, Microbial Ecology: Fundamentals and Applications,
5. **Tilak,** 1997, Aerobiology,.
6. **Ralph Mitechell**, Environmental Microbiology.
7. **Eweis,** Bioremediation principles.
8. **Buruage,**Techniques in Microbial Ecology.
9. **W.P. Grant and P.E. Long,** 1981, Environmental Microbiology.

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; *Penicillium 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, denitrification, sulpher, 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, Mycorrihiza, Biopesticides – toxins from *Bacillus thuringiensis, Psuedomonas syringae,* Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

RECOMMENDED BOOKS FOR MB 403:
1. **M.P. Dayle et al,** 2001, Food Microbiology: Fundamentals & Frontiers, 2nd edition, ASM press.
2. **Adams, M.R. and Moss M.O.** 1995, Food Microbiology, Royal Society of Chemistry Publication, Cambridge.
3. **Frazier W.C. and West haff D.C,**1988, Food Microbiology, Tata Mc.Graw Hill Publishing Company Limited, New Delhi.
4. **Stantury, P.F., Whitekar, A. and Hall, S.J.,** 1995, Principles of Fermentation Technology.
5. **Banwart, GJ,** 1989, Basic Food Microbiology, CBS Publishers and Distributors, Delhi
6. **Hobbs BC and Roberts.D,** 1993, Food Poisoning and Food Hygiene, Edward Arnold (A division at Hodder and Strong hton) London.
7. **G.Rangaswamy and Bagyaraj,** Agricultural Microbiology, Prentice Hall India.
8. **N.S. Subba Rao,** 1995, Bio-fertilizers in Agriculture and Forestry.
9. **N.S. Subba Rao,** 1995, Soil Microbiology and Plant Growth.

MB 404: PHARMACEUTICAL MICROBIOLOGY

UNIT-I:
Chemical disinfectants, antiseptics and preservatives and their industrial significance. Production of antibiotics – Penicillin, Streptomycin, Erythromycin, bacitracin and tetracycline. Mechanism of action of antibiotics – the bacterial cell wall, protein synthesis, chromosome function & replication, folate antagonis, the cytoplasmic membrane, Assay of antibiotics – Penicillin, Streptomycin.

UNIT-II:
Good manufacturing and Good Laboratory practices, Regulatory aspects and quality control, Quality assurance and quality management in pharmaceuticals ISO, WHO, US FDA, Documentation, Validation. Personal management, training, Personal Hygiene and Health.

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 B_{12}. Analytical Microbiology – microbiological assays of Vitamins (Riboflavin, B_{12}), amino acids (lysine, tryptophan).

UNIT-IV:
Ecology of Microorganisms as it effects the pharmaceutical industry; Microbial spoilage & preservation of medicines using antimicrobial agents; Control of microbial risk in medicines microbial limit tests and endotoxin tests, Contamination of non-sterile pharmaceuticals in hospital & community environments.

RECOMMENDED BOOKS FOR MB 404:

1. **W.B. Hugo & A.D. Russell,** Pharmaceutical Microbiology edited, 6th Edition, Black well science.
2. **Shanson D.C.,** Microbiology in clinical practice, 2nd edition, London; Wright.
3. **T Sammes Ellis Horwood**, opics in Antibiotic chemistry Vol I to V.
4. **Wulf Crueger,** Biotechnology – A textbook of Industrial Microbiology, 2nd Edition, Panima publishers
5. A.H. Patel, 1984, Industrial Microbiology , Macmilan India Limited.
6. **Coulson C.J., London; Taylor and Francis,** Molecular mechanisms of drug action.
7. **Denyes S.P. & Baird R.M. Chichester, Ellis Horwood,** Guide to microbiological control in Pharmaceuticals.
8. **Murray S. Cooper**, Quality control in in the Pharmaceutical Industry- Edt., Vol- II, Academic press, New York.
9. **Sydney H. Willin, Murray M. Tuckerman, William S. Hitchings IV,** Good Manufacturing practices for pharmaceuticals, second Edt., Mercel Dekker NC Nework
10. **Rajesh Bhatia, Rattan lal Ihhpunjani**, Quality assurance in Microbiology, CBS Publisher & Distributors, New Delhi.

MBP 405: INDUSTRIAL MICROBIOLOGY & ENVIRONMENTAL MICROBIOLOGY
1. Production of citric acid by *A.niger*. Recovery & Fermentation.
2. Production of Ethanol by fermentation, recovery and estimation by dichromate method.
3. Preparation of Wine from grapes by fermentation.
4. Production of glutamic acid by fermentation.
5. Estimation of bacteria, actinomycetes and fungi in soil by dilution – Plating method.
6. Observation of air-borne microflora by petriplate exposure.
7. Effect of pesticides on soil microbes.
8. DO Estimation.
9. BOD Estimation.
10. COD Estimation
11. Determination of potability of drinking water by MPN & coliform test

RECOMMENDED BOOKS FOR MB 405:

1. Srivastava, Handbook of milk Microbiology.
2. Demain, Manual of Industrial Microbiology and Biotechnology.
3. Aneja.,2001, Experiments in Microbiology, Plant Pathology, Tissue Culture & Mushroom production technology, 3rdEdition, New age international
4. **Mc. Niel & L.H. Harvey,** Fermentation: A practical Approach.
5. **C.J. Hurst,** Manual of Environmental Microbiology, 2nd Edition.
6. **Burns & Slater,** Experimental Microbial Ecology.

7. **Peppler, Gerba & Brendecks,** Environmental Microbiology: A Laboratory manual.

MBP 406: FOOD, AGRICULTURAL & PHARMACEUTICAL MICROBIOLOGY

1. Microbiological examination of milk & milk products.
2. Determination of efficiency pasteurization by milk phosphatase test
2. Preparation of Yoghurt
3. Microbiological examination of fresh & canned foods.
4. Microbiological quality testing of milk by MBRT test and Resazurin test
5. Isolation of yeasts from grapes, observation of culture characteristics and morphology.
7. Isolation of Rhizobium from root nodules.
8. Isolation of Azotobacter from soil.
9. Microbiological Assay of antibiotics.
10. Microbiological Assay of Vitamin B_{12}.
11. Preparation and observation/ evaluation of Bio-fertilizer
12. Preparation and observation/ evaluation of Biopesticide

RECOMMENDED BOOKS FOR MB 406:

1. **Srivastava,** Handbook of Milk Microbiology.
2. **W.F. Harrigan,** Laboratory methods in Food Microbiology.
3. **C.J. Hurst,** Manual of Environmental Microbiology, 2nd Edition.
4. **Aneja,** 2001, Experiments in Microbiology, Plant Pathology, Tissue Culture & Mushroom production Technology, 3rdEdition, New age international