DEPARTMENT OF MICROBIOLOGY
M.SC. SYLLABUS

Code	Paper Title	Credit	Marks
First Semester :			
MIC-PG-C101	Microbial Diversity	4	100
MIC-PG-C102	Microbial Biochemistry	4	100
MIC-PG-C103	Instrumentation and Bio-computation	4	100
MIC-PG-C104	Laboratory Course-I	4	100
Second Semester :			
MIC-PG-C201	Microbial Physiology	4	100
MIC-PG-O202	Microbial genetics and Molecular Biology (Open Paper)	4	100
MIC-PG-S203	Clinical Microbiology (Specialization Paper)	4	100
MIC-PG-C204	Laboratory Course-II	4	100
Third Semester :			
MIC-PG-S301	Food Microbiology (Specialization Paper)	4	100
MIC-PG-S302	Environmental Microbiology (Specialization Paper)	4	100
MIC-PG-O303	Basic Immunology and Immuno-techniques (Open Paper)	4	100
MIC-PG-C304	Laboratory Course –III	4	100
Fourth Semester :			
MIC-PG-S401	Molecular Virology (Specialization Paper)	4	100
MIC-PG-S402	Agricultural and Industrial Microbiology (Specialization Paper)	4	100
MIC-PG-S403	Laboratory Course - IV (Specialization Paper)	4	100
MIC-PG-S404	Dissertation (Specialization Paper)	4	100

SEMESTER I

MIC-PG-C101: Microbial Diversity

Unit I: Introduction to Microbiology

Three domain classification system. Overview of Microbial Systematics: phenotypic, genotypic and phylogenetic analysis. Structural and functional differences between prokaryotic and eukaryotic cells.

Bacteria- I

The Proteobacteria: General characteristics of the following major groups of Proteobacteria: Phototrophic, chemolithotrophic and methanoptrophic Proteobacteria. Aerobic and facultatively aerobic chemoorganotrophic Proteobacteria. Morphologically unusual Proteobacteria. Delta and Epsilon Proteobacteria.

Unit II: Bacteria-II

General characteristics of Gram Positive and Actinobacteria. Cyanobacteria and Prochlorophytes. *Chlamydia. Planctomyces*. The Verrucomicrobia. The Flavobacteria. The Cytophaga Group.

Green sulfur bacteria. The Spirochaetes. *Deinococci*. The green non-sulfur bacteria. Hyperthermophilic bacteria. *Nitrospira* and *Deferribacter.*

Unit III: Archaea and Mycology

Phylogenetic overview of Archaea. General account of habitat and physiology of Euryarchaeota(Halophilic, methane producing, *Thermoplasmatales, Thermococcales* and *Methanopyrus, Archaeoglobales, Nanoarchaeum and Aciduliprofundum)* and Crenarchaeota (Hyperthermophiles and Non- Hyperthermophiles)

Classification of Fungi. Morphology and reproduction alongwith economic importance.

Unit IV: Viruses

General characteristics and classification system of viruses. Isolation and cultivation of viruses. Viral multiplication and replication strategies for bacteriophages, DNA viruses (Herepesviruses, Pox viruses, Adenoviruses) RNA Viruses (Poliovirus, coronavirus, influenza, rabies and Reoviruses), Viruses that employ reverse transcriptase (Retroviruses, hepadnavirus).

Reading List

1. Carter, J. and Saunders, V. 2007. Virology: *Principles and Applications.* First edition Wiley.
2. Dimmock, N.J., Primrose, S.B. 1994. *Introduction to Modern Virology,* 4th edition, Blackwell Scientific Publications, Oxford.
3. Fields, B.N. et al. 2001. *Fields-Virology, Vol I and II,* 4th edition. Lippincott Williams & Wilkins Publishers.
4. Danson, M. J. 1992. *The Archaebacteria: Biochemistry and Biotechnology*, Portland Press, London.
5. Garrity, G.M. et al. 2005. *Bergey's Manual of Systematic Bacteriology Volume 1-V.* 2nd edition, Springer.
6. Garrett, R. A. and Hans-Peter Klenk, H-P. 2007. *Archaea: Evolution, Physiology, and Molecular Biology*. 1st edition, Wiley-Blackwell.
7. Kavanagh, K. 2005. *Fungi: Biology and Applications*, First edition, Wiley.
8. Madigan, M. T., Martinko, J. M., Dunlap, P. V. Clark, D. P. 2009. Brock Biology of Microrganisms, Twelfth edition, Pearson Education Inc, Pearson Benjamin Cummings, San Francisco.
9. Mehrotra, R.S. and Aneja, K. R. 1990 *An introduction to Mycology*. New Age International Publishers.
10. Willey, J. M., Sherwood, L. M. and Woolverton, C.J. 2008. Prescott, Harley and Klein's Microbiology. Seventh Edition. Mc Graw Hill Companies Inc. New Jersey.

MIC-PG-C102: Microbial Biochemistry

Unit I: Biomolecules I

Proteins**:** Introduction to Amino acids chemistry and Classification and properties; Brief account of Peptide bond, primary, secondary, tertiary and quaternary structures; Protein isolation, purification, characterization and functional analysis

Carbohydrate chemistry: Introduction to Properties and classification of carbohydrates; stereo-chemistry, functions, storage polysaccharides, structural polysaccharides; glycoconjugates

Unit II: Biomolecules II
Lipid Chemistry: Classification, properties and structure of lipids with emphasis on membrane lipids; brief account of archaebacterial and Mycobacterium lipids; Brief account of application of membrane lipids in classification of bacteria
Nucleic acids: Structural features and chemistry of nucleic acid.

Unit III: Enzymology
Introduction, classification of enzymes, kinetics, enzyme inhibition and inhibitors.

Unit IV: DNA replication, recombination and repair
DNA replication. Homologous and site specific recombination, DNA damage and repair.

Reading List

1. Nelson, D. L. and Cox, M.M. 2008. *Lenhinger's Principles of Biochemistry*. 5th edition. W.H. Freeman
2. Stryer, L. 1988. *Biochemistry*. 3rd edition, W. H. Freeman & Co.
3. Voet, D. and Voet, J.G. 1995. *Biochemistry*. Wiley.
4. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.

MIC-PG-C103: Instrumentation and Biocomputation

Unit I: Microscopy
Principle and application: Light microscopy (Brightfield, darkfield, Phase contrast and flourescence microscopy, confocal microscopy), electron microscopy (Scanning and transmission microscopy)
Spectrometric techniques: Ultraviolet and visible light spectroscopy, Fluorescence spectroscopy, Atomic spectroscopy, Infrared and Raman spectroscopy.
Centrifugation techniques: Preparative centrifugation and Analytical centrifugation, Care and safety aspects of centrifuges

Unit II: Electrophoresis and chromatography
Electrophoresis of proteins, Electrophoresis of nucleic acids
Principles and application of gel filtration, high pressure liquid, ion exchange, affinity, Gas liquid, paper and thin layer chromatography

Unit III: Radioisotopic techniques, Automated/Semi automated instruments
Radioisotopic techniques and Detection and measurement of radioactivity
Biolog, HPTLC, PCR, Real Time PCR, Sequencing techniques: Capillary sequencing, pyrosequencing, next-generation sequencing

Unit IV: Bio-computation
Types, properties and application of biological databases with suitable examples (Gene Bank at NCBI, PDB, Swiss Prot at EBI). Working with protein (predicting secondary structure, 3-D structures, RNA), building phylogenetic trees using DNA and protein sequences. General principles involved, global /local, tools available alike BLAST, CLUSTAL-W, Similarity Searches on sequence databases, comparing two sequences, building a multiple sequence alignment, editing and publishing alignments.

Reading list

1. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.
2. Bernard Rosner, B. 2005. *Fundamentals of Biostatistics.* 6th edition Duxbury Press.
3. Gerry, Q. P and Keough, M. J. 2002. *Experimental Design and Data Analysis for Biologists*. Cambridge Univ. Press.
4. Sokal, R. R. and Rohlf, F. J. 2008. *Introduction to Biostatistics.* Dover Publication.
5. Triola, M. M. and Triola, M. F. 2005. *Biostatistics for the Biological and Health Sciences with Statistics.* Addison Wesley.
6. Davis, L. G., Dibner, M. D. and Battey, J. F. 1986. *Basic Methods in Molecular Biology*. Appleton and Lange.
7. Field, K. G. and Ream, W. 1999. *Molecular Biology Techniques: An Intensive Laboratory Course*. Academic Press. Sambrook, J. and Russell David, W. R. 2001. *Molecular cloning A Laboratory Manual*, Three volumes, CSHL N.Y, Ed.
8. Plummer, D. T. 2004. *Introduction to Practical Biochemistry*. 3rd edition, Tata Mcgraw Hill Publishing Company Limited.
9. Sambrook, J. M., Fritsch, E. F. and Maniatis, T. 1989. *Molecular Cloning: A Laboratory Manual.* 3rd edition, Cold Spring Harbor Laboratory Press.
10. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.

MIC-PG-C104: Laboratory Course I

1. General instructions, microbiology laboratory and its discipline and demonstration of different instruments commonly used in microbiology laboratory
2. Handling of microscopes, calibration and measurement of microscopic objects (Bacteria, yeast and fungal filaments).
3. Staining: Simple techniques, Differential techniques, Special techniques (smear preparation, Gram's staining, Acid fast staining, staining for metachromatic granules, Negative staining and spore staining).
4. Motility test (hanging drop experiment).
5. Isolation, enumeration of pure culture of bacteria, fungus and yeasts, sterilization and disinfection methods, preparation of media and reagents/stains
6. Identification of bacteria using standard biochemical tests
7. Estimation of carbohydrate
8. Isolation and estimation of Protein
9. Assay of enzymes: Amylase
10. Enzyme kinetics
11. Factor influencing enzyme activity: pH, Temperature.
12. Demonstration of gas chromatograph**y,** Electrophoresis (Agarose and SDS-PAGE)
13. Demonstration of TLC/HPTLC, Biolog, ELISA
14. Hands on Biocompution I: Nucleotide sequence searches and alignments
15. Hands on Biocompution II: Building Phylogenetic trees
16. Hands on Biocomputation III. Working with proteins

Reading List

1. Goldman, E. and Green, L. H. 2008. *Practical Handbook of Microbiology.* 2nd edition, Francis and Taylor Group.

2. Plummer, D. T. 2004. *Introduction to Practical Biochemistry*. 3rd edition, Tata McGraw Hill Publishing Company Limited.
3. White, D. and G. D. Hegeman. 1998. *Microbial Physiology and Biochemistry Laboratory: A Quantitative Approach.* Oxford University Press: New York, NY.
4. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.
5. Krane, D. E. and Raymer, M. L. 2002. *Fundamental Concepts of Bioinformatics.* Benjamin Cummings, USA.
6. Baxevanis, A. D. and Ouellette, B. F. F. 2004. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* 3rd edition, Wiley-Inter Science.

SECOND SEMESTER

MIC-PG-C201: Microbial Physiology

Unit I: Membrane Biology and Bioenergetics

Plasma Membrane: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active and passive transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Membrane transport – models of carrier proteins; export of cell surface structural components.

Bioenergetics: Introduction to the Principles of bioenergetics, entropy, enthalpy, redox reactions in biological systems, pH and Buffers, Handerson Hasselbach equations

Unit II: Carbohydrate metabolism

Embden-Meyerhof pathway, glyoxalate pathway, Krebs cycle and reverse TCA cycle, gluconeogenesis; fermentation of carbohydrates- homo and heterolactic fermentation; Oxidative phosphorylation; anaerobic respiration

Unit III: Autotrophy and Microbial development

Photosynthesis: Brief account of photosynthetic and accessory pigments: chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, and phycobiliproteins. Oxygenic and anoxygenic photosynthesis, autotrophic generation of ATP; Fixation of CO_2 (Calvin cycle). Chemosynthesis: sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis and bioluminescence.

Unit IV: Microbial development

Peptidoglycan synthesis, bacterial cell division, sporulation, differentiation. Antimicrobial agents and its mode of action.

Reading List

Madigan, T. M., Martinko, J.M. and Parker, J. 2008. *Brock's Biology of Microorganisms*. 12th edition, Prentice Hall College Div.

1. Moat, A.G. and Foster, J.W. 2002. *Microbial. Physiology.* 4th edition, Wiley-Liss.
2. Nelson, D. L. and Cox, M.M. 2008. *Lenhinger's Principles of Biochemistry*. 5th edition. W.H. Freeman
3. Wilson, K. and Walker, J. 2008. *Practical Biochemistry - Principles and Techniques*. 5th edition, Cambridge Low Price Edition.

MIC-PG-O202: Microbial Genetics and Molecular Biology

Unit I: Classical Genetics

Introduction to the Gene transfer mechanisms: transformation, transduction, conjugation. Genetic mapping with the help of conjugation and transduction; Phage genetics: Fine structure analysis of T4 rII locus; Plasmid: Introduction, classification, incompatibility, copy number control.

Unit II: Transcription and gene regulation

Introduction, RNA polymerase structure and function, prokaryotic promoter sequence, of alternate sigma factors; transcription initiation, elongation and termination; attenuation and antitermination.

Operon – Introduction, Positive regulation and Negative regulation of operon, *lac* operon, regulation by attenuation- his and trp operons; antiterminaton - N protein and nut sites, role of cAMP in regulation of transcription

Unit III: Transposons, RNA Molecules, Mutations

Classification, IS elements, composite transposons, mechanism of transposition. RNA interference, SiRNA, MicroRNA, Small RNA molecules, Mutation - Types, causes and detection of mutation, Molecular nature of mutation, mutagens.

Unit IV: Genomics and Proteomics

Microbial genomics and proteomics a brief introduction: Physical mapping, genome sequencing & annotation, functional genomics, transcriptome and proteome analysis, Phenomenon of Restriction Modification systems; DNA cloning, expression of recombinant proteins in prokaryotic and eukaryotic vectors; Preparation of cDNA libraries in plasmid, phagmid, cosmid, BAC and YAC vectors; In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms, positional cloning.

Reading List

1. Karp, G. 1996. *Cell and Molecular Biology*. John Wiley and Sons.
2. Lewin, B. 2012. *Genes* XI. 11th Edition, Oxford University Press.
3. Maloy, S., Cronan, J.E., Freifelder, D. 2004. *Microbial Genetics (Jones and Bartlett Series in Bioogy)*. 2nd edition, Jones and Bartlett Publishers, Inc.
4. Snyder, L. and Champness, W. 2007. *Molecular Genetics of Bacteria (Snyder, Molecular Genetics of Bacteria)*. 3rd edition. ASM Press.
5. Streips, U. N. and Yasbin, R. E. 2002. *Modern Microbial Genetics*. 2nd edition, Wiley-Liss
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Losick, R. 2013. *Molecular Biology of the Gene*. 7th edition. Pearson Edn. Inc.
7. Weaver, R. F. 1999. *Molecular Biology*. WCB McGraw Hill Co., Inc., NY.

MIC-PG-S203: Clinical Microbiology

Unit I: Principles of Clinical Microbiology

Koch's Postulates. Classification of medically important microorganisms. Normal microbial flora of human body and their role. Host pathogen Interaction. Infection: Sources and vehicles of infection: water borne, air borne, STDs, insect borne, nosocomial.

Establishment of infection: Mechanism of infection.

Control of infectious diseases

Unit II: Bacterial pathogens

Brief account of morphology, cultural characteristics, pathogenesis, clinical features, laboratory diagnosis, prevention and control of following:

Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Clostridium, organisms belonging to enterobacteriaceae, vibrios, *Yersinia, Haemophilus, Bordetella, Brucella, Mycobacteria*, spirochaetes, actinomycetes; rickettsiae and chlamydiae.

Unit III: Viral Pathogens

Brief account of morphology, cultural characteristics, pathogenesis, clinical features, laboratory diagnosis, prevention and control of important viral pathogens

Unit IV: Fungal and parasitic pathogens

Brief account of morphology, cultural characteristics, pathogenesis, clinical features, laboratory diagnosis, prevention and control of human fungal diseses. Dermatophytes, Dimorphic fungi, opportunistic fungal pathogens.

Brief account of morphology, life-cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and control of important human parasitic diseases.

Reading List

1. Ananthanarayan And Paniker: 2013. *Ananthanarayan and Paniker's Textbook of Microbiology*. C. K. Jayaram Paniker, 9th edition, Orient Blackswan.
2. P. Chakraborty. 2013. *A Textbook of Microbiology*. 3rd edition. New Central Book Agency (P) Limited
3. Bottone, E. J. 2006. *Atlas of the Clinical Microbiology of Infectious Diseases, Volume 2: Viral, Fungal and Parasitic Agents.* 1st edition, Informa Health Care Publishing.
4. Collee, J.G., Fraser, A. G., Marmion, B. P. Simmons. 2011. Mackie & McCartney Practical Medical Microbiology. 14th edition, Churchill Livingstone.
5. Brooks, G., Carroll, K. C., Butel, J. and Morse, S. 2007. *Medical Microbiology (Jawetz, Melnick, and Adelberg's Medical Microbiology)*. 24th edition McGraw-Hill Medical.
6. Forbes, B. A., Sahm, D. F. and Weissfeld, A. S. 2007. *Bailey and Scott's Diagnostic Microbiology*. 12th edition, Mosby.
7. Kayser, F., Bienz, K., Eckert, J. and Zinkernagel, R. 2004. *Medical Microbiology*. 1st edition, Georg Thieme Verlag.
8. Mims, C. A. 2004. *Medical Microbiology*. 3rd edition C.V. Mosby.
9. Murray, P. R. and Rosenthal, K. 2005. *Review of Medical Microbiology*. 1st edition, Mosby.
10. Murray, P. R., Baron, E. J., Jorgensen, J. H. and Landry, M. J.: 2007, *Manual of Clinical Microbiology* (2 Volume Set),). 9th edition, ASM Press.
11. Spicer, W. J. 2007. *Clinical Microbiology and Infectious diseases*. 2nd edition. Churchill Livingstone.

MIC-PG-C204: Laboratory Course II

1. Biosafety and Good Microbiology Laboratory Practices
2. Isolation of Genomic and plasmid DNA from bacteria
3. Agarose gel Electrophoresis of the isolated genomic and plasmid DNA
4. Amplification of genomic DNA by PCR
5. Purification of PCR amplified DNA from agarose gel
6. Quantification of DNA by UV-Visual spectroscopy

7. Bacterial transformation and conjugation
8. Demonstration of Real Time PCR
9. Demonstration of DNA Sequencing techniques
10. Isolation and Identification of medically important bacteria from human skin, and some clinical samples like pus, urine & stool.
11. Antibiotic susceptibility testing by disc diffusion method and MIC
12. Demonstration of Acid Fast Bacilli (AFB) by ZN staining
13. Demonstration of BIOLOG for phenotypic identification of bacteria

Reading List

Arora, D.K., Surajit Das, Mesapogu Sukumar (Eds.) 2013. Analyzing Microbes: Manual of Molecular Biology Techniques, Springer-Verlag Berlin Heidelberg

1. Collee, J.G., Fraser, A. G., Marmion, B. P. Simmons. 2011. Mackie & McCartney Practical Medical Microbiology. 14th edition, Churchill Livingstone.
2. Field, K. G. and Ream, W. 1999. *Molecular Biology Techniques: An Intensive Laboratory Course* (1999). Academic Press.
3. Michael J. McPherson and Simon Geir Møller. 2006. PCR. Taylor and Francis, Madison Avenue, NY
4. Sambrook, J. and Russell David, W. R. 2001. *Molecular cloning A Laboratory Manual*, Three volumes, CSHL N.Y, Ed.

THIRD SEMESTER

MIC-PG-S301: Food Microbiology

Unit I: Taxonomy and microorganisms associated with fermented foods

Taxonomic Tools (phenotypic, biochemical and molecular) and Approaches (Culture dependents and culture independent techniques) to study microorganisms associated with fermented foods; Brief account of major groups of microorganisms associated with fermented foods: milk, vegetable, cereal, meat, fish, legumes, amylolytic starters and alcoholic beverages.

Unit II: Foodborne illness and Food safety

Food poisoning and mycotoxins in foods. Characteristics, pathogenesis and clinical features of foodborne diseases caused by *Clostridium botulinum, Escherichia coli*, *Listeria monocytogenes, Salmonella* and *Shigella.*

Hazard Analysis and Critical Control Point (HACCP) System- definition and application.

Unit III Fermented foods and beverages

Methods of production, microbiology and nutrition: Fermented vegetables (*any one*): *gundruk, sinki, kimchi, sauerkraut, soibum*. Fermented legumes (any one): *kinema, natto, chungkukjang, shoyu, dawadawa, tempe*. Fermented cereals (any one): *dosa, idli, selroti, nan, sourdough, kenkey.* Fermented milks (any one): *dahi, yogurt, chhurpi,cheese, shrikand.* Fermented fish (any one): *ngari, nam pla, tungtap, sidra, jeot kal.* Fermented meat (any one): sausage, *kargyong, nham, salami, nem-chua.* Asian amylolytic starters (any one): *marcha, ragi, bubod, nurul, hamei, loogpang, koji*. Alcoholic beverages (any one): *kodo ko jaanr, sake, Bantu beer, pulque, chicha*.

Unit IV: Probiotics
Probiotics: Definition, characteristic, Gut microbiota, beneficial effects of probiotic bacteria; prebiotics and synbiotics.

Reading List

1. Batt, C. and Tortorello, M.A. (2014). *Encyclopaedia of Food Microbiology*, 2 edition. Elsevier Ltd., Oxford, London.
2. Lee, Y.K. and S. Salminen. (2014). *Handbook of Probiotics and Prebiotics*, 3rd edition. Wiley, Hoboken.
3. Steinkraus, K. H. 1996. *Handbook of Indigenous Fermented Food*. 2nd edition, Marcel Dekker, Inc., New York.
4. Tamang, J.P. 2010. *Himalayan Fermented Foods: Microbiology, Nutrition and Ethnic Values*. CRC Press, Taylor and Francis Group, New York, USA.
5. Tamang, J.P. and Kailasapathy, K. 2010. *Fermented Foods and Beverages of the World*. CRC Press, Taylor and Francis Group, New York, USA.
6. Tamang, J.P. 2014. *Health Benefits of Fermented Foods and Beverages*. CRC Press, Taylor and Francis Group, New York, USA.

MIC-PG-S302: Environmental Microbiology

Unit I: Aquatic, Atmospheric and Extreme Environments
Microbial habitats in the aquatic environment- Planktonic, Benthic, Microbial Mats, Biofilms. Freshwater environments, brackish water, marine water, subterranean water. Aeromicrobiological Pathway (Launching, Transport and Deposition); Extramural and Intramural aeromicrobiology. Bioaerosol control.
General characteristics and mechanisms of adaptation of extremophiles.

Unit II: Microbial Communication
Communication via quorum sensing in Gram negative bacteria. N-Acyl Homoserine Lactones (AHLs). Quorum sensing in *Agrobacterium tumefaciens*. Quorum sensing in marine squid. Signaling in Gram positive bacteria (γ- Butyrolactones, peptide signaling).

Unit III: Microbial Biodegradation and Bioremediation
The overall process of biodegradation. Environmental factors affecting biodegradation. Biodegradation of organic pollutants (Aliphatic, alicyclic, aromatic).
Biodegradation of xenobiotics- pesticide catabolism, reductive dechlorination, aerobic dechlorination. Microbial leaching of ores and metal recovery.

Unit IV: Solid and Liquid Waste Management
Solid waste components and management. Modern wastewater treatment (Primary, secondary and tertiary). Drinking water purification. The concept of indicator microorganisms (Total coliforms). Criteria for an ideal indicator organism.

Reading List

1. Boland, G. J. and Kuykendall, L. D. 1998. *Plant-Microbe Interactions and Biological Control*. Marcel Dekker Inc., NY, USA.
2. Bitton, G. 2005. Wastewater Microbiology. Third Edition, John Wiley and Sons Inc, Hoboken, New Jersey.

3. Crawford, R.L. and Crawford, D. L. 2005. Bioremediation: Principles and Applications. Cambridge University Press, New York.
4. Maier, R.M, Pepper, I.L. and Gerba, C.P. 2009. *Environnemental Microbiology.* Second edition. Academic Press.
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D. P. 2009. Brock Biology of Microorganisms. Twelfth Edition, Pearson Education Inc. San Francisco.
6. Mitchell, R. and Gu Ji-D. 2010. Environmental Microbiology, Second Edition, Wiley Blackwell, John Wiley and Sons Inc, Hoboken, New Jersey.

MIC-PG-O303: Basic Immunology and Immuno-techniques

Unit I: Introduction to Immune system
Innate immune response and its components; adaptive immune response, Organs, cells and molecules involved in immune system, antigen and structure of antibody.

Unit II: Structure and Development of Immune system
B and T cell receptor, Development of B and T cells, Antigen presentation, Hypersenstivity, Cytokines and Complement system.

Unit III: Disease due to innate and adaptive immunity and escape from it
Sepsis, endotoxin, cytokine, complement, polymorphs, mast cells, avoiding pattern recognition, complement, phagocytosis, NK cells, dendritic cells and cytokine network. Hypersensitivity, self tolerance, polyclonal lymphocyte activation, antigen mimicry, release of sequestered antigens, anomalous antigen presentation and autoimmune disease.

Unit IV: Immunological techniques
Different types of Vaccine, Monoclonal and polyclonal antibodies, Immuno-techniques including ELISA, Immunoflorensccence, Immuno-precipitation.

Reading List

1. Abbas, A.H., Lichtman, A.K. and Pober. 2003. *Cellular and Molecular Immunology*, W.B. Sauders Company, Philadelphia.
2. Banerjee, A. K. and Banerjee, N. 2006. *Fundamentals of Microbiology and Immunology,* New Central Book Agency (Pvt.) Ltd., Kolkata.
3. Coleman, R. M., Lombard, M. F. and Sicard, R. E. 2000. *Fundamental Immunology*, 4th edition, WmC Publications, London.
4. Johnson, A. G., Ziegler, R.J., Lukasewycz, O. A. and Hawley, L. B. 1996. *Microbiology and Immunology*, Third edition, Williams & Wilkins.
5. Kindt, Osborne, B. A. and Richard, A. and Goldsby, R. A. 2006. *Kuby Immunology (Kindt, Kuby Immunology*). 6th edition, W. H. Freeman.
6. Paul, W. E. 2003. *Fundamental Immunology*. 5th edition, Lippincott Williams and Wikins Publishers, USA.
7. Pier, G. B., Lyczak, J. B. and Wetzler, L. M. 2004. *Immunology, Infection, and Immunity*. 1st edition, ASM Press.
8. Playfair, J. Bancroft, G. 2008. *Infection and Immunity*. 3rd edition, Oxford University Press. New York

MIC-PG-C304: Laboratory Course III

1. Isolation and identification of dominant microorganisms from two fermented foods (any local product)
2. Isolation and identification of microbes from environmental samples
3. Microbial testing of water
4. Assessment of air microbial quality
5. Estimation of BOD from sewage samples
6. Isolation of some extremophiles
7. Demonstration of Immuno-techniques like Agglutination, Precipitation Immuno-precipitation
8. Demonstration of western blot and ELISA
9. Separation of different blood cells by ficoll method
10. Demonstration of BIOLOG for phenotypic identification

Reading List

1. Harrigan, W.F. 1998. *Laboratory Methods in Food Microbiology.* 3rd edition. Academic Press, London.
2. Roberts, D. and Greenwood, M. 2002. *Practical Food Microbiology.* 3rd edition, Wiley-Blackwell.
3. Hay, F.C. and Westwood, O.M.R. 2002. *Practical Immunology.* Fourth Edition, Blackwell Science.
4. Hurst, C. J., Crawford, R. L., Knudsen, G. R., McInerey, M. J. and Stetzenbach, L. D. 2002. *Manual of Environmental Microbiology*, Second edition. ASM Press, Washington DC.
5. Cappuccino, J. G. and Sherman, N. 2007. Microbiology- A Laboratory Manual, Seventh Edition, Pearson Education, Inc. and Dorling Kindersley (Indi) Pvt Ltd, Delhi, India.

FOURTH SEMESTER

MIC-PG-S401: Molecular Virology

Unit I: Nature of viruses

Modern classification of viruses. Concept of viroids, satellite viruses, virusoids and prions. Structure of viruses and their cultivation: Capsid symmetry and virus architecture. Protein nucleic acid interaction.

Unit II: Bacterial and Plant Viruses

Bacterial Viruses: Viral multiplication and replication strategies of T4, T7, ΦX174.
Plant Viruses: Viral multiplication and replication strategies of Tobacco Mosaic Virus, Cauliflower Mosaic Virus, Tungro Virus.

Unit III: Animal Viruses

Epidemiology, lifecycle, molecular mechanism of pathogenicity, diagnosis, prevention and treatment of RNA viruses, Picorna, Corona, Orthomyxo, Paramyxo, Toga, Flavi and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses: Pox, herpes, Adeno, SV40, Papilloma; Hepatitis viruses.

Unit IV: Immuno-techniques and viral vaccines
Principles of important diagnostic techniques employed for virus detection and characterization. Detailed description of various microscopic, immunological and molecular techniques.
Viral vaccines: Conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA vaccines with examples). Interferons and antiviral drugs.

Reading List:

1. Carter, J. and Saunders, V. 2007. Virology: *Principles and Applications.* First edition Wiley.
2. Dimmock, N.J., Primrose, S.B. 1994. *Introduction to Modern Virology,* 4th edition, Blackwell Scientific Publications, Oxford.
3. Fields, B.N. et al. 2001. *Fields-Virology, Vol I and II,* 4th edition. Lippincott Williams & Wilkins Publishers.
4. Cann, A. J.: *Principles of Molecular Virology,* (2005). 4th edition. Academic Press.

MIC-PG-S402: Agricultural and Industrial Microbiology

Unit I: Rhizosphere, Biofertilisers, Biological Nitrogen Fixation
Microorganisms of soils, rhizospheres and phylloplane. Biogeochemical cycles like carbon, nitrogen, sulfur and Phosphorus. Biofertilizers: Biological Nitrogen Fixation- symbiotic and asymbiotic, and Phosphate solubilizing bacteria. Biological methane production.

Unit II: Genetic Engineering in Agriculture
Significance of *Agro bacterium tumifaciens and* viral vectors in development of transgenic plants-brief technique used. Microbial ecology of soil with biotic and abiotic factors. Brief discussion of Bt cotton, beta-carotene maize, golden rice, edible vaccines release of GMOs, eg. *Pseudomonas syringe, P. putida.* Biological control agent for plant disease control.

Unit III: Introduction to Industrial Microbiology and Fermentation Principles
Different types of fermentative approaches, economics of fermentation, Fermentation in batch culture: Microbial growth kinetics, growth and nutrient, growth and product formation, heat evolution, effect of environment in media formulation. Surface and submerged fermentation (Liquid and solid state fermentations); raw materials, mechanically & non-mechanically agitated fermenters.

Unit IV: Typical fermentations, Industrial strains and Immobilization technique
Fermentative production of antibiotics (Penicillin), solvents (ethanol), Biopolymers (PGA) and recombinant DNA products e.g. Insulin and amylase. Biotransformations, Strategies for selection and improvement, maintenance of recombinant organisms, large scale production using recombinant microorganisms. Product recovery. Downstream processes for fermentation product Immobilization of enzymes and cells: techniques and processes. Biosensors

Reading List

1. Stanbury, P. F., Hall, S. J. and Whitaker, A. 1999. *Principles of Fermentation Technology.* 2nd edition, Butterworth-Heinemann.
2. Casida, L.E. 2005. *Industrial Microbiology*. 2nd edition. New Age International Limited.

3. Crueger, W. and Crueger, A. 2003. *Biotechnology: A textbook of Industrial Microbiology*. Panima Publishing Corporation.
4. Boland, G. J. and Kuykendall, L. D. 1998. *Plant-Microbe Interactions and Biological Control*. Marcel Dekker Inc., New York.
5. Markandey D.K. 2006. *Agricultural Applications of Microbiology,* APH Publishing Corporation.
6. Subba Rao, N. S. 1982. *Advances in Agriculture Microbiology (Studies in the Agricultural & Food Sciences.* Butterworth-Heinemann.
7. Subba Rao, N. S. and Subba Rao, N. S. 1999. *Soil Microbiology.* 4th edition. Science Publishers.
8. Werner, D. and Newton, W. E. 2005. *Nitrogen Fixation in Agriculture, Forestry, Ecology, and the Environment*. Springer.

MIC-PG-S403: Laboratory Course IV

1. Isolation of bacteriophages
2. Isolation of animal viruses
3. Quantification of viruses by plaque assay/Real Time PCR
4. Ethanol production from any starchy materials.
5. Fermentation for the production of amylase, penicillin and citric acid
6. Enumeration of total bacterial, fungal and actinomycetes counts from soils by pour & spread plate method
7. Qualitative and quantitative evaluation of phosphate solubilization by soil isolates.
8. Demonstration of bio-fertilizer preparation.
9. Isolation of microorganisms from rhizospheric soil

Reading List

1. McNeil, B. and Harvey, L. 2008. *Practical Fermentation Technology.* Wiley.
2. Alexander, M. 1977. Soil Microbiology. John Wiley.
3. Cappucino, J. and Shuman, P. 2008. Microbiology: A Laboratory Manual. Benjamin Cummings.

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