PONDICHERRY UNIVERSITY
PONDICHERRY – 605 014 INDIA

M. Sc. Microbiology

BACKGROUND PAPER

Prepared by Dr. K. Jeevaratnam, Professor DBMB, Pondicherry University.

Microbiolgy is one of the important areas in the field of Life Sciences encompassing the field of Medicine, Food, Agriculture and Industry. There is a continually evolving of micro- organisms and virus presenting challenges with regard to emerging infectious diseases, ensuring microbial safety in processed foods and increasing the yield in agricultural produce. Microorganisms also are an important component of food processing and biotechnology, termed rightfully as future factories. The goals of this rapidly growing highly interdisciplinary field include (i) understanding of the microbial world and its diversity for wider application in various industries such as Biopharmaceutical industries, especially GRAS organisms; (ii) developing various diagnostics for speedy detection of infection and enabling appropriate treatment to reduce the morbidity; (iii) reducing various wastes using genetically engineered organisms to clean up the environment as well as to minimize the highly hazardous spread of infectious diseases.

M.Sc. in Microbiology offered at Pondicherry University is a programme designed to equip post-graduates with multi-disciplinary skills and knowledge in the area of Biomedicine, Food and Agriculture and Biopharmaceutical and processed food Industries, and Waste management and environmental sustainability. The course will be taught by a team of specialists working in the fields of microbial biochemistry and biotechnology, food microbiology, medical microbiology, agricultural microbiology and industrial microbiology. This program is designed for two years spread into four semesters. First three semesters are for hard core courses and a few soft-core (optional) courses and final semester is for project and a few soft core courses. Most of the first and second semester courses will be on essentials of Microbiology such as Bacteriology, Virology and Mycology; Microbial Biochemistry, Molecular Biology and Genetics, while third semester will have the applied aspects, viz., Genetic engineering, Medical Microbiology, Food Microbiology, Fermentation Technology and Down-stream processing and Industrial Microbiology, while the fourth semester deals with Environmental Microbiology and Agricultural Microbiology as well as Project/Dissertation. A student is expected to earn at least 72 credits to qualify for the M.Sc. degree.
Students with Bachelor's degree in Microbiology/ Biochemistry/Biotechnology/Medical Laboratory Technology or any other branch of Life sciences with a minimum of 55% of marks are eligible to undergo this program.

Development of research and communication skills.
Research Project and Dissertation: Specifically designed to give the student practical experience in the different areas of Microbiology. The student will undertake a research based project at Pondicherry University or at an associated academic or industrial partner and thus receive practical training in chosen area from an expert.
Seminars: Students need to deliver a number of seminars during their curricular learning to develop communication skills.

Teaching and Learning Methods
Lectures, tutorials and seminars form the main methods of course delivery enhanced by individual and group project work, laboratory work, computing workshops and industrial visits.

Assessment Methods
Assessment will be through Choice Based Credit System (CBCS) through session by continuous assessment (class tests, assignments, seminars, laboratory works and project work and report) and end semester examinations.
A thesis written for the project/dissertation will be evaluated by an expert followed by viva-voce.

Minimum credit requirement = 72; All teaching, learning and evaluations will follow Choice Based Credit System (CBCS) which is in vogue in Pondicherry University.

Employment:
It is envisaged that the M.Sc. graduates in Microbiology will gain employment in the R&D and industries pertaining to Diagnostics, Bio-Pharmaceuticals, and Processed Foods.

TENTATIVE COURSE STRUCTURE FOR M.Sc. IN MICROBIOLOGY

1st YEAR

1st Semester:

Theory Courses (3 credits each)

1. MB 401 General Microbiology and Microbial diversity (HC)
2. MB 402 Bacteriology (HC)
3. MB 403 Microbial Physiology (HC)
4. MB 404 Instrumentation & Techniques in Microbiology (HC)
5. Biostatistics (SC)

Lab Courses (HC) (1 Credit each)

1. MB 451 General Microbiology Lab
2. MB 452 Bacteriology Lab
3. MB 453 Microbial Physiology Lab
4. MB 454 Instrumentation & Techniques in Microbiology Lab

2nd Semester:

Theory Courses (3 credits each)

1. MB 405 Microbial Biochemistry (HC)
2. MB 406 Virology (HC)
3. MB 407 Mycology (HC)
4. MB 408 Molecular Biology (HC)
5. MB 409 Microbial Genetics (HC)
6. MB 410 Immunology (HC)

Lab Courses (HC) (1 Credit each)

1. MB 455 Microbial Biochemistry Lab
2. MB 456 Virology and Mycology Lab
3. MB 457 Molecular Biology and Microbial Genetics Lab
4. MB 458 Immunology Lab

2nd YEAR

3rd Semester:

Theory Courses (3 credits each)

1. MB 501 Genetic Engineering (HC)
2. MB 502 Food Microbiology (HC)
3. MB 503 Fermentation Technology & Down-stream processing (HC)
4. MB 504 Agricultural Microbiology (HC)
5. MB 505 Medical Microbiology (HC)

Lab Courses (HC) (1 Credit each)

1. MB 551 Genetic Engineering Lab
2. MB 552 Food Microbiology Lab
3. MB 553 Fermentation Technology & Down-stream processing Lab

4th Semester

1. MB 506 Industrial Microbiology (SC) – 3 credits
2. MB 507 Environmental Microbiology (SC) – 3 credits
3. MB 575 Project/Dissertation – 6 credits

MB-401 - General Microbiology **3 Credits**

UNIT – I 10 h

History and scope of Microbiology. Discovery, importance and relevance of microorganisms. Outline classification of living organisms. Characteristic of prokaryotes archaebacteria and eukaryotes. Sterilization and disinfection techniques, Principles and methods of sterilization. Physical and chemical methods. Outline classification of living organisms. Definition and characteristic of prokaryotes and eukaryotes.

UNIT – II 8 h

Culture of microorganisms – culture media, natural complex, semi defined and chemically defined media, minimal media. General and selective media. Media for anaerobic bacteria, Solid and liquid media, solid substrate and liquid fermentation, submerged and surface fermentation. Cultivation of viruses and mycoplasma. Aseptic culture techniques.

UNIT – III 8 h

Isolation of pure culture, Preservation of microbial cultures – Enrichment culture, Single cell and single spore isolation methods, hyphal tip isolation of filamentous fungi. Microbial strains and strain level identification – molecular tools and unique molecular bar coding. Strain improvement – spontaneous mutation and screening, induced mutation by chemical and physical methods and site directed mutagenesis. Screening and optimization of potential strains.

Unit - IV **5 h**

Diversity in the microbial World: Definition, Concepts and Scope of microbial diversity. Types of Diversity: Morphological, Structural, Metabolic, Ecological and Evolutionary diversity (Genetic diversity) of the Microbial World. Microbial succession. Methods for the detection of microbial diversity - culture and culture independent methods.

Unit - V **5 h**

Microbial diversity in agriculture, forestry, environment, industrial and food biotechnology, animal and human health. Conservation of biodiversity. *In situ* conservation and *Ex* situ conservation. Role of culture collection centers in conservation. Micro organisms in the extreme environments, ecological significance and utilization in industry.

Text Books:

1. Singh, R.P. (2007). **General Microbiology**. Kalyani Publishers, New Delhi.
2. Frobisher, H., Hinsdil, R.D., Crabtree, K.T. and Goodhert, D.R. (2005). **Fundamentals of Microbiology**, Saunder and Company, London.

Suggested Readings:

1. Reddy, S.M. (2003). **University Microbiology –I** . Galgotia Publications Pvt Ltd., New Delhi.
2. Prescott, M.J., Harley, J.P. and Klein, D.A. (2002). **Microbiology.** 5th Edition, WCB Mc GrawHill, New York.
3. Tortora, G.J., Funke, B.R. and Case, C.L. (2004). **Microbiology: An Introduction**. Pearson Education, Singapore.
4. Niclin, J. et al. (1999). **Instant Notes in Microbiology**. Viva Books Pvt. Ltd., New Delhi.
5. Relevant recent reviews and scientific articles in peer reviewed journals.

MB 402 BACTERIOLOGY

Units **3 CREDITS; 36 Lecture Hrs**

1.Bacterial taxonomy and Diversity: Classification based on Bergey's manual of Determinative Bacteriology-the Gram negative, Gram positive, the mycoplasmas and archea ; Classification based on serology, biochemistry, 16s rRNA, G+C content and other molecular tools; Salient features of major groups of Bacteria with representative examples- Staphylococcus, streptococcus, pneumococcus, Nesseria, corynebacterium, Bacillus, Clostridium, Proteus, Shigella, Salmonella, Vibrio, Pseudomonas, Yersinia, Haemophilus, Bordetella, Brucella, Mycobacterium, Spirochetes, Mycoplasmas, rickettsiae and chlamydiae **-8 Hrs**

2. Ultrastructure of Bacteria- bacterial size, shape, components of bacterial cell wall, cell wall synthesis, plasma membrane, Cytoplasmic matrix, nucleoid, Inclusion bodies, Ribosomes, Flagella and Pili. Bacterial reproduction-fission, budding and endospore formation. Staining procedures for identification of bacteria-Basic and Acidic dyes-methylene blue, saffranine, Grams stain, acid fast staining, flagella and spore stains. **-6 Hrs**

3. Culture conditions for bacteria -bactetrial culture media- chemically defined, complex, differential and special selective media - for aerobic and anerobic bacteria; Bacterial growth curve-Phases of Growth; Effect of physical and chemical factors on growth -pH, temperature, media components and radiation. Measuring bacterial growth-Spectrophotometric method, microscopic counting, serial dilution and viable cell count, MPN, and filtration technique. **-6 Hrs**

4. Economic importance of bacteria: A brief account on the economic importance of bacteria in Agriculture-Nitrogen fixing organisms; ecological importance-bioremediation and biopesticides; Industrial importance- source of antibiotics, production of recombinant proteins-growth factors, hormones, vaccines etc. Normal flora in the GIT and their advantages; **-8 Hrs**

5. Bacteria as Pathogens-some major bacterial diseases of Humans-Pneumococcal pneumonia, whooping cough, tuberculosis, anthrax, tetani, typhoid, diphtheria, shigellosis, cholera, peptic ulcer; Antibacterial agents-mode of action of antibiotics and chemotherapeutic drugs; Antibiotic sensitivity assays- disc method; replica plating technique; Ames test; Antibiotic resistance in bacteria-various factors that contribute to the development of resistance. **-8 Hrs**

Text Books:

1. Prescott, Harley and Klein- Microbiology-5th edition; Publisher: McGraw Hill science 2002
2. Jacquelyn G. Black-Microbiology Principles and Explorations-6th edition; Publisher:John Wiley &Sons, Inc. 2004

Suggested Reading:

1. Robert W. Bauman -Microbiology Brief edition, Publisher: Benjamin Cummings,2004.
2. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, , Microbiology: An Introduction.8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
3. Kenneth J. Ryan,C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.

Unit	MB-403 MICROBIAL PHYSIOLOGY	3 Credits
I	Classification and functions, Monosaccharides- glucose and mutarotation. Reducing and non-reducing sugars. Structure, occurrence and biological importance of structural polysaccharides- examples- cellulose, chitin, agar, alginic acids, pectin, bacterial cell wall peptidoglycan and outer membrane techoic acid polysaccharides. Storage food polysaccharides- Structure of starch. Lipids- Classification. Structure and functions of fatty acids, cholesterol, bacterial membrane lipids; peptidoglycan synthesis..	**9 h**
II	Major nutritional types of microorganisms- Autotrophs, Heterotrophs, Chemotrophs, Phototrophs, Lithotrophs and organotrophs. Functions of some common vitamins in microorganisms- Biotin, Cyanocobalmin, Folic acid, Niacin and Riboflavin. Uptake of nutrients by the cell- Passive diffusion, Faclitated diffusion, Active transport mechanisms, Group translocation- Phosphoenolpyruvate: sugar phosphotransferase system (PTS). Siderphores-iron.	**7 h**
III	Introduction to biocatalysis, differences between chemical and biological catalysis. Nomenclature and classification of enzymes. Enzyme specificity. Active site. Principles of energy of activation, transition state. Definition of holo-enzyme, apo-enzyme, coenzyme, cofactor. Factors affecting the catalysis- substrate concentration, pH, temperature. Michaelis - Menten equation for uni-substrate reaction (derivation not necessary), significance of KM and Vmax. Enzyme inhibitiors. Mechanism of Lysozyme action. Regulation of enzyme activity by non-genetic mechanisms – Allosteric regulation and Feedback control- Regulation of *E. coli a*spartate carbamoyltransferase. Multienzyme complex.	**7 h**
IV	Oxygenic and anoxygenic phototrophs and their diversity; Photosynthetic and accessory pigments- chlorophylls –carotenoids- phycobiliproteins- phycoerythrin-phycocyanin, bacteriochlorophylls. Cyclic photophosphorylation, Noncyclic photophosphorylation, - fixation of CO_2 - Calvin cycle. Aerobic and anaerobic respiration; sulfur reducers, methanogenesis, Bioluminescence- Luciferin in bacteria.	**7 h**
V	Extremophiles - Halophiles, Acidophiles, Neutrophiles, Alkalophiles, Psychrophiles, Facultative psychrophiles, Mesophiles, Thermophiles, Hyperthermophiles, Barophilic, Obligate anaerobes. **Quorum sensing**- Molecules used as signals in quorum sensing. Quorum sensing in *Pseudomonas aeruginosa* and the formation of bioflims.	**6 h**

Text Books:

1. Moat A.G. Foster J.W.Spector M.P. 2002. Microbial Physiology (4th ed). Wiley.
2. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury. Massachusetts.

Suggested Reading:

1. Johri, B.N. 2000. Extremophiles. Springer Verlag. New York
2. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
3. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington. D.C.
4. Sullia, S.B. and Shantharam, S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
5. Tortora, G.J., Funke, B.R. and Case C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.
6. Caldwell, D.R. 1995 Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.

MB:404 INSTRUMENTATION AND TECHNIQUES IN MICROBIOLOGY

UNIT **3 CREDITS**

I	Centrifugation - Basic principles-types of centrifuges-colloidal nature of particles-centrifugation methods and accessories - sedimentation velocity-sedimentation equilibrium-cell fractionation methods.	6 h
II	Microscopy: Principles of Microscopy: Different types of microscopes, their construction and working principles, Behavior of Light. Light theories Light microscopy- Simple microscopy (dissection microscope), Compound microscopy (Bright field, Dark field, phase contrast, and Fluorescence microscopy), and stereomicroscopy. Confocal microscopy. Electron microscopy, Principles, construction and mode of operation of scanning and Transmission electron microscopy, limitations. Preparation of specimens for electron microscopic studies (Ultra thin sectioning, negative staining, shadow casting and freeze etching	9 h
III	Principles and techniques of colorimetry and Beer-Lamberts Law, spectrophotometry- Spectrofluorimetry -Turbidimetry - Flame and Atomic absorption Spectrophotometer. Electrophoresis: Principles and working, types of electrophoresis, DNA and RNA electrophoresis, SDS PAGE, 2-D Gel electrophoresis, hybridisagtion hybridization, Western blot, Northern and Southern blot, North Western blot.	8 h
IV	Chromatography- types- partition - liquid-liquid, thin layer, adsorption, gas liquid, ion exchange, affinity, HPLC- principles of each type- instrumentation and accessories- detection methods and systems qualitative and quantitative aspects-applications.	6 h
V	Microbiological stains and staining techniques**:** Types of stains and principles of staining. Stains for bacteria, fungi, algae and protozoa, spirochetes; stains for azotobacter cysts, stains for mycoplasma. Preparation of bacterial smears for light microscopy: Fixation, simple staining (positive and negative), Differential staining (Gram's staining and acid- fast staining), Structural staining (Capsule, Flagella, Cell wall, and Endospore of bacteria), and nuclear staining.	9 h

Text Book:

1. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
2. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts.

Suggested Reading:

1. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
2. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.

3. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
4. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington. D.C. of microbial life. John Wiley 7 Sons Inc. Publication. New York.
5. Sullia, S.B. and Shantharam,S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
6. Tortora, G.J., Funke, B.R. and Case C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.
7. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.

Unit	MB-405 MICROBIAL BIOCHEMISTRY	3 Credits
I	Amino acids: Classification of amino acids based on R Group, Properties of amino acids- Solubility, Ampholyte, Zwitterions, Isoelectric pH. Handerson and Hasselbach equation for ionization of amino acids. Nature of peptide bonds- Rigid and planar nature- Ramchandran plot. Biosynthesis of major amino acids. Amino acid catabolism- Deamination and transamination reactions.	**7 h**
II	Proteins: Classification based on structure and function. Structural organization of proteins- Primary structure, Secondary structure- α-Helix, β- pleats and β – turn. Tertiary structure of lysozyme. Supersecondary structures of proteins. Forces stabilizing different structural levels of proteins. Amino acid analysis- Identification of the N-terminus using 2,4-dinitrophenylfluorobenzene, dansyl chloride and Edman Degradation. C-terminal group analysis by hydrazinolysis and carboxypeptidase.	**7 h**
III	Water as a biological solvent and its role in biological processes. Nature of Nucleic Acids: Structure of purines, pyrimidines, nucleosides and, nucleotides. Nucleic Acids - Isolation of DNA and RNA from biological sources– microbes. Physiochemical properties of nucleic acids - Denaturation of nucleic acids. Hyperchromic effect and Tm. Reassociation kinetics, cot curves. Chargaff's rule, Secondary structure of DNA - Watson and Crick model. Secondary structure of tRNA - clover leaf model. Other structural features in DNA - Stem loop structure- Palindromic sequences - Cruciforms. DNA- protein interaction - Zinc finger leucine zipper motif, Helix - Turn - helix motif. Introduction to circular DNA- super coiling. Biosynthesis of purines and pyrimidines.	**9 h**
IV	First and second law of thermodynamic, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, redox potentials. ATP and high energy phosphate compounds. Lipid Metabolism: Classification of lipids as energy reserves, Fatty acid oxidation. Biosynthesis of fatty acids, triacylglycerols and phospholipids.	**7 h**
V	Glycolytic pathway, Pentose phosphate pathway, Entner- Doudroff pathway, Tricarboxylic acid cycle, Electron transport and oxidative phosphorylation, Fermentation- Lactic acid fermentation- Alcoholic fermentation- Formic acid fermentation. Catabolisn of Reserve polymers.	**6 h**

Text Books:

1. Nelson D L, Cox M M. Lehninger s Principle of Biochemistry. 4th ed. Freeman, 2004.
2. Lansing M. Prescott. Microbiology. 5th ed. The McGraw−Hill Companies, 2002.

Suggested Reading:

1. Alcomo IE. Fundamentals of Microbiology. 6th ed, Jones and Bartlett Publishers, Sudbury, Massachusetts. 2001.
2. Berg J M, Tymoczko J L, Stryer L. Biochemistry. 6th ed. Freeman, 2006.
3. Murray R K, Granner D K, Mayes P A, Rodwell V W. Harpers Biochemistry. 27th ed. McGraw Hill, 2006.
4. White David. Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York, 2000.
5. Tortora, G.J., Funke, B.R. and Case C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.

MB-406 – VIROLOGY **3 Credits – 36 h**

Unit I **7 h**

Concept and scope of virology. Foundations of virology: Virus prehistory, discovery of viruses. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and enzymes. Classification and nomenclature of viruses; Trends in virology; Evolutionary importance of viruses. Epidemology of Virus infection. Principles of diagnosis of virology

Unit II **10 h**

Biological activity of viruses, Physical, chemical and structural components of viruses, Visualization and enumeration of virus particles, Detection of viruses: physical, biological, immunological and molecular methods. Cultivation of viruses in embryonated eggs, laboratory animals and cell cultures. Serological methods – haemaglutinin and HAI, complement fixation, immunofluorescence methods, ELISA and RIA: Physical, chemical and molecular methods-protein, radioactive tracers, electron microscopy, nucleic acid - PCR based assays, infectivity assays for phages and plant viruses. Characterization of viral product expressed in the infected cells. Isolation and purification of viruses,

Unit III **6 h**

Morphology, ultra structure, chemical composition and replication of: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – HBV. **Sub-viral particles**: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

Unit IV **10 h**

General aspects of plant and animal viral diseases. Introduction to viral vaccines, preparation of vaccines, new vaccine technology; antiviral drugs, antiviral gene therapy. Modern approaches of virus control: Antisense RNA, siRNA, ribozymes. Oncogenesis: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways.

Unit V **6 hrs**

Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases. Prospectus using medical technology to eliminate specific viral and other infectious diseases. **Silver lining**: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.

Texts:

1. Black JG, 2002 Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York.

2. Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5th edn. Blackwell publishing, USA.

Suggested Readings:

Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C.

Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science. Inc.

MB 407 – Mycology **3 Ctredits**

Unit I 8 h

Historical perspectives – history and significance of mycology in the scientific development. General characteristics of fungi - Structure and organization of fungi – single cell, filamentous fungi, hyphae and complex fungal tissues: Colony, communication and signaling. Cell differentiation and reproduction. Reproduction in fungi - Vegetative, asexual and sexual reproduction in fungi with special reference to their significance.

Unit II 6h

Taxonomy – Criteria for classification. Traditional, chemo and molecular taxonomy and their significance. Myxomycets, Ascomycets, Basidiomycets and inperfect fungi. Ecology and distribution of yeasts and fungi.

Unit III 6 h

Nutrition and metabolism in fungi – nutritional requirement of fungi, saprophytic, parasitic, obligatory and facultative. Biotrophic semi-biotrophic and necrotrophic mode of growth. Fungal-microbe interaction, fungal - plant and fungal - animal interaction – symbiotic and antagonistic interactions. Fungal culture media – natural, synthetic and semi synthetic media. Natural substrates of fungi.

Unit IV 10 h

Significance of fungi in human and livestock health - symbiotic fungi, toxigenic fungi and mycotoxins, pathogenic fungi; Significance of yeasts and fungi in agricultural production – symbiotic fungi, toxigenic fungi and mycotoxins, plant pathogenic fungi, endophytic fungi, fungi in biocontrol and improving plant productivity; Significance of fungi in biotechnology and industrial production; Fungal metabolites and their economic significance – mycotoxins, antibiotics, food additives, alcohol, vinegar, enzymes, biopesticides. Fungi as food – mushrooms, yeast as food, other special foods of fungal origin such as smut balls.

Unit V 6 h

Endophytic fungi - symbiotic and opportunistic associations, co evolution and loss of reproductive structures, Secondary metabolite production, toxins – toxic to herbivores and insects and importance. Use of endophytic fungi as biocontrol agents against plant diseases, insect herbivores. Mycorrhiza – endo and ecto mycorrhiza.

Text Books:

1. Ainsworth (2009), Introduction to the History of Mycology, Cambridge University Press
2. Prescot, Harley & Klein, 2000, Microbiology, McGrawHill

Suggested Readings:

1. Ronald M. Atlas, 1987, Microbiology, Fundamentals and Applications, Prentice Hall.
2. Stanier, 1986, General Microbiology, McMillan Publishing Co.
3. The Fungi: An Advanced treatise I-IV volumes (Ed) Ainsworth & Sussman; Academic Press.
4. Mehrotra RS and KR Aneja. An Introduction to Mycology, New Age Publishers
5. Alexopoulos, Mims, and Blackwell, 1996. Introductory Mycology (4th Ed), John Wiley and Sons, N.Y.

Unit	MB 408: MOLECULAR BIOLOGY	3 CREDITS

1.	History and scope of molecular biology- Discovery of DNA- evidence for DNA as the genetic material. The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast- Gene transfer in microorganisms- conjugation-transformation, transduction - protoplasmic fusion.	9 h
2.	Organisation of eukaryotic genome- components of eukaryotic chromatin-chromatin and chromosome structure- DNA-supercoiling -linking number-satellite DNA-possible functions- Cot curve- C- value paradox.	5 h
3.	DNA replication- Prokaryotic and eukaryotic DNA replication, mechanism of replication. Enzymes and necessary proteins in DNA replication. Telomeres, telomerase and end replication. Role of telomerase in aging and cancer. DNA Repair- Mismatch, Base-excision, Nucleotide-excision and direct repair DNA recombination- Homologous, site-specific and DNA transposition	9 h
4.	Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases-general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination. Post transcriptional modification- 5' cap formation-3' end processing and polyadenylation-splicing- editing- nuclear export of mRNA- mRNA stability.	8 h
5.	Translation- Genetic code- Prokaryotic and eukaryotic translation-translational machinery- Mechanism of initiation- elongation and termination-Regulation of translation.	5 h

Text Book:

1. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 5th The Benjamin / Cummings Pub. Co. Inc, 2003
2. Weaver. R. F. Molecular Biology. 3rd ed. Mc Graw Hill publilcation , 2005

Suggested Reading:

1. Darnell, Lodish and Baltimore. Molecular Cell Biology, Scientific American Publishing Inc, 2000
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. 4th ed. Garland publishing Inc, 2002
3. Benjamin Lewin. Gene VII. Oxford University Press, 2000
   Nelson Cox. Lehninger's Principle of Biochemistry. 3rd ed. MacMillian Worth Publ, 2000

Unit	MB-409: MICROBIAL GENETICS	3 Credits

I	Microbial Genetics: Definition and scope of Genetics. Premendelian genetics concepts – Performation, Epoigenesis, Inheritance of acquired characters, Germplasm theory. Hereditary and Environment, Genotype and Phenotype, Clones, Purelines and Inbred lines. Microbes as genetic tools for genetic studies.	**7 h**
II	Viral Genetics: General characteristics of viral genome, T4 virulent Phage: Structure- life cycle. Lambda temperate phage: Structure - Lytic and lysogenic cycle, lysogenic repression. Genetic mapping of viruses, Recombination in viruses; Genetics of Bacteriophage.	**7 h**
III	Bacterial Genetics: Organization of genetic material in bacteria, Gene transfer mechanisms: Conjugation, Transformation and Transduction. Recombination in bacteria. Natural transformation systems- *Streptococcus pneumonia* and *Haemophilus influenzae*.. Transfection and forced competence. Bacterial Conjugation: Properties of the F plasmid, F^+ x F^- mating, F' x F^- conjugation. Transduction: Generalized and specialized transduction.	**8 h**
IV	Fungal Genetics: Features and consequences of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy and aneuploidy. *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses – Induction of Mutations - Mitotic recombination in *Neurospora* – Transposable elements - Gene conversion.	**6 h**
V	Regulation of gene expression operon: concept, catabolite repression instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation - *E. coli* lacoperon; positive regulation- *E.coli* ara operon; regulation by attenuation his and trp operons. DNA binding sites on DNA, Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA syntheses.	**8 h**

Textbooks:

1. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, (2002). 3rd edition, ASM Press, Washington, D.C.
2. Prokaryotic gene expression by S. Baumberg (2002) Oxford University Press.

Recommended Reading:

1. Molecular Biology of the Gene, 4th edition by Watson J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz & A.M. Weiner (1987) Benjamin/Cummings.

2. Modern Microbial Genetics (Second Edition) by Uldis N. Streips, Ronald E. Yasbin (2002) Wiley-Liss, Inc.

MB- 410 IMMUNOLOGY

3 CREDITS

UNIT

1. Introduction to the field of Immunology: Historic perspective, Discovery of humoral and cellular immunity; Types of Immunity: Innate immunity components-physical, physiological defenses; – complement, acute phase proteins, Toll like receptors, interferons; Acquired immunity: (specific) natural, artificial, active and passive immunity. Inflammatory response; Phagocytic system- mononuclear phagocytes, macrophages, neutrophils, Natural killer cells, mast cells, basophils, and eosinophils. **6 h**

2. Organs, and tissues of immune system: Primary and Secondary Lymphoid organs- Thymus and Bone marrow; Lymph node, spleen and tonsils, MALT, GALT; cells of the f humoral Immunity (HI) and Cell mediated Immunity (CMI); Immune tolerance; Antigen presenting cells (APCs),T lymphocytes, B lymphocytes. MHC restriction-antigen presentation, T- subsets; Cytotoxic T cell (CTL) mediated killing. **8 h**

3. **Antigens and Antibodies:** Immunogenicity versus Antigenicity, Nature of antigens; Role of T helper cells in B cell activation; Antibody-structure and functions-subtypes; structural basis of Antibody diversity; Theories of Antibody formation., Genetic basis of antibody diversity-somatic hyper mutation recombination, class switching and clonal selection, Recent advances in the production of monoclonal antibodies and their applications. **8 h**

4. Host-microbe interactions- antibacterial, antiviral and anti parasitic immune responses; Immne sytem Disoreders-Hypersensititivities-Type I-TypeIV, Immunodeficiency diseases; Primary and secondary immunodeficiencies, AIDS; Auto immune diseases-organ specific and systemic; Vaccines–definition, conventional vaccines and modern trends in development of vaccines-recombinant and DNA vaccines; current vaccines, safety, active and passive immunization. **8 h**

5. **Immunotechniques and Immunodiagnosis:** Antigens and Antibody reactions *in vitro;* precipitation agglutination, complement fixation, ELISA, Western Blotting, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence, Immunoprecipitation, and Radioimmunoassay. **6 h**

Text Book:

1. I. Roitt. Essential Immunology. 10th ed. Blackwell Science, 2005
2. Janways Immunobiology. 7th edition. Publisher-Garland Science, 2007
3. Kuby Immunology- 4th edition. Publisher W. H. Freeman & Company

Suggested Reading:

1. Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne. Kuby Immunology. 4th ed. W. H. Freeman & Company, 2000.
2. Eli Benjamini, Richard Coico, G. Sunshine. Immunology- A Short Course. 4th Ed. Wiley's Publication, 2000.

MB-451 General Microbiology Lab 1 Credit

1. Introduction to microbiology.
2. Sterilization techniques – dry and wet heat, chemical and sterilization.
3. Calculation of phenol coefficient.
4. Study of water activity on microbial growth.
5. Preparation of cotton plugs and preparation of media.
6. Staining techniques – simple and differential staining.
7. Isolation of microorganisms, preparation of pure culture
8. Enrichment and isolation of oil degrading microorganisms near oil contaminated soil.
9. Study of microbial biodiversity: biodiversity of bacteriocin production in Lactobacillus as example.

MB 452 BACTERIOLOGY LAB 1 Credit

1. Introduction to good laboratory practices and sterilization techniques & Preparation of different nutrient media-Liquid and Solid media-minimal, complex and differential media
2. Isolation of bacteria from air, water, soil
3. Morphological characteristics of bacteria-Staining techniques – simple and Gram's staining Endospore staining, Flagella staining and Capsule staining
4. Bacterial culture techniques-Liquid broth culture & Pure culture techniques-serial dilution technique, Pour plate, spread plate, streak plate techniques.
5. Measurement of bacterial population by turbidimetry and colony counting by serial dilution of samples
6. Bacterial growth curve
7. Antibiotic sensitivity tests-disc method
8. Preservation of pure cultures: slant preparation, water stock, glycerol stock
9. Biochemical tests for bacterial identification

MB 453 MICROBIAL PHYSIOLOGY LAB 1 Credit

1. Study of bacterial growth curve
2. Effect of different temperature on bacterial growth
3. Effect of different pH on bacterial growth
4. Isolation of molds from soil
5. Isolation of enzyme producing microorganisms
6. Extracellular enzymatic activities of microorganisms— Casein hydrolysis
7. Extracellular enzymatic activities of microorganisms— Gelatin hydrolysis
8. Urease and catalase tests.
9. IMViC tests
10. Triple Sugar- Iron Agar Test

MB: 454 INSTRUMENTATION AND TECHNIQUES IN MICROBIOLOGY LAB

1 CREDIT

1. Study of simple and compound microscopes, their handling including oil immersion objective.
2. Preparation of Chromic acid and cleaning glasswares.
3. Absorption spectra- UV-Visible.
4. Paper Chromatography of amino acids, carbohydrates, nucleic acid.
5. Ion exchange chromatography.
6. SDS Gel electrophoresis.
7. Agarose Gel electrophoresis
8. Preparation of Stains: Methylene blue, Crystal violet, Safranin, Nigrosine, Malachite green, Gram's iodine, Cotton blue and Lacto phenol.
9. Staining of different microorganisms
10. PCR technique

MB 455 MICROBIAL BIOCHEMISTRY LAB 1 Credit

1. Preparation of standard buffers and determination of pH of a solution.
2. Qualitative tests for Carbohydrates- Tests for sugars: Fructose, lactose, maltose, glucose and starch.
3. Qualitative tests for aminoacids.
4. Quantitative estimation of glucose by Benedict's method
5. Quantitative estimation of protein by Biuret method.
6. Quantitative estimation of protein by Lowry's method.
7. Determination of Iodine value.
8. Estimation of carbohydrates by anthrone method.
9. Estimation of amino acids by ninhydrin method.
10. Estimation of ascorbic acid.

MB 456 – Mycology and Virology Lab 1 Credit

1. Methods of isolation, identification of fungi by traditional methods
2. Preparation of pure culture and preservation of culture
3. Isolation and identification of endophytic fungi from plants
4. Observation and identification of mycorrhiza
5. Isolation and identification of fungi from seeds
6. Isolation and identification of fungi from soil
7. Isolation of anti bacterial antimycotic compounds from fungi
8. Staining and observation of fungal pathogens in plant and human tissues
9. Extraction and artificial inoculation of TMV to healthy tobacco plant and study of Viral symptoms.
10. Isolation of bacteriophages

MB 457 Molecular Biology & Microbial Genetics Lab 1 Credit

1. Isolation & purification of genomic DNA from bacteria
2. Isolation & purification of plasmid DNA from bacteria
3. Isolation & purification of genomic DNA from plants
4. Agarose gel electrophoresis of chromosomal
5. Agarose gel electrophoresis of plasmid DNA
6. Determination of purity of DNA spectrophotmetrically
7. Restriction digestion of chromosomal & plasmid DNA
8. Isolation of DNA fragment from agarose gel

MB 458 IMMUNOLOGY LAB 1 Credit

1. Precipitation on gels-Ouchterlony test and Mancini technique
2. Immunoelectrophoresis
3. Isolation of Antigens from microbes
4. Raising antibodies from animals (from different Models), Development of polyclonal antibodies,
5. Purification of IgG antibodies from serum samples
6. ELISA technique
7. Western blotting
8. Vidal test and Mantoux test