ACHARYA NAGARJUNA UNIVERSITY : CENTRE FOR DISTANCE EDUCATION
M.Sc. – Microbiology - Program code: 05

Program Structure

Program code	Program	Internal assessment	External exams	Max. Marks	credits
SEMISTER 1					
101MB24	Virology	30	70	100	4
102MB24	Microbial Biochemistry and Analytical Techniques	30	70	100	4
103MB24	Bacteriology	30	70	100	4
104MB24	Biology of Eukaryotic Microbes	30	70	100	4
105MB24	Virology and Microbial Biochemistry and Analytical Techniques	---	---	100	4
106MB 24	Bacteriology and Biology of Eukaryotic Microbes	---	---	100	4
SEMISTER 2					
201MB24	Microbial physiology and metabolism	30	70	100	4
202FMB24	Microbial genetics and molecular biology	30	70	100	4
203MB24	Immunology	30	70	100	4
204MB24	Agricultural microbiology	30	70	100	4
205MB24	Microbial Physiology and Metabolism and Microbial Genetics and Molecular Biology	---	---	100	4
206MB24	Immunology and Agricultural Microbiology	---	---	100	4
SEMISTER 3					
301MB24	Medical Microbiology	30	70	100	4
302MB24	Recombinant DNA technology	30	70	100	4
303MB24	Cellular Microbiology and Bioinformatics	30	70	100	4
304MB24	Fermentation Technology	30	70	100	4
305MB24	Medical Microbiology and Recombinant DNA Technology	---	---	100	4
306MB24	Cellular Microbiology and Bioinformatics and Fermentation Technology	---	---	100	4
SEMISTER 4					
401MB24	Environmental Microbiology	30	70	100	4
402MB24	Food Microbiology	30	70	100	4
403MB24	Industrial Microbiology	30	70	100	4
404MB24	Biofertilizer technology	30	70	100	4
405MB24	Environmental Microbiology and Food Microbiology	---	---	100	4
406MB24	Industrial Microbiology and Biofertilizer Technology	---	---	100	4

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SEMESTER-I
M.SC. MICROBIOLOGY
101MB24 - VIROLOGY

UNIT-I

Brief outline of discovery of viruses; properties of viruses.Morphology of viruses- Structure, Capsid architecture; envelopes and peplomers.Chemistry of viruses- viral proteins, genome – structure and types.Study of sub-viral agents – Brief account of diseases caused by viroids – PSTV, Cadangcadang; Prions- Scrape, Cruetzfeldjakob; Satellite viruses, Satellite RNA's.

UNIT-II

General methods of cultivation of viruses-in embryonated eggs, experimental animals and cell cultures, monolayer cultures, cell lines.General methods of purification of viruses. Serological methods for detection of viruses- haemagglutination& HAI, immunoflourescense, ELISA, PCR and RIA. Infectivity assay – plaque method.

UNIT-III

Taxonomy of plant viruses, Symptoms of diseases caused by plant viruses (morphological, Physiological and histological), Ultra structure and life cycles of TMV and CaMV, Transmission of plant viruses – mechanical and biological (vector and nonvector), Basic control measures of plant diseases- vector and chemical control.

UNIT-IV

Taxonomy of human viruses.Ultra structure and brief account on life cycles of RNA viruses- Polio, Influenza and HIV.Ultra structure and brief account on life cycles of DNA viruses- Vaccina, Adenovirus, SV40.

UNIT-V

Ultra structure and life cycles of bacteriophages- M13, Mu, T4 &lambda.General account of viruses of Cyanobacteria, algae and fungi.Viral vaccines- Types, preparation and production of vaccines.New generation vaccines- genetic recombinant vaccines.General account on interferons and antiviral drugs.

REFERENCE BOOKS

1. Dimmock Nj, Primrose Sb (1994). Introduction to Modern Virology IV Edition, Blackwell Scientific publications. Oxford.
2. Morag, C And Timbury M (1994). Medical Virology, Churchill Livingstone, CONRAT HF, KIMBALL PC and LEVY JA (1994).Virology-III Ed. Englewoood cliff, New Jersey.
3. Mathews, Re (1992). Functional of plant Virology, Academic Press, San Diego.TOPLEY and WILLIAMS (1995). Text book on Principles of Bacterilogy, virology and immunology, Edward Arnold, London.
4. William Hayes (1985), The genetics of bacteria and Their viruses, black Well Scientific publishers, London.
5. David Ga Walkey (1985). Applied Plant Virology. William Heinemann Ltd, London.

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SEMESTER-I

M.SC. MICROBIOLOGY

102MB24 - MICROBIAL BIOCHEMISTRY AND ANALYTICAL TECHNIQUES

UNIT-I

Properties of Biomolecules: Carbohydrates – Structure and physicochemical properties of mono and oligosaccharides. Structures and biological importance of structural and storage polysaccharides.Lipids– Physicochemical properties of fatty acids, Triacylglycerols, Glycolipids, Phospholipids, Lipid aggregations (micelles, monolayers, bilayers, liposomes).Nucleic Acids: Structure of DNA and RNA. Renaturation and denaturation of DNA, cot values of DNA.

UNIT-II

Aminoacids: classification, amino acid properties, essential amino acids, Biological significance.

Proteins: peptide bond and types of peptides, peptides of non-protein origin, three dimensional structure of proteins (Primary, Secondary, Tertiary, Quaternary). Chaperones, denaturation and renaturation of proteins.

UNIT-III

Enzymes – Nature and outline classification of enzymes, binding energy, activation energy, rates of reactions, MM equation, factors influencing the enzyme action, mechanism of enzyme action, enzyme inhibitors, allosteric enzymes, isoenzymes, ribozymes, abzymes.Protein purification and characterization methods, methods of lipid separation and analysis.

UNIT-IV

Spectroscopy – Principles and applications of UV-Vis, NMR, ESR and Mass spectroscopy.

Centrifugation: Instrumentation for centrifugation, principles and applications of differential and density gradient centrifugation.

UNIT-V

Chromatography – Principles and applications of adsorption, ion exchange, gel filtration, affinity and ion exchange chromatography.

Electrophoresis – Principles and applications of Polyacrylamide, Agar, Pulsefied, and Immuno electrophoresis.

SUGGESTED BOOKS:

1. Nelson and Cox 2000. Lehninger Principles of Biochemistry.
2. Moat, A. Gand J.N. Foster.1999. Microbial Physiology.
3. Wilson, K and J.Walker 1995. Practical Biochemistry. Principles and Techniques. 4thed.
4. Upadhyay, A., Upadhyay, K and Nirmalendru Nath. 2003. Biophysical Chemistry – Principles and Techniques.
5. David Freifeilder and W. Freeman 1982. Physical Biochemistry – Applications to Biochemistry and Molecular Biology. 2nded.
6. Caldwell, D.R. 1995. Microbial Physiology and Metabolism.

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SEMESTER-I
M.SC. MICROBIOLOGY
103MB24 - BACTERIOLOGY

UNIT-I

Outline classification of microorganisms – Different types of kingdom systems (Haeckel`s three kingdom concept, Whittaker`s five kingdom concept); three domain concept of Carl Woese.Principles of bacterial taxonomy and classification of bacteria – Numerical taxonomy, Identification characters – morphological, staining, physiological, biochemical and genetical (mol% G+C, Nucleic acid hybridization, 16S rRNAsequencing) characters.Bacterial classification as per the latest edition of Bergey's Manual of Systematic Bacteriology.Ultrastructure of typical bacterial cell – Surface appendages, Cell envelope and Cytoplasmic components. Sporulation in bacteria.

UNIT-II

Sterilization methods to control bacterial growth – Physical (Heat, Filtration, Radiation)and Chemical methods.General methods of isolation of bacteria from soil (Plating methods, Serial dilution technique, MPN technique, Contact slide technique, Winogradsky column) and water (Multiple tube fermentation test, Membrane filter technique); anaerobic culture methods.Maintenance and Preservation of bacterial cultures – Sub-culturing, Oil over laying, Lyophilization, Cryo- preservation.Techniques for staining bacteria – Negative, Simple and Differential staining methods.

UNIT-III

Bacterial Nutrition – Nutritional classification of bacteria, Essential macronutrients, micronutrients and growth factors.Bacterial Growth – Growth characteristics of bacteria on solid medium, Kinetics of growth, Typical bacterial growth curve, Diauxie growth curve, Batch culturing, Continuous culturing – chemostat and turbidostat, synchronous culturing.Factors affecting the bacterial growth; Methods for measurement of bacterial growth.Bacterial Homeostasis.

UNIT-IV

Classification, General characters, Reproduction and significance of Archaeobacteria.Classification, General characters, Reproduction and significance of Cyanobacteria.Classification, General characters, Reproduction and significance of Actinomycetes.

UNIT-V

Taxonomy and characteristic features of the following bacterial genera-*Agrobacterium*, *Bacillus*, *Clostridium*, *Escherichia*, *Mycoplasma*, *Nitrosomonas*, *Pseudomonas*, *Rhizobium*, *Rickettsia*, *Spirochaete*, *Staphylococcus*, *Streptococcus*.

REFERENCE BOOKS

1. Brock, T.D.andMadigam, M.T. – Biology of Micoroorgansims (1999)
2. Prescott, L.M., Harley, J.P. Klein, D.A. – Microbiology (2008)
3. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R. – The Microbial World (1988)
4. Pelczar, M.J, Chan, E.C.S., Kreign, N.R. – Microbiology (2006)
5. Black, J.G.- Microbiology – Principles and Explorations (1999)
6. Atlas, R.M. – Priniciples of Microbiology (1996)
7. Salle AJ. Fundamental principles of Bacteriology (2001)
8. Birge-Modern Microbiology
9. Schlegel HG. General Microbiology (2008)
10. Sneath, P.H.A., Mair, N.S., Elizabeth, M. –Bergey`s Bergey`s Manual of Systematic Bacteriology
11. Dubey RC and Maheswari DK. - A Text Book of Microbiology (2010)
12. Alcamo E. - Fundamentals of Microbiology (2001)

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SEMESTER-I
M.SC. MICROBIOLOGY
104MB24 - BIOLOGY OF EUKARYOTIC MICROBES

UNIT-I

Ultra structure of eukaryotic cell; Organelles of eukaryotic cell – Ultrastructure of Cell wall, Cell membrane, Nucleus, Chloroplast, Mitochondria, Endoplasmic reticulum, Ribosome, Golgi apparatus, Lysosomes.

UNIT-II

Phases of cell cycle, role of check points in monitoring and regulation of cell cycle, Kinenins. Cell division – different stages of mitosis and meiosis.

Cytoskeleton – definition, types and structure of cytoskeletal filaments, role of cytoskeleton in cell division.

UNIT-III

Algae – Distribution, General account, Thallus organization, nutrition, reproduction and classification of algae. Economic importance of algae – Algae as primary producers and commercial products.Algae as SCP.Algal blooms and toxins.

UNIT-IV

Fungi – General characters, Nutrition (parasitic, saprophytic & symbiotic), Reproduction, Parasexuality. Ainsworth's system of classification.

Importance of fungi in Agriculture and Industry.Importance of yeasts.Edible and poisonous mushrooms.Mycotoxins.

UNIT-V

Protozoa – General account, morphology, nutrition and locomotion.Brief account of – *Entamoeba, Trypanosoma, Leishmania, Trichomonas, Giardia, Balantidium* and *Pneumocystis*.

REFERENCE BOOKS:

1) Introductory Phycology - HD Kumar
2) Biology of Algae – Round
3) The Fungi - Alexopolus
4) Prescott *et al*- Microbiology
5) Barner R.D – Invertebrates Zoology

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M.Sc. MICROBIOLOGY

SEMESTER - I

105

~~205~~MB24-Practical-I: Virology and Microbial Biochemistry and Analytical Techniques

Virology

1. Study of morphological characters of plant and animal viruses (photographs/ diagrams)
2. Study of symptoms caused by plant viruses
3. Chlorophyll estimation in healthy and viral infected leaves
4. Mechanical/Sap transmission of plant viruses
5. Seed transmission of plant viral disease
6. Isolation of bacterial viruses from sewage water
7. Routes of inoculation and cultivation of viruses in embryonated chicken eggs

Microbial Biochemistry and Analytical Techniques

1. Quantitative estimation of carbohydrates by DNS method
2. Quantitative estimation of proteins by Lowry's method
3. Separation of Aminoacids by paper chromatography
4. Determination of saponification number of fats
5. SDS PAGE separation of soluble proteins

6 PAGE separation of DNA and RNA

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M.Sc. MICROBIOLOGY
SEMESTER - I
106MB24: Bacteriology and Biology of Eukaryotic Microbes

Bacteriology

1. Streak plate technique
2. Spread plate technique
3. Pour plate technique
4. Isolation of bacteria from soil
5. Contact slide technique
6. Simple staining
7. Gram's staining
8. Spore staining
9. Effect of temperature on bacterial growth
10. Effect of pH on bacterial growth
11. Effect of NaCl on bacterial growth
12. Effect of antibiotics on bacterial growth (disc method)

Biology of Eukaryotic Microbes

1. Observation of different cell organelles
2. Observation of different mitotic and meiotic stages
3. Identification of different algae from pond water
4. Isolation of soil algae
5. Isolation of fungi from soil, air and water
6. Isolation of *Aspergillus* from lemon
7. Observation of important fungal pathogens
8. Observation of important protozoan pathogens (slides)

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M.Sc. MICROBIOLOGY
SEMESTER – II
201MB24: MICROBIAL PHYSIOLOGY AND METABOLISM

UNIT-I
Concept of thermodynamic principles, entropy, enthalpy, concept of free energy. Oxidation – reduction potential, ATP structure, free energy change in oxidation/reductions, different types of phosphorylations, solute uptake – passive and active transport, Phosphotransferase system, Iron uptake, group translocation; Regulation of bacterial metabolism.

UNIT-II
Photosynthesis – Oxygenic (cyanobacteria) and anoxygenic (Rhodospirillaceae, Chromatiaceae, Chlorobiaceae, Chloroflexaceae); Photosynthetic pigments, Bacteriorhodopsin, Photochemistry of photosystems; Photosynthetic Carbon Reduction (Calvin Cycle, RTCA, Hydroxy propionate pathway, reductive acetyl COA pathway).

UNIT-III
Chemolithotrophy: - Hydrogen (H_2), Carbon monoxide (Co), ammonia (NH_3), nitrite (NO^-_2), sulphur (S^0) and Iron (Fe^{2+}) Oxidizing Bacteria; bioluminescence.
Respiration – EMP, ED, HMP, Methyl glyoxylate. HMP pathways, TCA cycle, ETC in bacteria and mitochondria, ETC inhibitors. Anaplerotic sequences.

UNIT-IV
Anaerobic respiration (SO_4^{2-} and NO_3^-).
Fermentations – Mixed acid, propionate and Butyrate-Butanol fermentations. Syntrophy, anaerobic food chain, gluconeogenesis. Methanogenesis and its biological importance.

UNIT-V
Biosynthesis of aminoacid. Catabolism of amino acids (deamination, decarboxylation and transamination).
Protein degradation – exo and endo proteases.
Fatty acid synthesis (saturated and unsaturated), Fatty acid degradation (saturated and unsaturated).
Bacterial cell wall synthesis (+ve and –ve). Polyamine biosynthesis, Biochemistry of 'N_2' fixation.

SUGGESTED BOOKS

1. Reddy and Reddy (2005). Microbial physiology.
2. Freeman, W.H.(2001). Biochemistry, by Stryer, 5th edition
3. Nelson and Cox.2000; Lehninger principles of Biochemistry
4. Moat, A.G and J.W. Foster (1999). Microbial physiology
5. Caldwell, D.R.1995. Microbial Physiology and Metabolism
6. David White.1995. The Physiology and Biochemistry of Prokaryotes
7. Gottschalk, G. Bacterial Metabolism
8. Hans G. Schlegel. General Microbiology
9. Lansing M. Prescott et al. 2005. Microbiology

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M.Sc. MICROBIOLOGY
SEMESTER - II
202MB24: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

UNIT-I

Experimental evidences for establishing the nucleic acids as genetic material.

Gene concept– classical concept, Modern concept (cistron, muton, recon, exon & intron); Different theories of gene concept.

Plasmids – Definition, characteristics of plasmids, types of plasmids, properties of F plasmids, R plasmids, col plasmids, Ti plasmids and other plasmids; Replication of plasmids; Isolation of plasmids; Significance of plasmids.

Mutations – spontaneous mutations versus induced mutations; Types of mutations –forward, backward, suppressor, point and frame shift mutations; Radiation induced mutations – ionizing and non-ionizing radiation. Chemical mutagens – Base analogues, nitrous acid, acridines, alkylating and hydroxylating agents.

UNIT-II

Genetic recombination in Bacteria – Transformation, Conjugation, Transduction (Generalized and Specialized); Gene mapping in bacteria; Gene transfer techniques – Electroporation, Microinjection, Biolistics and chemical methods.

Phage Genetics – Lytic phage – Genome organization of phage T4, genetic recombination; gene expression in T4 life cycle. Lysogenic phage – λ-phage genome organization; recombination, genetics of lysogenic life cycle;.

UNIT-III

Replication of DNA – Semi-conservative replication, enzymology of replication, continuous and discontinous DNA synthesis. Unidirectional replication, bi-directional replication, rolling circle replication.

DNA damage and repair - Types of DNA damage- deamination, alkylation, pyrimidine dimers; Repair mechanisms – Photoreactivation, base excision repair, nucleotide excision repair, post replication and recombination repair, methyl-directed mismatch repair and SOS repair.

Gene expression – Central dogma of gene action; Transcription – initiation, elongation and termination of transcription; post transcriptional processing and RNA splicing in eukaryotes; Translation – initiation, elongation and termination of translation; Post translational modifications of polypeptide.

UNIT-IV

Regulation of Gene expression in bacteria – Operon concept, Inducible and repressible operons, Inducer molecules, Repressor molecules, Co-Repressor molecules.

Induction and catabolite repression of lac operon in *E. coli*.

Repression and attenuation of trp operon in *E. coli*.

Genetics of nitrogen fixation – nif genes, regulation of nif genes (local control and global control mechanisms); nod genes and their regulation.

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UNIT - V

Transposable elements in bacteria - IS elements, Composite transposons, Tn3 transposons.
Transposable elements in eukaryotes - Ac and Ds elements in maize, Ty elements in yeast, transposons in Drosophila, Human retrotransposons.
Mechanisms of transposition – Conservative and replicative modes.
Genome rearrangements – mating type switching in yeast; Regulation of genome activity during sporulation by special σ subunits.

REFERENCE BOOKS

1. Gene VII – Benjamin lewin (2000)
2. Principles of genetics – Gardener, E.J., Simmons, M.J., Snustad,D.P. (1991)
3. Genetics – Peter J Russell (1998)
4. Microbial Genetics – David Freifelder (1990)
5. Molecular Biology – David Freifelder (2001)
6. Molecular genetics of bacteria – Dale JW
7. Principles of genetics – Tamarin RH (1999)
8. An introduction to Genetic analysis - Suzuki,D.T et al.
9. Molecular Cell Biology - Darnell, J., Lodish, H. Baltimore, D. (1986)
10. Cell and Molecular Biology - Karp,G. (1986)
11. Molecular Genetics of Bacteria - Dale,J.W.
12. Principles of Genetics - Snustad, D.P., Simmons, M.J., Jenkins, J.B. (1997)

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M.Sc. MICROBIOLOGY
SEMESTER - II
203MB24: IMMUNOLOGY

UNIT - I

Structure, composition and functions of cells and organs involved in immune system- B-cells, T-cells, phagocytes, auxilliary cells, soluble mediators. Lymphokines and Cytokines, functions of important Interleukins; Lymphoid organs- primary (Thymus and bone marrow), secondary (spleen and lymph node); Types of immunity - Innate and acquired immunity; Humoral and cell mediated immunity; primary and secondary.

UNIT - II

Antigens- nature and properties;
Immunoglobulins- structure, heterogenicity, types, sub-types; antibody production- hybridoma technique, catalytic enzymes.
Complement system- structure, components, pathways and biological sequences of complement activation. Antigen- antibody reactions- agglutination, precipitation, complement fixation, Immuno fluorescence microscopy, ELISA, RIA.

UNIT – III

Hypersensitivity reactions- antibody mediated- Anaphylaxis; antibody dependent cell toxicity; immune complex mediated reactions; cell mediated hypersensitivity reactions. Brief account on the respective diseases.

UNIT - IV

Structure and functions of MHC. Transplantation immunology- concept, tissue typing methods, role of HLA, survival of allograft, graft versus host reaction.
Autoimmunity- general account of autoimmune diseases; mechanism and therapy of Rheumatoid arthritis. Tumor immunology- Tumor diagnosis by onco fetal antigens, effector mechanisms in tumor immunology.

UNIT –V

Immune response to infectious diseases: viral infections, bacterial infections, protozoan diseases. Vaccines – Designing vaccines for active immunization, whole organism vaccines, purified macromolecules as vaccines, recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines and multivalent subunit vaccines.

REFERENCE BOOKS

1. ROITT, I.M. (1998). Essentials of Immunology. ELBS, Blackwell Scientific Publishers, London.
2. Kuby's Immunology. IV Edition. Freeman and Company, New York.
3. KLAUS D ELGERT (1996) immunology- Understanding of immune system. Wiley-Liss. NY.
4. TOPLEY and WILLIAMS (1995). Text book on Principles of Bacteriology, Virology and immunology, Edward Arnold, London.

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M.Sc. MICROBIOLOGY
SEMESTER – II

204MB24: AGRICULTURAL MICROBIOLOGY

UNIT-I

Rhizosphere – Microbial flora of rhizosphere soil, rhizosphere effect; root exudates; soil fungistasis. Techniques - soil plate, contact slide method, Fluorescence microscopy.
Plant growth promoting rhizobacteria.
Phyllosphere microflora and their significance.

UNIT-II

Biofertilizers - Mycorrhiza – Ecto mycorrhizas and Arbuscular mycorhiza, *Azatobacter* and *Azospirillum*.
N - fixing cyanobacteria; Legume-Rhizobium association – Nitrogenase, Rhizobia complex, cross-inoculation groups; Development, structure and functions of legume root nodules.
Phosphate solubilizing microorganisms and their use.

UNIT-III

Concept of disease in plants; Symptoms caused by plant pathogenic fungi, bacteria and viruses. Symptomology, etiology, epidemiology and control of following plant diseases:
Late blight of potato, powdery mildew of cucurbits, smut of sorghum, tikka disease of groundnut, blast disease of rice, angular leaf spot of cotton and tobacco mosaic disease.

UNIT-IV

General principles of plant disease control – Plant quarantine, seed treatment, cultural practices, chemical control, development of disease resistance varieties; Biological control of plant diseases.
Biopesticides – *Bacillus thuringiensis*, NPV and CPV.

UNIT – V

Biostatistics - Basic principles; Measures of Central tendency – Mean, Median, Mode; Standard deviation and Standard Error; Simple hypothesis tests – Students 't'- test , 'F'- test and Chi-square test. Analysis of variance – one-way ANOVA and two-way ANOVA, Correlation and LinearRegression. Experimental designs – Randomized Block Design (RBD) and Completely Randomized Design (CRD).

REFERENCE BOOKS

1. Subbarao, N.S. 2000. Soil Microbiology 4th Edn.
2. Subbarao, N.S. 1995 Biofertilizers in Agriculture and Forestry
3. Tilak, K.V.B.R. 1991. Bacterial biofertilizers, ICAR publications
4. Atlas, R.M. and Bartha, R. 1998. Microbial ecology: Fundamentals and Applications, Addison Wiesley Longman Publications
5. Lynch and Poole, 1983 Microbial ecology, ELBS Publications
6. Singh, R.S. 1990 Plant diseases 6th Edn. Oxford & IBH publications

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7. Rangaswami,G. and Mahadevan, A. 1999. Diseases of crop plants in India. Prentice Hall of India publications, New Delhi
8. Rangaswami, G. and Bagyaraja, D.J.2001. Agricultural Microbiology, 2nd Edn., Prentice Hall of India, New Delhi.
9. Mehrotra, R.S.1980. Plant Pathology, Tata
10. Schaum's Outline Statistics by Murray.R, Spiegel, Larry.J.Stephens, 4th edition, McGraw Hill Companies.
11. Zar, J. - Bio-statistical Analysis, Prentice Hall of India.
12. An introduction to Bio-Statistics by N.Gurumani.2009 – MJP Publications.
13. Daniel, 2006, Biostatistics, Eighth Edition. John Wisley and sons.

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M.Sc. MICROBIOLOGY
SEMESTER - II
205MB24-Practical-I: Microbial Physiology and Metabolism and Microbial Genetics and Molecular Biology

Microbial Physiology and Metabolism

1. Spectrophotometric method of ATP estimation
2. Separation of bacterial photosynthetic pigments by gradient centrifugation
3. Volumetric estimation of alcohol or lactic acid produced by fermentation bacteria
4. Estimation of Fatty acids from bacterial cell wall

Microbial Genetics and Molecular Biology

1. Isolation of plasmids
2. Ames test
3. Problems in Gene mapping in bacteria.
4. Isolation of DNA
5. Isolation of RNA
6. Estimation of DNA
7. Estimation of RNA
8. Problems in Genetic code and gene expression
9. Problems in regulation of gene expression

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M.Sc. MICROBIOLOGY
SEMESTER - II
206MB24-Practical-II: Immunology and Agricultural Microbiology

Immunology

1. Cells and organs in immunology (Diagrams)
2. Demonstration of Heamagglutination reaction
3. Agglutination reactions- WIDAL, VDRL
4. Morphology of PMN cells
5. Electrophoretic separation of serum proteins
6. Immunodiffusion techniques – Oucterlony, Radial
7. Immunoelectrophoresis- Rocket gel
8. MHC complex (Diagrams)
9. Hypersensitivity reactions (Diagrams)

Agricultural Microbiology

1. Enumeration of bacteria from rhizosphere and non-rhizosphere soils
2. Enumeration of fungi from rhizosphere and non-rhizosphere soils
3. Isolation of microflora from rhizoplane
4. Isolation of microflora from phyllosphere
5. Clearing and staining technique for observation of AM fungi
6. Isolation of PGPR from field soils
7. Isolation of rhizobium from root nodules
8. Section cutting of nodules for observing the nodule structure
9. Isolation of *Azospirillum* and *Azotobacter* from the soil
10. Isolation of Cyanobacteria from field soils

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M.Sc. MICROBIOLOGY
SEMESTER – III
301MB24: MEDICAL MICROBIOLOGY

UNIT-I

Important developments in Medical Microbiology. Normal microbial flora of human body. Nosocomial infections and their control. Epidemiology – Types of epidemics, disease reservoirs, methods of transmission and control of epidemics.

UNIT-II

Detailed study of the pathogen, pathogenesis, symptoms, epidemiology, diagnosis and control of the diseases caused by the following bacteria:

Staphyloccus aureus, Streptococcus pneumoniae, Corynebacterium diphtheriae, Clostridium tetani, Salmonella typhi, Vibrio cholerae, Treponema pallidum and *Mycobacterium tuberculosis*.

UNIT - III

Detailed study of the pathogen, pathogenesis, symptoms, epidemiology, diagnosis and control of the following fungal infections.

Dermatomycoses – tineas; Systemic mycoses – Histoplasmosis and Cryptococcosis; Opportunistic mycoses – Candidiasis and Aspergillosis.

UNIT-IV

Detailed study of the following viral diseases – Poliomyelitis, Influenza, Rabies, Hepatitis, AIDS. Brief note on oncogenic viruses.

UNIT-V

Chemotherapy: Properties of chemotherapeutic drugs, chemical nature, clinical use and mode of action of the following drugs.

Antibacterial drugs: Sulpha drugs, Penicillins, Streptomycin, Tetracyclines, Chloramphenicol, Rifamycin, Polymyxin.

Antifungal drugs: Imidazoles, Flucytosine, Nystatin, Amphotericin-B.

Antiviral drugs: Amantadine, Azidothymidine, Acyclovir.

REFERENCE BOOKS:

1. Ananthanarayana, R. and Panicker, C.K.J. 2000. Text book of Microbiology, Oriental Longman publications
2. Jawetz *et al*. 1998. Medical Microbiology 21st Edn. Prentice Hall International Inc.
3. White, D.O. and Fenner, F. 1994 Medical Virology, Academic Press, London
4. Bailey and Scott 1998 Diagnostic Microbiology (10th Edn.) Published by Mosby.
5. Madigan *et al*. 1997. Brock's Biology of Microorganisms 8th Edn. Prentice Hall International Inc.
6. Presscott *et al*. 2005. Microbiology 3rd. edition.

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M.Sc. MICROBIOLOGY
SEMESTER – III
302MB24: RECOMBINANT DNA TECHNOLOGY

UNIT-I
Introduction and importance of recombinant DNA technology.
Tools in DNA technology: Enzymes: restriction endonucleases, DNA and RNA polymerases, DNA ligases, S1nuclease, polynucleotide kinase, alkaline phosphatases, Oligonucleotides – linkers, adaptors and homopolymer tails. Characteristics of different types of Vectors – plasmids (pBR322, phagemids, cosmids), Yeast artificial chromosomes, Ti plasmid derivatives, caulimoviruses, constructs of SV40.

UNIT-II
DNA sequencing: Chemical and enzymatic methods. Automated sequencing. Genome sequencing and physical mapping of genomes.
Molecular diagnostics: Preparation of DNA and RNA probes and their application, nucleic acid hybridization, factors influencing hybridization and Microarrays.

UNIT - III
PCR - Principles, factors affecting PCR, different types of PCR and their applications.
Site-directed mutagenesis– Definition, types – PCR based site-directed mutagenesis, Random mutagenesis and its applications.
Blotting techniques: Southern, Northern and Western blotting techniques.

UNIT-IV
Cloning strategies: Generation of DNA fragments and construction of cloned gene into vector. Methods of transformation of rDNA molecule into the host. Screening and identification of recombinants (antibiotic, nucleic acid and protein based methods). Construction of DNA libraries - genomic and cDNA libraries.
Strategies for over expression of cloned genes in prokaryotic expression systems - *E.coli* expression, Yeast expression systems.
Strategies for over expression of cloned genes in Eukaryotic expression systems- Baculovirus and mammalian expression systems.

UNIT-V
Production of human growth hormone and insulin using recombinant microorganisms.
Development of transgenic plants with desired traits – herbicidal, pest and stress resistance and for various economically important plant products –Transgenic plants as bioreactors.
Development of transgenic animals with desired traits – construction of expression vectors, transfer of cloned genes, production and use of transgenic animals – mice, cow, sheep, & goat.

REFERENCE BOOKS

1. Old and primrose. 1994. Principles of Gene Manipulation: An introduction to genetic engineering. 5 th ed. Blackwell Scientific publ.
2. Glick and Pasternak 1994, Molecular Biotechnology, panama publ.
3. Watson et al 1992 Recombinant DNA. Freeman & co

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4. Walker and Rapley 2002. Molecular biology and Biotechnology 4th ed. Panima publ
5. Ratledge & Kristinsen 2001 Basic Biotechnology, University press
6. Higgins and Hames (eds) Protein expression : A practical approach., Oxford University press
7. Hunt & Liveey (eds) 2000 Functional Genomics, Oxford University press
8. Krenzer & Massey – Recombinant DNA and Biotechnology : A guide for teachers 2nd ed. ASM press.
9. Brown, t.a. (2001). *Gene cloning and DNA Analysis*. 4th Edition. Blackwell Publishers
10. Gene biotechnology – S.N. Jogdand.
11. Principles of Gene Manipulation - An Introduction toGenetic Engineering - R. W. Old and S. B. Primrose.

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M.Sc. MICROBIOLOGY
SEMESTER - III
303MB24: CELLULAR MICROBIOLOGY AND BIOINFORMATICS

UNIT-I

Bacterial adhesion to Host Cells: Basic principles of microbial adhesion – pre adhesion events, molecular mechanisms of adhesion, bacterial adhesins.
Consequences of bacterial adhesion.
Bacterial Invasion – Routes of invasion (phagocytosis, induced endocytosis, active invasion).
Intracellular niches for pathogens (intralysosomes, isolated vacuoles, cytosol).
Mechanisms of bacterial invasion (Zipper mechanism and trigger mechanism); Consequences of invasion.

UNIT-II

Types of Secretion systems in Animal-and plant- interacting bacteria.
Bacterial toxins – Toxins acting on cell surface (super antigens, toxins cleaving cell surface molecules, pore forming toxins).
Soluble toxins with an Intracellular target (toxins acting on protein synthesis and G-Proteins; cAMP generating toxin).
Toxins directly delivered by bacteria into eukaryotic cell cytoplasm (EPEC Tir; *P.aeruginosa* exoenzyme *S; C.botulinum* exoenzyme 3).
Biological effects of toxin action (cell death, nerve transmission, interactions with cytokines, signal transduction).

UNIT-III

Basic characteristics of cell signaling systems.
Extracellular first messengers in signaling.
Intracellular second messengers (cAMP, IP3, DAG, Calcium ions) in signaling.
Eukaryotic cell-to-cell signaling–GPC receptor, RTK receptor, endocrine hormone signaling, cytokine signaling.

UNIT-IV

Prokaryotic cell-to-cell signaling (bacterial pheromones, quorum sensing, signals controlling conjugation in *Enterococcus faecalis*, signals controlling sporulation in *Myxococcus xanthus*).
Intracellular signaling mechanisms in prokaryotes.
Apoptosis – triggering of apoptosis, effector molecules of apoptosis, induction of apoptosis by microbes, activation of host cell receptors that signal apoptosis.

UNIT-V

Bioinformatics – introduction, scope and applications. Data bases – CBI Genebank, PDB, OMIM, EMBL. Literature Data Bases- Pub Med, Agricola, Med line. Types of Biological data bases; Sequence databases, Structural databases, Protein secondary structure prediction. Tools for sequence alignment – BLAST, FASTA. Visualization of protein structures using Rasmol or SPDB Viewer.

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Proteomics: Basics of proteomics; proteome analysis – two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Applications of proteomics.

REFERENCE BOOKS

1. Cellular Microbiology – Henderson et. al. (1999).
2. Cellular Microbiology – Cossart et. al. (2000).
3. Genomes – T.A. Brown (2002).
4. Principles of Genetics – Snustad et. al. (1997).
5. Genes VII – Lewin (2000).
6. Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery) - S.C. Rastogi et al., Kindle Edition.
7. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins - Edited by Andreas D. Baxevanis and B.F. Francis Ouellette (1998, ISBN-13: 978-0471383918)
8. Biological sequence analysis - Durbin, Eddy, Krogh, Mithison.
9. Introduction of Bioinformatics - T.A. Attwood - D.J. parry – smith (2001).
10. Bioinformatics a Practical Approach - K. Mani & N. Vijayaraj, Aparna Publications, Coimbatore.
11. Proteomics – Pennington, S.R. and Dunn M.J. (2002)

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M.Sc. MICROBIOLOGY
SEMESTER – III
304MB24: FERMENTATION TECHNOLOGY

UNIT-I

Introduction to fermentation processes: The range of fermentation processes, chronological development of fermentation industry, component parts of fermentation process. Primary and secondary metabolites. Screening of commercially valuable microorganisms: Primary and secondary screening procedures.

UNIT-II

Strain improvement of industrially important microorganisms: Conventional and modern genetic engineering approaches. Preservation of commercially useful microbial cultures: Storage at reduced temperatures, storage in dehydrated form.

Design of culture media for industrial fermentations: Sources of energy, carbon and nitrogen, minerals, growth factors, buffers, addition of precursors and metabolic growth regulators, oxygen requirements, antifoams.

UNIT-III

Fermentors: Basic functions, body construction, aeration and agitation systems, maintenance of aseptic conditions, valves and steam traps, types of fermentors.

Fermentation processes: Batch, fed-batch, semi-continuous and continuous fermentation systems, dual and multiple fermentations.

UNIT-IV

Recovery and purification of fermentation products (Downstream process): Separation of microbial cells from liquid fraction (filtration, centrifugation, and flocculation), cell disruption, solvent extraction, chromatography, membrane processes, drying of the product.

Solid-state fermentations: Characteristics, microbial growth, production of enzymes and other metabolites, processes: Criteria used for scale-up, physical, chemical and process factors.

UNIT -V

Microbial production of commercially important metabolites.

Treatment of industrial effluents: Physical, chemical and biological (aerobic and anaerobic) treatments, disposal of effluents. Economics of the fermentation process.

REFERENCES BOOKS

1. Biotechnology- A text book of Industrial Microbiology. W.Crueger and A.Cruegar, 2000.
2. Manual of Industrial Microbiology and Biotechnology, Biochemistry and Technology. Joshi and Pandey (Eds.), 2 vols. 1999.
3. Priniciples of fermentation technology. P.F.Stanbury, A.Whitaker and S.J.Hall, 1997.
4. Molecular Biotechnolgy. B.R.Glick and J.J.Paternak, 1996.
5. Concepts in Biotechnology. D.Balasubramanian, C.F.A.Bryce, K.Dharmalingam, J.Green, Kunthala Jayaraman, 1996.
6. Microbial Biotechnology. A.N.Glazer and H.Nikaido, 1995.

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7. Comprehensive Biotechnology-The principles, applications and regulations of Biotechnology in Industry, agriculture and Medicine. Murray Moo-Young (Editor-in-Chief), 1989.
8. A Revolution in Biotechnology. J.L. Marx (Ed.), 1989.
9. Biotechnology- A comprehensive treatise in 8 vols. H.J.Rehm and G.Reed (Eds.), 1985.
10. Microbial Technology. H.J.Peppler and D.Perlman1980.

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M.Sc. MICROBIOLOGY
SEMESTER – III
305MB24-Practical-I: Medical Microbiology and Recombinant DNA Technology

Medical Microbiology

1. Observation of normal flora
2. Isolation and identification of enteric pathogen - *Salmonella typhi*
3. Isolation and enumeration of pathogenic moulds and yeasts
4. Observation of *Plasmodium* spp. in blood smears
5. Observation of important bacterial and viral pathogens- slides and photographs
6. Visit to the nearby hospitals

Recombinant DNA Technology

1. Isolation of bacterial genomic DNA
2. Restriction enzyme digestion of DNA and its electrophoretic separation
3. Ligation of DNA fragments with cloning vectors
4. Amplification of DNA using Polymerase Chain Reaction (PCR)
5. Transformation in *E.coli* using plasmid
6. Construction of restriction maps (Assignments)

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M.Sc. MICROBIOLOGY
SEMESTER – III
306MB24-Practical-II: Cellular Microbiology and Bioinformatics and Fermentation technology

Cellular Microbiology and Bioinformatics

1. Assignments in Cellular Microbiology
2. Biological Data banks Sequence Databases, Structure Databases
3. Data retrieval tools and methods
4. Database file formats FASTA
5. Gene structure and function prediction (using GenScan, GeneMark)
6. Sequence similarity searching (NCBI BLAST)
7. Protein sequence analysis (ExPASy proteomics tools)
8. Multiple sequence alignment (Clustal)
9. Molecular phylogeny (PHYLIP)
10. Homology Modeling using SPDBV

Fermentation Technology

1. Screening of extracellular microbial metabolites of commercial importance (Enzymes, Alkaloids, Fatty acids)
2. Quantitative estimation of extracellular microbial metabolites of commercial importance (Enzymes, Alkaloids, Fatty acids)
3. Optimization of carbon source (minimum 04 carbon Sources) for maximizing the product in broth fermentation (Enzymes, Alkaloids, Fatty acids)
4. Optimization of pH (minimum 04 pH) for maximizing the product in broth fermentation (Enzymes, Alkaloids, Fatty acids)
5. Solvent extraction of crude metabolite and identification by chromatography
6. Solid state fermentation on agri waste material

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M.Sc. MICROBIOLOGY
SEMESTER – IV
401MB24: ENVIRONMENTAL MICROBIOLOGY

UNIT-I

Aerial environment; kinds of micropropagules in air; adaptations of airspora to aerial environs.

Seasonal and diurnal periodicities of airspora; importance of aerobiological studies.

Methods of detecting the micropropagules in extramural and intramural environs- air sampling techniques.

General account on aeroallergens and allergic reactions.

UNIT-II

Aquatic environment, microorganisms in water bodies- phytoplankton populations and importance.

Sampling of water samples, detection and enumeration of microorganisms in water, coliform test for water quality.

Treatment of waters for drinking purpose. BOD determination. Sewage water treatment.

UNIT-III

Soil environment: components of soil, diversity and abundance of dominant soil microorganisms, methods of isolation and estimation of soil microflora.

Soil organic matter- nature, synthesis and decomposition.

Beneficial and antagonistic interaction among soil microorganisms.

UNIT-IV

Transformation of carbon, sulphur, phosphorus and iron (nature of microorganisms, mechanism and importance) in soil.

Organisms, mechanisms and ecological significance of transformations of nitrogenous compounds in soil – Dinitrogen fixation, ammonification, nitrification and denitrification.

UNIT-V

Bioremediation of polluted soils: Microbial degradation of xenobiotics – recalcitrance of pesticides in soil, microbial degradation of pesticides. Microbial degradation of petroleum products (hydrocarbons) in oil spills.

Bioleaching of minerals- factors affecting leaching, microbial leaching processes of copper, uranium and gold.

Bioenergy – role of microorganisms in production of biogas, hydrogen and bioethanol.

REFFERENCE BOOKS

1. RAPLH MITCHELL - Environmental Microbiology (1978)
2. LYNCH & POOLE - Microbial Ecology : A conceptual approach (1979)
3. PAUL & CLARK - Soil Microbiology & Biochemistry (1989)
4. RHEINHEIMER - Aquatic Microbiology (1974)
5. TILAK - Aerobiology (1997)
6. SUBBA RAO - Soil Microorganisms and Plant Growth (1995)
7. SUBBA RAO - Soil Microbiology (1999)
8. SUBBA RAO - Biofertilizers in Agriculture and Forestry (1995)
9. ATLAS & BARTHA - Microbial Ecology (1997)
10. MAIER, PEPER & GERBA - Environmental Microbiology (2000)
11. COYNE - Soil Microbiology (2000)
12. RATLEDGE C - Biochemistry of Microbial degradation

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Nagarjuna Nagar-522 510, Guntur Dt.

M.Sc. MICROBIOLOGY
SEMESTER – IV
402MB24: FOOD MICROBIOLOGY

UNIT-I

Microorganisms associated with foods and sources of microbial contamination of foods.
Factors affecting microbial activity in foods – intrinsic factors (Nutrient content, pH, Redox potential, Water activity) and extrinsic factors (Relative humidity, Temperature, Gaseous atmosphere).
Methods for microbial examination of foods – enumeration methods, alternative methods and rapid methods.

UNIT-II

Food spoilage – causes of food spoilage, microbial spoilage of vegetables, fruits, cereals & cereal products, fresh and processed meats, poultry & eggs, fish & shellfish, beverages (beer and wine) and canned foods.
Food preservation methods – low temperature, high temperature, drying, radiation and chemical preservation (salting, benzoic acid, sorbic acid, sulphur dioxide, sulphates, nitrites, nitrates, acetic acid, antibiotics).

UNIT-III

Dairy microbiology – Microorganisms in milk (normal flora & biochemical types of bacteria), sources of contamination of milk, causes of milk spoilage, enumeration of microorganisms in milk samples, fermented milk products (natural butter milk , cultured butter milk, acidophilus milk, bulgarian butter milk, kumiss, kefir, yoghurt), types and production of Cheddar cheese.

UNIT-IV

Fermented foods – Fermented vegetables (Sauerkraut); Alcoholic beverages (beer, wine); Non-alcoholic beverages (tea, coffee); Fermented meat products; Bread making.
Introduction to Probiotics.
GM foods and biosafety.

UNIT-V

Food poisoning and food-borne infections – botulism, gastroenteritis of *Staphylococcus* and *Clostridium perfringens*, Salmonellosis, Shigellosis, Listeriosis, Vibriosis, Yersiniosis, paralytic shellfish poisoning.
Preventive measures – Good manufacturing practices, health hazard critical control point analysis. Food control Agencies and Acts.
International commission on the microbiological specifications for foods.

REFERENCE BOOKS

1. Food Microbiology - **Frazier WC and Westhoff Dc (2003)**
2. Food Microbiology - **Adams, MR and Moss, MO (2015)**
3. Modern Food Microbiology - **James M.Jay (1996)**
4. Basic Food Microbiology - **George J. Banwart (1989)**
5. Food Processing and preservation -**Sivasankar, B (2002)**
6. Essentials of food Microbiology -**John Garbutt (1997)**
7. Outlines of Dairy Technology - **Sukumar De (1997)**
8. Dairy Microbiology - **Robinson RK (1990)**

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Nagarjuna Nagar-522 510, Guntur Dt.

M.Sc. MICROBIOLOGY
SEMESTER – IV
403MB24: INDUSTRIAL MICROBIOLOGY

UNIT-I

Introduction to Industrial Microbiology: Definition, scope, microorganisms, properties and industrial products. Production of antibiotics by fermentation: Production, biosynthesis and regulation, strain development, fermentation, recovery of Penicillin, semi-synthetic penicillins, Tetracyclines and Streptomycin; Production of organic feed stocks by fermentation: Ethanol, Acetone/butanol fermentation.

UNIT-II

Fermentative production of Enzymes: Microbial enzymes for industrial use. Amylases: Microbial groups producing ά–amylases, β–amylases, glucoamylases, pullulanases, strain development, medium formulation, process conditions and recovery. Proteases: Microbial production of Alkaline, Neutral and Acid Proteases, Production methods. Industrial production of vitamins by microorganisms: vitamin B12 and Riboflavin-Structure, biosynthesis and production process. Production of Nucleosides and Nucleotides by fermentation: Structure, biosynthesis and production process.

UNIT-III

Production of Organic acids by fermentation: Microbial strains, biosynthesis and production process of Citric acid and Acetic acid. Production of Amino acids by fermentation: Production strains, biosynthesis and production process of L-Glutamic acid and L-Lysine: Microbial polysaccharides: Nature, mechanism of synthesis, bacterial polysaccharides, fungal polysaccharides and yeast polysaccharides.

UNIT-IV

Microbial Transformations: Types of bioconversion reactions, procedures for biotransformation, application of Bioconversions, transformation of steroids and sterols, transformation of non-steroid compounds, transformation of antibiotics.

Industrial waste management: Types of waste (Solid, liquid, air, toxic, medical, radioactive) and their management. Bioremediation of various types of industrial waste. Concept of xenobiotics and their management.

UNIT-V

Immobilization of cells and enzymes: Matrices for immobilization, Methods of immobilization, Immobilized cell fermentations versus conventional fermentations, applications of immobilized cells and enzymes.

Intellectual Property Rights: Copy right patent, Trademark, Trade secrets, Utility model, procedure for patent filing , Geographical indication, Industrial design rights.

Bio safety - Concept of Biosafety regulation in development and handling of recombinant microbial products

REFERENCE BOOKS

1. Biotechnology-A text book of Industrial Microbiology. W. Crueger and A.Cruegar, 2000.
2. Manual of Industrial Microbiology and Biotechnology. A.L.Demain and J.W.Davies (Eds), 1999.
3. Biotechnology:Food fermentation-Microbiology, Biochemistry and Technolgy. Joshi and Pandey (Eds.), 2 vols.1999.
4. Molecular Biotechnology. B.R. Glick and J.J.Paternak, 1996.
5. Concepts in Biotechnology. D.Balasubramanian, C.F.A.Bryce,

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6. K.Dharmalingam, J.Green, Kunthala Jayaraman, 1996.
7. Microbial Biotechnology. A.N.Glazer and H.Nikaido, 1995.
8. Comprehensive Biotechnology-The principles, applications and regulations of Biotechnology in Industry, agriculture and Medicine. Murray Moo-Young (Editor-in-Chief), 1989.
9. A Revolution in Biotechnology. J.L.Marx (Ed.), 1989.
10. Biotechnology-A comprehensive treatise in 8 vols. H.J.Rehm and G.Reed (Eds.), 1985.
11. Microbial Technology. H.J.Peppler

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Nagarjuna Nagar-522 510, Guntur Dt.

M.Sc. MICROBIOLOGY
SEMESTER - IV
404MB24: BIOFERTILIZER TECHNOLOGY

UNIT-I

Introduction: importance & scope of biofertilizers in agriculture & organic farming.
History of biofertilizer production; classification of biofertilizers, Factors influencing efficacy of biofertilizers. Advantage of biofertilizers over chemical fertilizers.
Types of biofertilizers, qualitative screening of phosphate solubilization, ammonia and IAA production; mechanism of action of phosphate solubilization, ammonia and IAA production.
Benefits of biofertilizers. Carrier material: Different types of carrier materials, properties of carrier, sterilization methods of carrier, advantages and disadvantages of carrier material.

UNIT-II

Rhizobium – Morphology, molecular identification, collection and preservation of root nodules, isolation technology of different strains, screening of N_2 fixation. Bioprocessing (carrier based and liquid inoculants), Field application methods.
Azospirillum - Morphology, molecular identification, collection and isolation technology of endophytic bacteria, associate bacteria from rice fields. Screening of ammonia production. Bioprocessing (mass inoculum and liquid inoculants), Field application methods.

UNIT-III

Mycorrhiza - Morphology, collection, identification and isolation technology of Vesicular-arbuscular mycorrhiza from roots and spores. Bioprocessing (Trap culture and peat culture), preservation, field application methods.
Phosphate solubilizers - Morphology, collection, identification and isolation of inorganic phosphate and organic phosphate solubilizers from soil. Bioprocessing (carrier based and liquid inoculants), preservation, field application methods.

UNIT-IV

Vermicompost - Importance of vermicompost, economic importance of earthworms in maintenance of soil structure. Useful species of earthworms (Local species of earthworms. Exotic species of earthworms). Limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Physico-chemical parameters of vermicompost. Different Methods of vermicomposting (Small- and large-scale Bed method, Pit method Small Scale Earthworm farming for home gardens). Nutritional composition of vermicompost for plants, comparison with other fertilizers.

UNIT-V

General concept of Quality control: Microbial function and shelf life of recommended biofertilizers, Properties of microbial products and Quality management.
Quality control procedures- mother culture test, broth culture test, peat culture.
Quality control of laboratory; preparation room, growth room and storage room.
Inoculationon media, count of colony forming units. Quality text for certifications and prospects.

REFERENCE BOOKS

1. The Complete Technology Book on Biofertilizer and Organic Farming (2nd Revised Edition) – 2012 by NIIR Board
2. Microbes as Bio-fertilizers and their Production 2015-By S.G.Borkar
3. Hand Book Of Microbial biofertilizer 2006 - edited by M.K. Roy

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M.Sc. MICROBIOLOGY
SEMESTER – IV
405MB24-Practical-I: Environmental Microbiology and Food Microbiology

Environmental Microbiology

1. Isolation and Identification of extramural aerospora
2. Isolation and Identification of intramural aerospora
3. Coliform test by MPN number
4. Determination of Biological Oxygen Demand in water bodies
5. Analysis of sewage water
6. Estimation of soil organic matter
7. Estimation of Dissolved Oxygen in soil sample
8. Ammonia production from soil microorganisms by Nessler's method

Food Microbiology

1. Isolation of microbes from spoiled foods
2. Isolation of yeast from grapes
3. Enumeration of microorganisms of milk sample by SPC method
4. Presumptive test for coliforms of milk sample
5. Milk quality detection by methylene blue reduction test
6. Detection of calcium and phosphorus in milk
7. Detection of mastitis through milk test
8. Determination of phosphatase activity in milk
9. Determination of phosphatase activity in butter milk
10. Determination of phosphatase activity in whey

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M.Sc. MICROBIOLOGY
SEMESTER – IV
406MB24-Practical-II: Industrial Microbiology and Biofertilizer Technology

Industrial Microbiology

1. Estimation of streptomycin.
2. Estimation of amylase by 3,5- dinitro salicyclic acid method
3. Estimation of cellulase
4. Estimation of protease
5. Quantitative estimation of citric acid by titrimetric method
6. Estimation of alcohol by $K_2Cr_2O_7$ method

Biofertilizer Technology

1. Isolation of bradyrhizobia from dried root nodules and screening of N_2 fixation by acetylene reduction assay
2. Isolation and screening of phosphate solubilizer bacteria from rhizosphere
3. Isolation and identification of VAM spores from soil
4. Isolation of endophytic bacteria from chilli roots and screening of IAA
5. Quantitative estimation of IAA from liquid formulation of endophytic bacteria
6. Quantitative estimation of N abundance of *Rhizobium* by broth test

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CDE – MICROBIOLOGY- PRACTICAL PAPERS

Semester I

Practical – I: Virology and Microbial Biochemistry and Analytical techniques
Practical –II: Bacteriology and Biology of Eukaryotic Microbes

Semester II

Practical – I: Microbial Physiology and Metabolism and Microbial genetics and Molecular biology
Practical – II: Immunology and Agricultural Microbiology

Semester III

Practical – I: Medical Microbiology and Recombinant DNA technology
Practical – II: Cellular Microbiology and Bioinformatics and Fermentation Technology

Semester IV

Practical – I: Environmental Microbiology and Food Microbiology
Practical – II: Industrial Microbiology and Biofertilizer technology

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