COURSES OF STUDIES

For

MASTER OF SCIENCE EXAMINATION

(With Effect from the Session 2023-24 and onwards)

MICROBIOLOGY

(Under Choice Based Credit System)

Maharaja Purna Chandra (Autonomous) College,
Takhatpur, Baripada- 757003, Mayurbhanj

Affiliated To

MAHARAJA SRIRAM CHANDRA BHANJA DEO UNIVERSITY

Sriram Chandra Vihar, Takatpur, Baripada-757003

M.Sc. (MICROBIOLOGY)

(Choice Based Credit System)

I. The course is of two years duration comprising of four semesters of theory and laboratory works.

II. There is one open elective (OEC-MB 305) in semester-III. This paper is open for other departments. Students of this department in semester –III will choose one open elective from other department.

III. Each student has to carry out project work during Semester-IV and submit a dissertation before the commencement of Semester-IV theory examination.

IV. The student can opt one elective course comprising of two papers in the 2^{nd} year of PG programme.

V. The theory examination shall be held for 80 marks (3 hours) and one Mid-Semester/ Internal Assessment Examinations (IAE) of 20 marks (1 hour). The questions shall be of unit pattern, having equal marks, with two alternatives from each unit.

VI. For IAE, question shall be asked at least from any two units of a paper covered and will be of one hour duration. The durations of the practical examination shall be of 6 hours.

VII. In order to pass a semester examination a candidate must have to secure a minimum of 40% marks in both practical & theory papers in each semester.

VIII. If candidate passes all the four semester examinations he/she will be declared to have passed the M.Sc. (Semester) examinations in Microbiology, provided further that in no case a candidate shall be allowed to appear any Semester Examination after twice the duration of course period.

IX. In order to be eligible to appear at the University examination, a student has to secure at least 75% of attendance in both Theory and Practical classes.

Programme outcome:

- The students will acquire basic knowledge on Microbial diversity, conservation and utilization of resources and role of microbes in the protection of environment.
- They will be able to contribute towards present day sustainability for climate change, global warming, restoration and reclamation of waste land for crop production and inventorisation of microbes for new chemicals & drugs.
- They will be equipped with adequate technical and analytical skill to pursue their further studies and to develop continuous learning throughout their professional career.
- They will be able to compete national and state level tests like UGC-CSIR NET, ASRB- NET, UPSC, OPSC and SSB etc.
- They will acquire motivational forces for higher study and research related to applied field of microbiology.

Programme Specific Outcome:

- The student will understand both the basic and applied branches of Microbiology namely Diversity, Microbial Physiology & Biochemistry, Agriculture Microbiology, Bioinstrumentation, Molecular biology & Genetic Engineering, Immunology, Clinical Microbiology, Environmental Microbiology and Industrial & Food Microbiology.
- Systematic study of selected Species will explore the knowledge on the taxa including genetic diversity and molecular phylogeny which will be helpful for conservation & sustainable utilization of those Species.
- They will develop creative thinking and problem solving capabilities through mentor system.
- They will able to involve in the environment programmes, launched by UNEP through inspirational and motivational ethics.
- They will understand the subject in detail through the elective courses such as clinical Microbiology, Advance Agricultural Microbiology and Food Microbiology.
- They will get motivation towards research in Microbiology through the dissertation work in both field and laboratory based exposure.

(Effective from the academic session 2023-24 & onwards)

Semester –I

Code	Course Title	Credit	Marks
MB 101	Fundamentals of Microbiology	5	100 (80+20)
MB 102	Microbial Diversity	5	100 (80+20)
MB 103	Microbial Physiology and Biochemistry	5	100 (80+20)
MB 104	Agricultural Microbiology	5	100 (80+20)
MB 105	Practical	5	100
	Total	**25**	**500**

Semester—II

Code	Course Title	Credit	Marks
MB 201	Bioinstrumentation	5	100 (80+20)
MB 202	Molecular Biology and Genetic Engineering	5	100 (80+20)
MB 203	Immunology	5	100 (80+20)
MB 204	Clinical Microbiology	5	100 (80+20)
MB 205	Practical	5	100
	Total	**25**	**500**

Semester–III

Code	Course Title	Credit	Marks
MB 301	Environmental Microbiology	5	100 (80+20)
MB 302	Industrial and Food Microbiology	5	100 (80+20)
MB 303	Research Methodology	5	100 (80+20)
MB 304	Practical	5	100
OEC-MB 305	Open Elective Course (OEC)	5	100
	Total	**25**	**500**

Semester–IV

Code	Course Title	Credit	Marks
	Discipline Specific Elective – I		
MB-EC 401-A	Clinical Microbiology	5	100 (80+20)
MB-EC 401-B	Pharmaceutical Microbiology	5	100 (80+20)
	Discipline Specific Elective – II		
MB-EC 402-A	Advances in Agricultural Microbiology	5	100 (80+20)
MB-EC 402-B	Plant Pathology	5	100 (80+20)
	Discipline Specific Elective – III		
MB-EC 403-A	Industrial Microbiology & Applications	5	100 (80+20)
MB-EC 403-B	Food Microbiology	5	100 (80+20)
MB 404	Practical	5	100
MB 405	Dissertation	10	200
	Total	**25**	**500**
	Grand Total of Four Semesters	**100**	**2000**

SEMESTER-I

MB-101 Fundamentals of Microbiology Full Mark: 100

Course objective: To give an introduction about the microbial world, their distribution, morphology, growth and about the role of microorganism in various fields of life sciences and Industry. Makes the student aware of the role of microbes in the daily life as well as in the various fields of science and how it can be controlled is also deal with.

UNIT–I **(20)**

- Landmark Discoveries, The Germ theory of disease, Controversy over Spontaneous generation, Hierarchical organization & position of microbes in the living world, Haeckel's Three kingdom, Whittaker's Five kingdom and Carl Woese's three domain classification system.
- Rules of Nomenclature, Polyphasic Taxonomy, Important criteria used in the classification, Modern trends in Nomenclature, Numerical taxonomy, Scope of Microbiology.

UNIT–II **(20)**

- Basic techniques and functional mechanism of equipment used in microbial culture and study: Laminar Air Flow, Autoclave, Hot air oven, pH meter, Quebec's colony counter, Shaker-cum-Incubator, Nephelometer.
- Microscopy techniques: Principles of Microscope, Resolving power of different types of Light microscopy: Bright field, dark field, phase contrast, Fluorescent microscopy.
- Sterilization: Physical and Chemical methods.

UNIT-III **(20)**

- Ultrastructure of Prokaryotic & Eukaryotic cell, Structure of Peptidoglycans & pseudomurein of Prokaryotic Cell wall, Plasma membrane: Composition and dynamics. Transport across cell membrane. Cell junction, cell adhesion and extra-cellular matrix of Eukaryotic cell,
- Nucleoid and Nucleus: Structure and function of nuclear envelope, nuclear pore complex, nucleolus & Chromatin organization and its packaging, nuclear transport, Structures for attachment and motility, Bacterial endospore.

UNIT-IV **(20)**

- Microbial Nutritional and Growth: Function of different nutrients and their stress on microbes, Nutritional Classification of microorganisms. Preparation of culture media, Different types of media used for microbial culture, Methods of *in vitro* culture of microbes, various methods for the selection and isolation of microbes, Maintenance and preservation of microbes.
- Microbial Staining techniques for different bacteria and fungi. Various cultural characteristics of microbes. Bacterial Growth curve, generation time, Factors affecting growth (Solute concentration, temperature, pH, O_2 concentration, Pressure, radiation), Measurement of growth: Direct and indirect methods, Growth in batch culture & continuous culture. Design of chemostat & turbidostat.

SEMESTER-I

MB-102 Microbial Diversity Full Mark: 100

Course objective: To give an introduction about the microbial diversity, their classification, morphology, structural components, reproduction and ecological importance imparts knowledge regarding microbial diversity to the students of Microbiology.

UNIT–I (20)

- Bacteriology: Features of Bergey's manual of Systematic Bacteriology, Characteristics of various organisms under Archaea: Phylum Crenarchaeota, Thaumarchaeota, Euryarchaeota, Bacteria: Deinococci, Mollicutes and Nonproteobacterial Gram Negatives, Proteobacteria, Low G+C Gram Positives, High G +C Gram Positives.

UNIT–II (20)

- Mycology: Distribution, Morphology, Nutrition & reproduction of Fungi, hetrothallism and heterokaryosis. Classification & life-cycles (*Synchytrium, Mucor, Rhizopus, Saccharomyces, Neurospora, Agaricus, Volvariella, Aspergillus*) Economic and ecological significance of fungi.

- Phycology: Distribution, Thallus organization, pigment system, Nutrition & reproduction of Algae & BGA. General characteristics of different Divisions, Economic and ecological significance of Algae.

UNIT-III (20)

- Lichenology: Distribution, Structure and classification, Nutrition & reproduction of Lichen, Economic and ecological significance of Lichen, Harmful effects of Lichen.

- Protozoology: General characters, Nutrition, encystment & excystment, classification and reproduction of protozoa.

UNIT-IV (20)

- Virology: Structure and composition of viruses, Classification & Life-cycle of viruses, Replication mechanism of Viruses under the classification system, Virulent and temperate viruses, cultivation and enumeration of viruses, Regulation of phases and viruses. Infectious molecules: viriods, satellites, prions; Interferons.

Course outcome: At the end of this course the students will get knowledge about the diversity of microorganisms which is an important aspect of Microbiology.

SEMESTER-I

MB-103 Microbial Physiology and Biochemistry Full Mark: 100

Course objective: To give an introduction about the basic biochemistry related to the biological molecules, their diversity and biosynthesis. The aim is to develop a thorough knowledge among the students about the various biochemical reactions and metabolic pathways. It explains molecular basis of mutations and DNA repair.

UNIT–I (20)

- Biomolecules: General Properties, Structure, classification and functions of Carbohydrates and lipids; General structure, classification, physical & chemical properties of Amino acids, Peptide synthesis; primary, secondary, tertiary & quaternary structure of proteins, Ramachandran plot.

- Nucleic acid: Structure and forms of DNA, Cot curve, types of RNA, Ribozymes.

UNIT–II (20)

- Carbohydrate metabolism: Bacterial photosynthesis (Bacterial Photosynthetic pigments, Mechanism of Photosynthesis- Light reaction and dark reaction),Glycolysis, Entner-doudoroff pathway, pentose- phosphate pathway, TCA cycle, ETC, Oxidative phosphorylation, glyoxalate pathway

- Lipid metabolism: Biosynthesis of fatty acids, phospholipids and LPS, β-oxidation.

UNIT-III (20)

- Protien metabolism: Biosynthesis of aminoacids, anaplerotic pathway, catabolism of protiens and aminoacids.

- Enzymes- Classification, multistep reaction and rate limiting steps, enzyme inhibition, mechanism of action. Kinetics of enzymes; allosterism, kinetic analysis of allosteric enzymes, principles of allosteric enzyme regulation.

UNIT-IV (20)

- DNA metabolism: Mechanisms of DNA replication in *E. coli* (bi- directional), Enzymes involved in replication; Mutations, Types of mutation, Types of mutagens, detection and isolation of mutants, DNA damage and repair mechanisms.

- RNA metabolism: Transcription in prokaryotes and eukaryotes, Enzymes involved, RNA processing, Genetic code, Wobble concept, Translation in prokaryotes and eukaryotes, post- translational modification, Protein folding.

Course objective: The student will get an idea about the principles behind molecular biology which makes students to understand the basic molecular tools and its application in basic research and applied research in various fields of life sciences.

SEMESTER-I

MB-104 Agricultural Microbiology Full Mark: 100

Course objective: To give a detailed and comprehensive knowledge on the various aspects of plant-microbial associations, plant diseases and genetics of plant disease in detail. The course gives account of the microbial degradation of various organic compounds.

UNIT–I **(20)**

- The soil as habitat for microorganisms: General description of soil, soil humus formation and structure, differences among soils and factors of ecological significance. Soil Microorganisms: Distribution, abundance, methods of estimation of biomass, environmental factors, activity and functions of soil bacteria, fungi, algae, protozoa, blue green algae and soil fertility.

- Microbial diversity in soil and its significance; Microbes and plant interactions - Rhizosphere, Phyllosphere, Mycorrhizae.

UNIT–II **(20)**

- Organic matter decomposition both native and added organic matter and factors governing the decomposition. Degradation of carbonaceous materials in soil- cellulose, hemicellulose and lignin decomposition, factors governing the decomposition and biochemistry of decomposition. Mineralization of nitrogenous organic matter- microbes involved and factors influencing the processes.

UNIT-III **(20)**

- Nitrification-Microbes involved, factors influencing nitrification, nitrifying bacteria and biochemical mechanisms. Denitrification- microbes involved, factors influencing and the mechanism of denitrification and nitrate pollution.

- Nitrogen fixation- Asymbiotic and symbiotic nitrogen fixation, microorganisms involved, Physiology, biochemistry and genetics of nitrogen fixation, ecological and economic importance of nitrogen fixation; Cyanobacterial Nitrogen fixation.

UNIT-IV **(20)**

- General symptoms of plant diseases, pathogenic and non-pathogenic diseases, Principles of plant diseases, Biochemical aspects of disease development, Host-parasitic relationship, Biochemical and genetic aspect of disease resistance, Defence mechanism in plants.

- Diseases caused by fungi, bacteria, and virus: mildews, smuts, blight, rust, mosaic disease, leaf curl, blast of rice. Control of plant diseases.

Course outcome: On completion of the course, students shall be able to understand the role of microbes in agriculture and identify several plant diseases based on external and microscopic observations.

SEMISTER-I

MB-105 PRACTICALS

1. Microbiology laboratory- Basic rules and requirements
2. Methods of sterilization (moist heat, dry heat, filtration).
3. Demonstration of pH measurement of solution and culture media.
4. Preparation of culture media (broth, solid agar, agar slants and plates).
5. Demonstration of techniques for pure Pour plate, Spread plate, Serial Dilution) culture of microorganism. (Streak plate,
6. Method of culture preservation and maintenance (Storage in soil, mineral oil, stabbing and sub-culture)
7. Counting of microbial population (Total cell count, Viable cell count using haemocytometer.
8. Isolation and enumeration of microorganism from water, soil and air (Algae, fungi, bacteria, protozoa, cyanobacteria).
9. Section cuttings showing important plant diseases
10. Staining methods: Simple staining, Negative staining, Gram staining acid-fast staining, spore staining.
11. Standardization using stage and ocular micrometer.
12. Phenol coefficient.

SEMESTER-II

MB-201 Bioinstrumentation Full Mark: 100

Course objective: To get introduced to the fields of various instruments used in microbiology including the basic principle - application and working, molecular tools and techniques essential for the understanding of life sciences and microbiology.

UNIT–I (20)

- Spectroscopy: Electromagnetic spectrum, Beer Lambert's Law: Absorbance, Transmittance and Extinction coefficient; Principle and applications of UV- Visible Spectroscopy, spectrofluorimetry and Atomic absorption spectroscopy (AAS).
- Molecular structure determination using NMR and X- Ray diffraction.

UNIT–II (20)

- Centrifugation: Basic principles of sedimentation, types of centrifuge and their applications, design of rotors, Separation techniques: differential, density gradient, isopycnic centrifugation.
- Chromatography: Principle, methodology and applications of Paper chromatography, thin layer chromatography, affinity chromatography, adsorption chromatography, ion-exchange chromatography, gel permeation chromatography, gas- liquid chromatography (GLC), HPLC.

UNIT-III (20)

- Gel Electrophoresis: Principle, methodology and application of Agarose, SDS-PAGE, Native and 2-D gel Electrophoresis, FIGE. Blotting techniques - Southern blotting, Northern blotting and Western blotting.
- Molecular techniques: Principle and applications of PCR, RT-PCR and multiplex PCR, design of primers, identification of PCR products; DNA Sequencing Technology: Maxam- Gilbert method, Sanger's method and Whole genome shotgun sequencing, Human Genome Project (HGP); Chromosome mapping: Physical mapping, Restriction mapping, Hybridisation techniques: FISH, GISH; Molecular markers: RAPD, RFLP, AFLP, SNP; DNA Micro-array.

UNIT-IV (20)

- Advances in microscopy techniques: Principle and applications of Confocal microscopy, Electron Microscopy: SEM, TEM, Scanning Probe Microscopy; Types and role of Radioisotopes in biological sciences, Tracer techniques: PET, SPECT.

Course outcome: On completion of the course, the students will develop the capability to carry out experiments involving several instrumentation techniques. The student will be aware with a basic knowledge of modern molecular biology and genomics.

SEMESTER-II

MB-202 Molecular Biology and Genetic Engineering Full Mark: 100

Course Objective: The course is designed to train the students in various aspects of gene regulation and expression.

UNIT–I **(20)**

- Recombination: Types and Mechanism of recombination, Transformation- Discovery, detection, molecular mechanisms of transformation, transformation methods. Bacterial Conjugation - Sex factor in bacteria, F, F´ and HFR transfer mechanism of transfer.
- Bacterial Transduction- Phenomenon of Transduction, Methods of transduction: Generalized and Specialized transductions, Co- transduction and Abortive transduction, Sexduction.

UNIT–II **(20)**

- Gene regulation and expression in prokaryotic systems: Lac, arabinose and tryptophan operons, Repressors and activators in lambda, Sigma switch in *B. subtilits* Gene regulation and expression in eukaryotic systems: repetitive DNA, gene rearrangement, promoters, enhancer elements, gene amplification.
- Signal transduction, Concept of secondary messengers: cAMP, cGMP, protein kinases, G-proteins, Transposable elements.

UNIT-III **(20)**

- Basic techniques in gene analysis: Restriction enzymes- Types of restriction-modification system & its mechanisms, other modification systems; Cloning vectors-Plasmids, phagemids, cosmids and phages, other viral vectors (M13 and retroviruses);
- Gene transfer methods: Physical and Chemical methods of gene transfer, Agrobacterium mediated gene transfer. Expression vectors, promoter probe vectors, vectors used for construction of library- artificial chromosomes; BAC vectors, YAC vectors. Cloning strategies, cloning and selection of individual genes; Gene libraries-cDNA and genomic libraries.

UNIT-IV **(20)**

- Gene Identification: Screening by nucleic acid hybridization, immunoscreening, screening by function, Other interaction screens: one hybrid, two-hybrid screening & phage display.
- Analysis of Gene Function: Relating Genes and functions, genetic Maps, relating Genetic and physical maps, Transposon Mutagenesis, Allelic replacement and Gene knock-outs, Complementation, Studying Gene function through protein interaction. Manipulating Gene Expression: Factors affecting expression of Cloned Genes, Expression of Cloned Genes in Bacteria, and Expression in Eukaryotic Host Cells, Adding tags and signals. In-vitro Mutagenesis. Site directed mutagenesis, Synthetic genes.

SEMESTER-II

MB-203 Immunology Full Mark: 100

Course objective: To get introduced to the principles of immunology, molecular and diagnostic techniques of immunology, immune- techniques and its application, the importance of immunology and its theoretical aspects and on the principles of immunology and immunotechnology. Antigen-antibody reactions involved in diseases and vaccine development.

UNIT–I (20)

- Introduction to the Immune system, Haematopoesis, Defense mechanism (First, Second and Third line), Organisation and structure of lymphoid organs of the immune system, primary and secondary lymphoid organs. Innate and acquired immunity.
- Cells and molecules involved in innate and acquired immunity: B and T lymphocytes, Macrophages, Neutrophils, Mast cell, NK cells, dendritic cells, Cytokines; Effectors Responses of Cell- mediated and Humoral Immunity. Antigen, Antigenicity, Haptens, Superantigens,

UNIT–II (20)

- Structure and functions of Antibody; Structure and function of immunoglobulin classes, Immunoglobulin genes- Organisation and expression, Maturation, activation and differentiation of B and T cells, Structure organization of BCR and TCR, MHC-Complex; Organisation and structure of MHC class-I and MHC class-II, Antigen processing and presentation.
- Complement System: Complement system as a part of innate & adaptive immune system, complement activation by classical, alternative and lectin pathway, complement mediated lysis and other effects of complement activation, Monoclonal antibody

UNIT-III (20)

- Antigen- Antibody interaction: Antibody affinity and avidity, forces stabilizing antigen-antibody interaction, Agglutination Reaction, Precipitation reaction, Immunodiffusion, Immuneelectrophoresis, ELISA, RIA, Immunofloursenence, Western blotting. Elispot assay.

UNIT-IV (20)

- Hypersensitivity and Mechanisms of type 1, 2, 3 & 4 hypersensitive reactions; Autoimmune diseases. Immune responses against tumors/Cancer.
- Immune responses against Transplantation, Graft Rejection, prevention and treatment of Graft Rejection, Immunosupressive therapy during Transplantation. Immunology of tolerance. Immunodeficiency diseases, vaccines.

Course outcomes: Students will get the deep foundation in the immunological processes after the end of the course.

SEMESTER-II

MB-204 Clinical Microbiology Full Mark: 100

Course Objective: The course will impart knowledge regarding various diseases of humans, chemotherapeutics used to combat diseases and molecular basis of cancer.

UNIT–I (20)

- Principles of Medical Microbiology: Classification of medically important microorganisms, Normal flora of human body - Origin of normal flora, role of the resident flora, effect of antimicrobial agents on normal flora, characteristics of normal flora; Distribution and occurance of normal flora (Skin, conjunctiva, nose, nasopharynx, sinuses, mouth, upper respiratory tract, intestinal tract and urogenital tract), Bacteria in the blood and tissues.
- Factors influencing normal flora, Properties of pathogenic microorganisms, Factors influencing pathogenicity. Type, sources and different modes/means of infections.

UNIT–II (20)

- Bacterial pathogens: Detailed study of morphology, cultural characteristics, epidemiology, prevention and treatment caused by following bacterial pathogens: B-Haemolytic *streptococcoi, pneumococci, Corynebacteium diphtheriae, Mycobacterium tuberculosis, Mycobacterium leprae, Neisseria meningitides, Haemophilus influenzae, Pseudomonas*. Sexually transmitted diseases caused by bacteria: *Treponima pallidum, Neisseria gonorrhea*. Bacterial diseases: Anthrax, Tetanus, Syphilis, Cholera, Botulism, Salmonellosis, Shigellosis, Staphylococcal food poisoning, Diarrhea, Typhoid fever, Chlamydial pneumonia.
- Fungal diseases: Superficial, cutaneous, sub-cutaneous and systemic Mycosis.

UNIT-III (20)

- Viral diseases: Chikenpox, Influenza, Measles, Viral Pneumonia, Rubella Mumps, Smallpox, AIDS, viral STD, Common Cold, Leukemia, Rabies, Viral Hepatitides, Polio. Protozoan Disease: Amebiasis, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis.
- Cell-cycle and its regulation: Tumor Cells and the Onset of Cancer, Loss of Growth-Inhibiting and Cell-Cycle Controls, The Role of Carcinogens.

UNIT-IV (20)

- Antimicrobial chemotherapy: General properties of antimicrobial agents, The Spectrum of Activity, Modes of Action: Inhibitors of Cell wall synthesis, Disrupters of Cell membranes, Inhibitors of Protein Synthesis, Inhibitors of Nucleic Acid synthesis, Kinds of Side Effects; Antibacterial, Antifungal, Antiviral, Antiprotozoan and Antimetabolites
- The Resistance of Microorganisms, Determining microbial sensitivities to antimicrobial agents: The Disk Diffusion Method, The Dilution method, Automated method.

SEMESTER-II

MB-205 PRACTICALS

1. Identification and characterization of bacteria (Morphological and Biochemical tests).
2. Microbial growth measurement of fungal growth by linear determination.
3. Measurement of fungal growth from increase of biomass. Determination of bacterial growth by turbidometry.
4. Pigment estimation of algae/cyanobacteria
5. ELISA
6. Gel Electrophoresis.
7. Submission of Study Tour Report.
8. Bacterial DNA extraction.
9. Plasmid DNA extraction.
10. Immune electrophoresis.
11. PCR,
12. RAPD, RFLP
13. Restriction mapping
14. Examination for blood-group and Rh factors.

SEMESTER-III

MB-301 Environmental Microbiology Full Mark: 100

Course Objective: The course will provide necessary information related to microorganisms in various environments and their role in the ecosystems. It will provide necessary information related to microorganisms in leaching and bio-mining and several biotechnological and environmental management approaches.

UNIT I **(20)**

- Microbial diversity in extreme environments: Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, barophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles.
- Microbial ecology: Microbes in water (fresh water & marine water), air and soil environment, role of microbes in bio-geochemical cycles of water, carbon, nitrogen, phosphorous, sulphur and other inorganic elements.

UNIT II **(20)**

- Interaction between microbial populations: commensalism, mutualism, cooperation, antagonism, competition, parasitism, and predation. Interaction between micro and macro- organisms, growth of microbes in plants and animals.
- Microbial diversity in terrestrial (agricultural and desert soils), aquatic (fresh water and marine), atmospheric (stratosphere) animal (cattle, termites, pests such as cockroach and nematodes, and human being) Methods of controlling microorganisms in air, components of soil, soil pathogens, fresh water environment, marine environments, hydrothermal vents and cold seeps, Internal Air Quality assessment.

UNIT III **(20)**

- Bioremediation- types and microbes involved, Bioremediation of contaminated soil and waste lands, Genetically engineered microbes in biodegradation, Bioleaching and its significance- copper, uranium, other metals.
- Microbial degradation of herbicides, pesticides, fungicides, insecticides, hydrocarbons and other compounds, persistence of these compounds in the environment.

UNIT IV **(20)**

- Water pollution: Water-borne pathogenic microorganisms and their transmission. Sanitary quality of water. Aerobic sewage treatment: activated sludge treatment, primary, secondary (aerobic processes- trickling filters, Roughing filter, Rotating biological contractors, packed bed reactors, anaerobic processes) and tertiary treatments. Sewage treatment systems : Oxidation ponds, Septic tank.
- Sludge disposal & Solid waste management.

Course outcome: On completion of the course, Students will get an idea about the various groups of microorganisms, their role in various environments and their interactions with their surroundings.

SEMESTER-III

MB-302 Industrial and Food Microbiology Full Mark: 100

Course Objective: The course will provide knowledge regarding fermentation technologies, and use of microbes for industrial exploitations. Student will learn about the source of Microbes in Food, food spoilage and preservation techniques.

UNIT I **(20)**

- Industrial microbiology: Definition, scope, history, microorganisms, properties and industrial products. Screening for microbes of industrial importance. Primary screening, screening of industrially important compounds (amylase, organic acid, antibiotics, amino acids and vitamin).

UNIT II **(20)**

- Preparation of fermentation media and sterilization, Raw materials, inoculum preparation, Types of fermentations processes Solid state, surface and submerged fermentations. Fermentation techniques: Batch, fed batch and continuous fermentations. Design of bioreactor, types of bioreactor. Downstream processing.

UNIT III **(20)**

- Strain development strategies. Environmental factors and genetic factors for improvement. Immobilization methods: Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages.
- Fermented Foods: Types of fermented food its benefits, microflora in fermented foods, nutritional value. Lactic acid, mixed acid, propionic acid, butandiol and acetone-butanol, types of fermentation. Industrial production of vitamin B_{12}, B_2, Glutamic Acid, Penicillin, SCP.

UNIT IV **(20)**

- Food Microbiology: Intrinisic and Extrinsic parameters of foods that affect microbial growth. Production of fermented foods: cheese, butter, yogurt, bread, idli. Production of Distilled Beverages: wine, beer.
- Food spoilage and factors affecting food spoilage: Spoilage of meat, poultry, fish, egg, flour, fruits, vegetables and canned foods Food preservation methods: Food preservation techniques: High & Low temperature, radiation drying, chemicals-antibiotics & antifungal agents.

Course outcome: On completion of the course, Students will get an overall idea regarding design of bioreactors, use of culture systems for several industrial product formations as well as downstream processing & the source of Microbes in Food, food spoilage and preservation techniques.

SEMESTER-III

MB-303 Research Methodology Full Mark: 100

UNIT–I **(20)**

- Meaning of research, Research objectives, Types of research, Research methods & Research ethics.

- Computer application, DOS command, MS Office, MS Excel, MS PowerPoint. Accessing Internet Services: Browsing, Downloading, e- correspondence, E-mail.

UNIT–II **(20)**

- Basics of Biostatistics: Types and collection of data, presentation of data, Measures of central tendency: Mean, Median and Mode, Frequency distribution, Measures of Dispersion: Range, Quartile deviation, mean deviation, Standard Deviation, Variance and Coefficient of variation.

- Test for significance: Chi-square test. Student's t-test, f-test, Analysis of Variance (ANOVA), Correlation and Regression analysis.

UNIT-III **(20)**

- Bioinformatics: Definition, history, scope & applications of Bioinformatics, Biological databases: Primary & secondary, Bioinformatics Databases and analysis services: NCBI- GenBank, EMBL, PDB, KEGG, DBJ, Microbial genomic databases (MBGD), Similarity searching (FASTA & BLAST), Similarity based database searching: Global Vs Local Alignment, Multiple sequence alignment, Methods of illustrating evolutionary relationship: Features of a Phylogenetic tree, cladogram.

UNIT-IV **(20)**

- Basics of research practice: Writing of Research papers, abstracts and Review papers, Dissertations and thesis writing, developing research proposal, delivering of effective oral presentation, preparation and presentation of posters.

- Biological resources management: Threats; Management strategies, Bio-prospecting; IPR: Forms of IPR, Convention of Biodiversity (CBD), Forms of protection: Copyright, Trademark, Patent- Process of Patenting, Indian and international agencies involved in IPR & Patenting; Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal.

SEMESTER-III

MB-304 (PRACTICALS)

1. Estimation of total sugar of the supplied material.
2. Estimation of reducing sugar of the supplied material.
3. Estimation of protein of the supplied material.
4. Chromatography (TLC, Paper).
5. Total solid and total dissolved solids of the given water sample.
6. Hardness of the given water sample.
7. Estimation of dissolved CO_2 concentration.
8. Isolation of micro flora from human skin/ throat.
9. Food microbiology.
10. Spoilage of meat.
11. Spoilage of milk.
12. Spoilage of poultry and fish.

SEMESTER-III

OPEN ELECTIVE COURSE

OEC-MB-305 **Full Mark: 100**

Course objective: To educate the students on Microbiology, plant pathology, Animal disease, Microbes in Environment and their role.

UNIT–I **(20)**

- History and Scope of Microbiology: Discovery and history of microbes, Theory of spontaneous generation, Koch's Postulates, General accounts: Bacteria, Fungi, Algae, Protozoa, Virus.

UNIT–II **(20)**

- Common Plant Diseases: Symptoms, Causal organism and Prevention of the Bacterial diseases: Blight disease, Wilt of potato, Citrus canker; Fungal Diseases: Smut of sugarcane, Rust of wheat, Blast of rice, Early blight of potato, Wilt of tomato. Viral Diseases: Tobacco mosaic virus, Yellow leaf curl of tomato, Yellow vein mosaic of Lady's Finger.

- Common Animal Diseases: Symptoms, Causal organism and Prevention of the Bacterial diseases: Diarrhea, Tubercolosis, Leprosy, Cholera, Pneumonia, Typhoid; Viral diseases: Chicken pox, Measles, Polio, HIV, Hepatitis, Herpes; Fungal Diseases: Cutaneous Mycosis Protozoan diseases: Malaria, Amoebiasis.

UNIT-III **(20)**

- Microbes in Ecosystem: Microbes involved in the cycling of Carbon, Phosphorous, Sulphur; Nitrogen fixation; Decomposition; Water pollution; Soil formation; Microbial Indicator; Plant growth promoting microbes; Symbiosis.

UNIT-IV **(20)**

- Application of Microbes: Industrial application of microbes, vaccines, antibiotics, vitamins, organic acids, PHB, extraction of ores; Bioremediation; Microbes in Food Microbiology: Spoilage of food, Preservation of food, Beverage production, SCP.

Course outcome: Students will learn on Microbiology, plant pathology, Animal disease, Microbes in Environment and their role.

SEMESTER-IV

ELECTIVE-A

MB-EC-401 Clinical Microbiology Full Mark: 100

Course Objective: The course will impart knowledge regarding various diseases of humans, chemotherapeutic used to combat diseases, and immune system.

UNIT–I **(20)**

- Host pathogen interaction: The role of the microbial flora, Pathogenesis of infection: colonization and invasion. Role of microbiology laboratory in the diagnosis and control of infections. Management, safety and quality control in medical microbiology laboratory.

UNIT–II **(20)**

- Specimen collection and processing: Basic principles of specimen collection, preparation of container and swabs for collection of specimens for microbiological examination, preservation storage and transport of specimens, documentation of specimen, Microbiological examination of clinical specimens: Microscopic examination, use of colonial morphology for presumptive identification, biochemical identification of microorganisms. Immunodiagnosis of infectious diseases: Principles of immunological assays, use of serological testing in specific diseases (WIDAL, VDRL, TPHA, ASO, TORCH- profile, HBS ELISA, HIV- ELISA). Application of molecular diagnostics: Nucleic acid hybridization, nucleic acid amplification.

UNIT-III **(20)**

- Clinical syndromes and their laboratory diagnosis: Upper and Lower respiratory tract infections (Pharyngitis, otitis media, pneumonia), Skin and soft tissue infection (Impetigo, folliculitis, furuncle, carbuncle, cellulites and erysipelas), Infection of central nervous system (Meningitis and Encephalitis). Bacteremia and sepsis, Pyrexia of unknown origin (PUO).Gastrointestinal infection and food poisoning, Urinary tract infections, Sexually transmitted diseases, Infection in special populations (Malignancy, AIDS, Tuberculosis and leprosy). Zoonotic diseases-epidemiology, diagnosis, control and prevention.

UNIT-IV **(20)**

- Epidemiology, surveillance and control of community and hospital infections. Antimicrobial chemotherapy, emergence of drug resistance (MRSA, ESBL and MDR TB). Methods of prevention and control- isolation of patients, quarantine and incubation period of various infectious diseases. Management of patients in infectious diseases hospital.

Course outcome: On completion of the course, Students will be benefitted in understanding the role of various agents and treatment mechanisms to combat various pathogenic diseases of human and to create public health awareness.

SEMESTER-IV

ELECTIVE-B

MB-EC-401 Pharmaceutical Microbiology Full Mark: 100

Course Objective: The course will impart knowledge regarding various diseases of humans and role of antibiotics in disease control.

UNIT–I **(20)**

- Concepts of pharmaceuticals, biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, heamopoetic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases), Vaccines & their production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines).

UNIT–II **(20)**

- Drug discovery and development Introduction to drug discovery and development, sources of drugs, approaches to new drug discovery, role of molecular recognition in drug design, enzymes and receptors as drug targets, pro-drug design and applications, computer aided drug design, preclinical and clinical trials.

UNIT–III **(20)**

- Microbial production contamination and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization, FDA, govt. Regulatory practices and policies, concept of R & D, quality control and market planning. Significance of IP, BP and USP. Reimbursement of drugs, biological and legislative aspects, patenting of drugs and biological products.

UNIT–IV **(20)**

- Quality Assurance and Validation. Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.

Course outcome: On completion of the course, Students will be benefitted in understanding the role of various agents and treatment mechanisms to combat various pathogenic diseases of human and to create public health awareness.

SEMESTER-IV

ELECTIVE-A

MB-EC-402 Advances in Agriculture Microbiology Full Mark: 100

Course Objective: The course is designed to teach students regarding the microbial activity in rhizosphere and phyllosphere, nitrogen fixing and phosphate utilization mechanisms in microbes, diseases and resistance against diseases.

UNIT–I (20)

- Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity: significance and conservation; effect of agricultural practices on soil organisms Biological nitrogen-fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen-fixation; Rhizobium-Legume Association; N2 fixation by non- leguminous plants.

UNIT–II (20)

- Chemical transformation by microbes: Organic matter decomposition, nutrient mineralization and immobilization; transformation of carbon and carbon compounds; availability of phosphorus, sulfur, iron and trace elements to plants; biodegradation of herbicides and pesticides, Biofertilizer: Mass cultivation of microbial inoculants; green manuring; algalization; Azolla.

UNIT-III (20)

- Microbial products and plant health: PGPR (plant growth promoting rhizobacteria); significance of mycorrhizae; toxin producing microbes (antibiotics, aflatoxin, etc.); microbial herbicides; biological control. Bioindicators - their relevance and utility; Measurement of Microbial activity in environmental samples; Microbial transport and bioaugmentatin. Edible and poisonous mushrooms, morphology, classification and nutritional values.

UNIT-IV (20)

- Microorganisms and organic pollutants; Biodegradation, Bioremediation; Microorganisms and metal pollutants; Emerging Technologies in environmental microbiology and its application; Bio reporters, Biosensors, and Microprobes; Micobial Fuel Cell; Environmental Risk assessment of GMOs.

Course outcome: On completion of the course, Students will get an idea about several mechanisms for nutrition uptake by microorganisms, various pathogenic and non- pathogenic plants diseases and their resistance in terms of physiological, biochemical and genetic aspects.

SEMESTER-IV

ELECTIVE-B

MB-EC-402 Plant Pathology Full Mark: 100

Course Objective: The course is designed to impart students about microbes use in compositing; bioenergy production. The course will also provide insights into use of microbes as biofertilizers and transgenic manipulations.

UNIT–I **(20)**

- Plant Pathology: Terminology of disease, components of disease, causes and classification of disease, disease cycle; general symptoms of plant disease. Pathogenesis in disease development, plant-parasite relationship, microbial toxins in plant disease. Effects of pathogens on physiology of plants.

UNIT–II **(20)**

- Genetic basis of host-pathogen interactions: Genetics of virulence in pathogen and resistance in host plant. Epidemiology and Forecasting of plant diseases. Methods of control of plant diseases: Physical, Chemical and Biological methods of control. Integrated pest management. Biocides in crop protection: Biocides and its types, Recombinant DNA technology for insecting, Bt genes into other organisms.

UNIT-III **(20)**

- Diseases caused by bacteria: General symptoms, Survival and spread of bacterial plant pathogen. Diseases caused by Pathogenic Fungi: General symptoms, Survival and spread of fungal plant pathogen. Diseases caused by mastigomycotina.

UNIT-IV **(20)**

- Diseases caused by ascomycotina, Diseases caused by Basidiomycotina: Rust and smut. Diseases caused by deuteromycotina Diseases caused by nematodes, Diseases caused by flowering plants, Non parasitic diseases caused by environmental factors,

Course outcome: On completion of the course, Students will get an idea about microbial uses for improving agriculture and compacting several plant diseases and will help in future research in the field of sustainable agriculture.

SEMESTER-IV

ELECTIVE-A

MB-EC-403 Industrial Microbiology and Applications Full Mark: 100

Course Objective: The course will provide knowledge regarding fermentation technologies, and use of microbes for industrial exploitations.

UNIT–I **(20)**

- History, scope and development of Industrial Microbiology, Industrially important microorganisms, Suitability of microbial strains in industrial processes, Types of fermentation processes, Design of a fermenter, Economic aspects of fermentation processes

UNIT–II **(20)**

- Isolation, selection, improvement and maintenance of industrial important strain. Metabolic pathways and metabolic control mechanisms.
- Substrates for industrial fermentation, Fermentation media formulation and sterilization, Inoculum development, Production of primary metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins).

UNIT-III (20)

- Batch and continuous culture in fermentation, growth kinetics of micro-organisms, classification of fermentation process; Effect of environmental factors on the growth of microorganisms: Temperature, pH, Nutrient concentration, Kinetics of thermal death of micro-organisms.

UNIT-IV **(20)**

- Downstream processing objectives and criteria: Foam separation, Precipitation methods Filtration devices, Industrial scale centrifugation and cell disruption methods, Liquid-liquid extraction, Solvent I recovery, Chromatography, Two phase aqueous extraction, Supercritical fluid extraction, Ultrafiltration, Crystallization.

Course outcome: On completion of the course, Students will get an overall idea regarding design of bioreactors, use of culture systems for several industrial product formations as well as downstream processing.

SEMESTER-IV

ELECTIVE-B

MB-EC-403 Food Microbiology Full Mark: 100

Course objective: Student will learn about the source of Microbes in Food, food spoilage and preservation techniques.

UNIT–I **(20)**

- Intrinsic and extrinsic parameters of foods that affect microbial growth, Primary sources of microorganisms in foods, Types of microorganisms in foods: Meat (Fresh and Frozen), Poultry, Vegetables, Dairy products.

UNIT–II (20)

- Food Borne Diseases: Incidence of microorganisms, nutritional requirements for growth, gastrointestinal syndrome and prevention of diseases caused by *Staphycoccus aureus*, *Clostridium botulinum* and *Clostridium perfringens*.

UNIT-III (20)

- Microbial spoilage of foods: Spoilage of fruits and vegetables, Spoilage of fresh meat and processed meats, poultry and processed poultry meats, Spoilage of eggs, cereals, bakery products, beer, wines and canned foods.

UNIT-IV **(20)**

- Food preservation: Preservation of foods with with high temperature, low temperature, radiation (drying), chemicals, antibiotics and antifungal agents, Fermentation.

Course outcome: After completion of the course students will get an idea about source of Microbes in Food, food spoilage and preservation techniques.

SEMESTER-IV

MB-404 **PRACTICAL** **Full Mark: 100**

1. Dissolved oxygen
2. BOD
3. COD
4. Estimation of protein from unknown sample.
5. Iodine test for polysaccharides
6. Benedict's test for reducing sugar from unknown sample.
7. Estimation of carbohydrates by anthron method.
8. Production of wine.
9. Production of ethanol.
10. ELISA
11. Cloning
12. Mushroom cultivation/spawn production
13. Pathogen isolation from diseased plants/animals
14. Screening of antibiotic production from bacteria/fungi/Clinical sample collection/isolation of food spoilage microbes from different sources

SEMESTER-IV

MB-405 Dissertation Full Mark: 200

Course Objectives: The course aims to develop the skill of experimental design, critical thinking and scientific writing.

Content:

Each student is required to carry out a dissertation work involving either experimental research work or a review work under the supervision of a faculty member and submit a dissertation. The student has to start the project work from beginning of Semester- IV and submit the dissertation before the commencement of Semester IV theory examination. The project will be evaluated in Semester IV .The student has to give a Power Point Presentation in the presence of an external examiner and an internal examiner (the Supervisor). The project will be evaluated by the examiners based on the dissertation (100 marks), Power Point Presentation (50 marks) and viva-voce (50 marks).

Course Learning Outcomes: Students will learn how to design experiments, think critically and write dissertation. The course will be a preliminary training to do research.

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