MANGALORE UNIVERSITY

DEPARTMENT OF STUDIES AND RESEARCH IN MICROBIOLOGY
POST GRADUATE CENTRE, JNANA KAVERI CAMPUS, KODAGU-571232

Microbiology

M.Sc. Degree Programme in
Choice Based Credit System

Syllabus

General Objectives of the Programme

1. To excel in various fields of Microbiology.
2. To gain higher education in the field of microbiology.
3. To gain knowledge regarding microbiological and analytical skills related to medical, food, pharmaceuticals, environmental and agricultural aspects.
4. To train the students practically eligible to pursue higher research work.
5. To make them competent to address various societal issues.

Programme Outcome: M.Sc. in Microbiology

The M.Sc., Microbiology programme, equips the candidate with microbiological skills to render their service in various institutions and companies. The program prepares the students to gain knowledge in various specific areas/fields of Microbiology. The students are trained to get through competitive examinations at international, national and state level. The students are taught different aspects of microbiology and trained for creative self-employability.

Programme specific Outcomes

PSO 1	Employability skills capable to work in research institutes, Industries and Government departments.
PSO 2	Research skills to pursue Ph. D and Research Assistants, Research Associates in reputed institutes.
PSO 3	Establishment of own diagnostic centers and industries.
PSO 4	Teaching – Universities and Colleges.
PSO 5	Work with FSL laboratories, Pollution control boards and Coffee board.
PSO 6	Take up further research in abroad and outside the state.
PSO 7	Work with NGOs to create awareness of hygiene in rural and urban areas.
PSO 8	Field work research through Project Works

Question Paper Pattern for University Examination
Microbiology (CBCS-PG-CGPA)

Time: 3 Hours **Max Marks: 70**

I. Answer **any three** of the following 3 x 10 =30

1.
2.
3.
4.
5.

II. Write notes on **any five** of the following 5 x 5 = 25

6.
7.
8.
9.
10.
11.
12.
13.

III. Write short notes on **any five** of the following 5 x 3 = 15

14.
15.
16.
17.
18.
19.
20.
21.

While setting question paper equal weightage should be given to all the units of the paper.

Question Paper Pattern for Internal Assessment
Microbiology (CBCS-PG-CGPA)

Time: 1.30 Hours **Max Marks:30**

I. Answer **any two** of the following 2 x 6 =12

1.
2.
3.

II. Write notes on **any three** of the following 3 x 4 = 12 4.

5.
6.
7.
8.

III. Write short notes on **any three** of the following 3 x 2 = 6

9.
10.
11.
12.
13.

Note: Two tests to be conducted for 30 marks each and the average of the two shall be awarded as IA marks

MANGALORE UNIVERSITY

CBCS- PG-CGPA

To be implemented from 2016-17

CHOICE BASED CREDIT SYSTEM- POST GRADUATE-SYLABBUS
CUMULATIVE GRADE POINTAVERAGE
Approved in the BOS meeting held on 30-05-2016,
PROGRAMME: **MICROBIOLOGY**

I SEMESTER

Hard Core	Credit	Total Credits	Grand Total Credits (86+6)
MBH- 401: Virology	4		
MBH- 402: Bacteriology	4		
MBH- 403: Mycology	4		
MBH- 404: Phycology	4	20	23
MBP- 405: Practical I (Virology & Bacteriology)	2		
MBP- 406: Practical II (Mycology & Phycology)	2		
Soft Core			
(Any one of the two shall be opted)			
MBS- 407: Microbial Genetics	3		
MBS- 408: Microbial Methods and Techniques	3	3	

II SEMESTER

Hard Core	Credit	Total Credits	Grand Total Credits
MBH- 451: Microbial Physiology	4		
MBH- 452: Immunology	4		
MBP- 453: Practical III (Microbial Physiology)	2	12	
MBP- 454: Practical IV (Immunology)	2		
Soft Core			
(Any three of the four shall be opted)			
MBS- 455: Food Microbiology	3		
MBS- 456: Environmental Microbiology	3	9	24
MBS- 457: Phytopathology	3		
MBS- 458: Geomicrobiology	3		
Open Electives			
(Any one of the two shall be opted)			
MBE- 459: Microbial Diversity	3		
MBE- 460: Biofertilizers and Biopesticides	3	3	

III SEMESTER

Hard Core	Credit	Total Credits	Grand Total Credits
MBH- 501: Molecular Biology MBH- 502: Industrial Microbiology MBP- 503: Practical V (Molecular Biology) MBP- 504: Practical VI (Industrial Microbiology)	4 4 2 2	12	24
Soft Core **(Any three of the four shall be opted)**		9	
MBS- 505: Pharmacognosy & Pharmacology MBS- 506: Microbial Biotechnology MBS- 507: Medical Microbiology MBS- 508: Microbial Ecology	3 3 3 3		
Open Electives **(Any one of the two shall be opted)**			
MBE- 509: Applied Microbiology MBE- 510: Techniques in Microbiology	3	3	

IV SEMESTER

Hard Core	Credit	Total Credits	Grand Total Credits
MBH- 551: Agricultural microbiology	4		
MBH- 552: Biostatistics and Bioinformatics	4	12	
MBP- 553: Project work	4		
Soft Core			21
(Any three of the four shall be opted)			
MBS- 554: Fermentation Technology	3		
MBS- 555: Cancer Biology	3	9	
MBS -556: Bio Nanotechnology	3		
MBS- 557: Genetic Engineering	3		

"We Emphasize Student Achievement and Success Because Achievement and Success Are Essential to Shape Future Leaders and Transform Lives."

I SEMESTER

Hard Core

MBH401Virology 56h

OBJECTIVES

1. Isolation, preservation and maintenance of viral particles.
2. Techniques in managements of viral diseases.
3. To understand structural and functional characteristics of viruses.
4. To learn different types of viruses and their causative diseases.
5. To learn prevention and treatment methods of viral infections.

COURSE OUTCOME

CO1: Identification and classification of different types of viruses.
CO2: Diagnosing viral disease of plant, animal and human.
CO3: Employment in diagnostic labs as virologist.
CO4: Practical approach to isolation and culturing of viruses.

Unit I

Virus: Definition, History, theories of origin. Importance of viral study, scope, general Morphology, Chemical composition. Ultra Structure of virion, Types of Envelops and Nucleic acids and their composition, Viral classification: Baltimore Classification, LHT classification, ICTV classification

Unit II

Plant viruses: General symptoms, economic importance, diseases in pulses: transmission and control. Special references - BCMV, PMV, SMV, ULCV, BYMV, Human viruses: importance epidemiology symptoms and control measures - HIV, H1N1 Ebola virus, SARS virus, Small pox virus, Rabies virus, Zica virus. Bacterial viruses: classification, Lytic and lysogenic cycle. Phage therapy, biotechnologicalapplications

Unit III

Diagnostic methods in Virology: principle, procedure, merits and demerits. Physical assays: Microscopy- Electron Microscopy, Immunosorbent EM, Histopathological examination, Biological - cytopathic effect, plaque assay, Pock assay, Serological assays: Enzyme linked Immunosorbant Assay, Dot immune binding assay, RIA, Western blot analysis,Immunofluorescence

Unit IV

Cultivation of viruses: cell culture techniques and their types, fertilized egg, Maintenance of virus- Host plant inoculation test, indicator plant test Multiplication of viruses: attachment, uncoating, penetration, biosynthesis and release viral pathogeneses: transmission, tropism, virulence, host factors, host defensemechanism.

Note: Each unit is for 14h

Hard Core

MBH-402: Bacteriology 56h

OBJECTIVES

1. Isolation, identification and preservation of bacterial stains.
2. Screening of bacterial strains from natural source for metabolite production.
3. Mass cultivation of industrially important bacteria.
4. To learn importance of bacteria in Industry, Pharmacy, Agriculture etc.,

COURSE OUTCOME

CO1: Study, diagnosis and treatment of bacterial disease.

CO2: Employment in diagnostic labs as pathologists

CO3: Able to maintain bacterial cultures for different applications.

CO4: Understanding different groups of bacteria.

CO5: Preservation and Culture collection centre

Unit I

Morphology and ultrastructure of bacteria**-**An overview of bacterial size, shape and arrangement: Bacterial cell wall, Plasma membrane, Cytoplasmic matrix; Ribosomes, Flagella and pili, Bacterial Motility, Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes. Endospore and exospores.

Unit II

Characteristics and Salient features of major groups of microbes: Taxonomy of bacteria – Bergy's Manual of Systematic Bacteriology – characteristics of major groups of bacteria. a) Actinomycetes – general characteristics, classification and economic importance. b) Cyanobacteria - general characteristics, classification, ultra-structure, reproduction and economic importance. c) Mycoplasma– general characteristics and examples, growth and multiplication and their significance. d)Archaebacteria – general characteristics and classification.

Unit III

Nutrition and Cultivation- Micro and macro nutrients, growth factors. Culture media:Classification: broth, solid and semisolid media. Simple, complex and special media. Growth: Growth kinetics, generation time, growth curve, factors affecting growth. Aerobic, anaerobic, batch, continuous and synchronous cultures. Mechanism of cell cycle and binary fission. Preparation of bacterial stains: simple staining (positive and negative), differential staining (Gram's staining and acid-fast staining), structural staining (Capsule, flagella and endospore) and nuclear staining.

Unit IV

Importance of bacteria- A brief account of economic importance of bacteria in Brewing industry- and Pharmaceuticle- Antibiotics, Vaccines & hormones. Agriculture as Biofertilizers-*Rhizobium, Azospirillum* and Plant growth promoting bacteria (PGPR). Biopesticides-*Bacillus thurengiensis*. Environment- Bioremediation and bioleaching.

Note: Each unit is for 14h

Hard Core

MBH-403: Mycology 56h

OBJECTIVES

1. Isolation, identification and maintenance of fungi from various ecosystems.
2. Study of plant, human and animal pathogens.
3. To learn fungal pathogens diagnosis and treatment.
4. Identification of wood rotting fungi and edible mushrooms.

COURSE OUTCOME

CO1: Mass cultivation industrially important fungi.
CO2: Isolation identification and mass cultivation of bio-fertilization and biocontrol agents.
CO3: Development of protocols for the production of antibiotics, enzymes other industrially important compounds.
CO4: Mass cultivation of mushrooms.
CO5: Mycological Culture collection centre

Unit I

History and development of Mycology, Recent developments in Mycology, General characters, distribution and classification of fungi, Ultra structure of fungal cell and cell wall. Growth, Hyphae and non-motile uni-cells, motile cells, spores and dormancy.

Unit II

Nutrition in fungi, Reproduction in fungi- Vegetative, Asexual and Sexual. Fungal spores and fruiting bodies. Difference between fungi and algae. Fungal systematic- Chytridiomycota, Hypochytridiomycota, Oomycota, Basidiomycota, Ascomycota, Deuteromycota,

Unit III

Different types of mycosis- Cutaneous, subcutaneous and Systemic mycosis. Mycotoxins Opportunistic fungal infections, Lab diagnosis and treatment of fungal infections. Aspergillosis, Candidiasis, Dermatitis, Plant Fungal Diseases

Unit IV

Economic importance of fungi- fungi in Agriculture, Industry, Medicine. Fungi as biocontrol agent, Mycorrhiza- Ecto and Endomycorrhiza, Vesicular and Arbuscular Mycorrhiza, Folicolous and Endophytic fungi, Lichens and their importance. Macrofungi and their importance in food industries – cultivation of mushrooms and applications. Role of fungi in biodegradation.

Note: Each unit is for 14h

Hard Core

MBH-404: Phycology 56h

OBJECTIVES

1. To understand general properties of algae.
2. To learn identification of algae from different habitats.
3. To study significances of algae in various field such as bio-fuel food and medicines.
4. To study importance of algae in environmental pollution monitoring water purification plant soil fertility and other commercial bi-product.

COURSE OUTCOME

CO1: Large scale cultivation of algae for pigment production and extraction.

CO2: Self-employment in setting up small scale industries of bio-fertilizers and singe cell proteins etc.

CO3: Development of algal based food and fodder

CO4: Knowledge on economic importance of various types of algae

Unit I

General characters and classification of algae, distribution and classification, morphology & ultrastucture of cyanophycean cell. Photosynthetic pigments. Difference between microalgae and macroalgae. Difference between prokaryotic- blue green algae and eukaryotic algae- green, red, brown. Significance of figments (structure of chlorophyll a, b, c, and c2, xanthophyll, carotenoids and other figments)

Unit II

Ecology of fresh water, marine water and soil algae, measurement of algal growth. Cultivation and Reproduction in algae, Economics importance of algae, uses of algae as SCP, *Spirulina &Chlorella*, Algal biofuel. Bio diesel, bio ethanol, mass culturing of algae. Extraction and refinement. Symbiotic algae, lichens, coral reefs and seasponges.

Unit III

Algae as indicators of pollution, algae as biofertilizers, eutrophication, algal blooms, algal toxins, algae as raw food and feed. Industrially important algal products. Algae with special references to soil fertility, commercial products, food and medicine.

Unit IV

Role of algae in heavy metal removal, immobilized and labelled algae, strain section and large scale cultivation. Role of algae in water purification.

Note: Each unit is for 14h

MBP- 405: Practical I (Virology &Bacteriology)

1. Isolation and enumeration of coliphage from sewage
2. ELISA, western blot for viral receptors
3. Host plant Inoculation
4. Indicator plant test
5. DIBA
6. Preparation of bacterial culture media
7. Bacterial Inoculation methods
8. Colony characteristics of bacteria
9. Staining techniques (Simple, Negative, Gram's, Endospore, flagellar)
10. Bacterial Growth curve (Titrimetric and Turbidometric)
11. Enumeration of bacteria from different sources
12. Micrometry

MBP- 406: Practical II (Mycology & Phycology)

1. Lactophenol cotton blue staining for fungal culture
2. Enumeration of fungi from soil, water and air
3. Study of endophytic fungi
4. Study of follicolous fungi
5. Isolation of VAM fungi
6. Isolation of microbes from Rhizosphere and phyllosphere
7. Identification of wood rotting fungi
8. Identification of Phytoplanktonsin freshwater
9. Identification of Phytoplanktonsin marinewater
10. Isolation and culturing of Cyanophycean members
11. Study of Lichens
12. Extraction of lagal pigments

Soft Core

MBS-407MICROBIALGENETICS 40h

OBJECTIVES

1. Study of hereditary components and structural features in detail.
2. Study the genetic difference between eukaryotes and prokaryotes.
3. Factors influencing genetic mutations.
4. History and evolution of genetics studies in the field of life science.
5. Study of cloning techniques.

COURSE OUTCOME

CO1: Isolation of DNA and their analysis for mutation.
CO2: Employment in FSL laboratories, diagnostic/ medical fields.
CO3: Development of hybrids of plants and animals for the benefit of human kind.
CO4: Understanding development of recombinants.

Unit I

Structure and types of chromosomes, centromere, telomere, nucleosome, genome organization, split gene. Types of histones, histone modifications- methylation, acetylation, phosphorylation and their effects on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence. Law of DNA constancy, C value paradox and genome size, karyotype and ideogram. *E. coli* genome: coiled, supercoiled, folded fibremodel.

UNIT II

Mendelian Laws, Contribution of Griffith, Avery, Hershy and Chase towards Genetics. Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes. Plasmids and Bacteriophages: Plasmids, F-factors - description and their uses in genetic analysis, R plasmids. Lysogeny and lytic cycle in bacteriophages.

UNIT III

Structure of gene, Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution. Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms. Site directed mutagenesis and its applications.

UNIT IV

Genetic recombination in bacteriophages and *E. coli,* synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, Genetic Mapping: Complementation analysis, deletion mapping, cis-trans test. Overlapping genes. Transposons. General mechanism of genetic engineering in eukaryotes and prokaryotes. Restriction Mapping, Genetic Engineering, Transfection of a cloned gene into a eukaryotic cell & its expression

Note: Each unit carry 10 hrs

Soft Core

MBS- 408: Microbial Methods and Techniques 40h

OBJECTIVES

1. Students are trained to identify bacteria based on the growth characteristics.
2. Study of different types of micro-organisms and their applications.
3. Preparation of microbial specimens and staining technique for microscopy.
4. Media formulation and factor influencing microbial growth.
5. Qualitative and quantitative assessment of bacterial growth.

COURSE OUTCOME

CO1: Study of biochemical, analytical and molecular technique.
CO2: Employment as bacterial taxonomist, general microbiologist and in analytical labs.
CO3: Optimization of microbial culturing media.
CO4: Concepts of Microbiological and Biochemical techniques

Unit I

Laboratory procedures for identification of bacteria and fungi, classification of bacteria. Brief study of Bergey's manual. Microscopy- Principles and applications (Compound, Bright field, Phase Contrast, Fluorescent. Electron Microscopy)- specimen preparation, staining technique. Morphological study of bacterial and fungal cells.

Unit II

Media, types, factors influencing microbial growth- pH, temperature, Carbon, Nitrogen and metal ions. Bacterial photosynthesis, aerobic and anaerobic respiration, bacterial growth curve, DMC, SPC, MPN. Turbidity, Metabolic Activity and dry weight, haemocytometer.

Unit III

Chromatography, TLC, Gel filtration, IEC, Affinity, GC, HPLC, Electrophoresis, Centrifugation, Spectroscopy: Principle, types and application. Autoradiography and X-ray Crystallography. Florescent, Spectroscopy, Molecular Techniques: Electrophoresis-SDS page, agarose gel, IEF, 2D –Page, PFGE, southern western northern blotting, PCR and it's a types.

Note: unit: I 14h, & II, III 13h

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II SEMESTER

Hard Core

MBH- 451: Microbial Physiology 56h

OBJECTIVES

1. Study of the structures, classification and function of various molecules such as carbohydrates, proteins, lipids and vitamins.
2. Metabolisms of bio-molecules through various pathways.
3. Study of bio-energetic and interaction of biomolecules.
4. Study on laws of thermodynamics.

COURSE OUTCOME

CO1: Understanding structure, classification and role of enzymes in microbial metabolism
CO2: Establishment of fermentation industry and biochemical labs.
CO3: To understand the enzyme kinetics.
CO4: Understanding of bio-molecule interaction.
CO5: Amino acids, vitamins, Lipids in cells

Unit I

Bioenergetics: Entropy, enthalpy, Electron donors, electron carriers, Inhibitors, Uncouplers, Energy bonds, Phosphorylation, Concepts of acids and bases, pH and Buffers. High Energy yielding phosphate bonds. ATP, Creatine Phosphate. Laws of Thermodynamics, Interactions of Biological macromolecules- Van der waal's interaction, Hydrophobic, Hydrogen- Bonding interactions, Ionic bonding.

Unit II

Amino Acid and Peptides, Protein structure: Primary, Secondary, Tertiary and Quaternary. Carbohydrate: Structure, Classification, Cell wall Polysaccharides. Vitamins: Role of Vitamins: Role of Vitamins and Coenzymes, Lipids: simple and compound lipids and their properties.

Unit III

Aerobic and Anaerobic respiration, EMP pathway, Kreb's Cycle, Phosphorylation, ED pathway, Pentose- Phosphate pathway, Homo and Hetero Lactic Fermentation. Gluconeogenesis, Glyoxalite pathway, bio synthesis of peptidoglycan (fermentation)

Unit IV

Enzymes: Definition, Classification, Kinetics, E-S complex, interactions. Inhibitions – reversible and irreversible. Michaelis – Menton equation, Specificity, Active Site, Regulatory Site, allosteric regulators, ribozymes and abzymes.

Note: Each unit is for 14h

Hard Core

MBH-452: Immunology 56h

OBJECTIVES

1. Study various aspects of immunology such as immunity, immune cells, antigens and antibody.
2. Types of immunity and hypersensitivity studies
3. Study of antigen antibody reaction through various immunological techniques.
4. Factors influencing autoimmune diseases and their management.

COURSE OUTCOME

CO1: Basics of immunology, cells and organs involved
CO2: Immunogenecity, Antigenicity, hypersensitivity
CO3: Principles and assays of immunological techniques
CO4: Understanding Immunological aspects of organ grafting.
CO5: Employment in diagnostic lab.
CO6: Identification of pathogens and cancer markers.
CO7: Understanding of autoimmune diseases.

Unit I:

Immunity, Innate(non-specific) and Adaptive(specific) immunity, primary and secondary lymphoid organs, Cells of the immune system- macrophages, B-cells, T-cells, NK Cells, Basophils, mast cells, hematopoiesis, Humoral or antibody mediated immune response and Cell mediated immune response, receptors of the B-cells, T-cells, monoclonal and polyclonal antibodies.

Unit II:

Immunogenicity, antigenicity, factors that influence immunogenicity, exogenous and endogenous antigens, epitopes, haptens, primary and secondary immune response, antigen processing and presentation, antigen recognition MHC, pattern recognition receptors, Immunoglobulin classes, Immunoglobulin superfamily, secretion of immunoglobulins. Principles and assays of Immunological Techniques: Precipitation, agglutination-hemagglutination, ODD, Radioimmunoassay, ELISA. Western blotting, Immunofluorescence, Flow cytometry, Immuno Fluorescence, Immuno-electron microscopy.

Unit III:

Hypersensitivity: IgE-Mediated (Type I) Antibody-Mediated Cytotoxic (Type II) Immune Complex–Mediated (Type III) Type IV or Delayed-Type Hypersensitivity (DTH) Primary and Secondary immunodeficiency, Acquired immunodeficiency syndrome, SCID, X-linked gammaglobulinemia, Opportunistic infections Cancer induction, Tumors of the Immune System, Tumor Antigens, viral induced antigens, Immune Response to Tumors, Evasion of the Immune System ,Immunosurveillance,

Unit IV:

Organ-Specific Autoimmune Diseases, Systemic Autoimmune Diseases, CD4+ T Cell, MHC and TCR in Autoimmunity, Autoimmune Diseases: Hashimoto's thyroiditis, autoimmune anemia, Insulin-dependent diabetes mellitus, Goodpasture's syndrome, Graves' disease, myasthenia gravis, Systemic Lupus Erythematosus, Rheumatoid arthritis, multiple sclerosis Immunologic Basis of Graft Rejection_ Clinical Manifestations of Graft Rejection, Immunosuppressive Therapy, Immune Tolerance to Allografts

Note: Each unit is for 14h

MBP- 453: Practical III (Microbial Physiology)

1. Estimation of inorganic phosphate by AAM method
2. Estimation of organic carbon by chromic acid
3. Estimation of organic carbon by titrimetric method
4. Triple sugar Iron test
5. Urease production test
6. Determination of catalase activity
7. Determination of V_{max} and K_m value
8. Qualitative testing of carbohydrates (Glucose, Fructose, Lactose, Starch)
9. Estimation of proteins
10. Estimation of Lipids (Cholesterol, Phospholipids, triacylglycerols)

MBP- 454: Practical IV Immunology)

1. Detection of allergens and pollen count by Sticky slide method
2. Blood group determination
3. Radial immunodiffusion assay
4. Ouchterlony double diffusion assay
5. DOT-ELISA
6. SDS-PAGE
7. Rocket Immuno Electrophoresis
8. RBC Count
9. Study on Immune cells
10. Isolation of Lymphocytes
11. VDRL
12. WIDAL test

Soft Core

MBS- 455: Food Microbiology 40h

OBJECTIVES

1. Detailed study on factors responsible for microbial food spoilage.
2. Detection of food spoilage methods.
3. Microbial spoilage of milk and fermented dairy products.
4. Food preservation techniques.

COURSE OUTCOME

CO1: Understanding food processing and packaging hygiene.
CO2: To learn food safety standards at international and national level.
CO3: Employment as food quality controller, in food and sewerage manufacturing industries.
CO5: Understanding importance of microorganisms in food industry.

UNIT- I

Food and its constituents: carbohydrates, proteins, fats & oils, vitamins, minerals, fiber and water- properties and significance. Food as substrate for microorganisms, Extrinsic and Intrinsic factors influencing microbial growth, Microbes important in food: molds, yeasts, bacteria. Detection of food spoilage, Food- borne Infection & Intoxication: Bacterial, Fungal, Nematodal, Protozoal. Spoilage of fruits, vegetables, cereals, meat, fish, sea foods, poultry and canned foods.

UNIT- II

Milk handling & processing, microbial contamination of milk, Biochemical activities of milk: Souring, Lactosis, Proteolysis. Milk - borne infections, Probiotics and their importance. Fermented dairy products- buttermilk, sour cream, cheese, yoghurt, Pasteurization and its types, Fermented Foods- Bread, Cocoa, Vinegar, Sausage, Oriental foods- Shoyu, Tofu, Idli. Food preservation: Classification- physical, chemical and biological.

UNIT- III

Principles of Food Packaging: Types of containers, Food packaging materials and forms, Package testing, Packages with special features, Safety of food packaging. Food Processing and Environment: Food Sanitation in manufacture and Retail trade, Properties and requirements of processing water, Waste water and waste solids disposal, up-gradation and treatment.

UNIT-IV

Food Safety, Risks and Hazards: Microbiological consideration in Food Safety, Effects of processing and storage on Microbiological safety, Microbiological methodology, Food Laws and Regulations- HACCP, FSSAI, BIS, Federal Food, Drug and Cosmetic Act, International Food Standards and Codex Alimentarius.

Note: Each unit is for 10h

Soft Core

MBS- 456: Environmental Microbiology 40h

OBJECTIVES

1. To learn Microbiology of air and isolation of microbes from air.
2. Types of air pollutants and transmission of air borne microbes.
3. Causes of allergy and its detection methods.
4. Study of microbes in various soil and water ecosystem.

COURSE OUTCOME

CO1: Understanding microbial contamination of water and its management.
CO2: Implementation of Waste water and solid waste treatment technologies.
CO3: Detailed study of microbes in the degradation of various chemicals.
CO4: Establishment of bioleaching of different metals.
CO5: Air pollutions, types and control

UNIT I

Air Microflora in different layers of atmosphere, Bioaerosol, Assessment of air quality using principles of sedimentation, impaction, impingement, suction and filtration. Air pollutions - types of pollutants, Brief account of transmission of airborne microbes; Microbiology of indoor and outdoor. Allergy: Causes and tests for detection of allergy.

UNIT II

Distribution of microorganisms in the aquatic environment. Fresh and Marine ecosystems (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonation of water ecosystem. Upwelling, Eutrophication, Food chain in aquatic ecosystems. Potability of water. Microbial assessment of water. Ground water contamination. Biofilm.

Unit III 14 h

Biotic and abiotic interactions. Microbial communities; nature, structure and attributes, levels of species diversity, succession and stability, Biodiversity management and conservation. Role of microbes in organic solid waste treatment. Subterranean microbes. Biogeochemical cycles of Carbon, Nitrogen, Phosphorous and Sulphur. Waste treatment: sewage and effluent treatment; primary, secondary and tertiary treatment, Solid waste treatment. Solid wastes as sources of energy and food.

Unit IV 14 h

Role of microbes in degradation, Biodegradation of Xenobiotics, hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper. Biosorption/ bioaccumulation of heavy metals. Bioremediation, advantages and disadvantages. Bioleaching of iron, copper, gold and uranium. Diversity in anoxic ecosystem. Methanogenesis.

Note: Each unit is for 10h

Soft Core

MBS-457: Phytopathology 40h

OBJECTIVES

1. To learn general concepts of Plant disease and its history.
2. Study of Plant diseases caused by different pathogens and their life cycle.
3. To learn prevention and plant disease management.
4. To understand Mechanism of host- Parasite interaction in the development of disease.

COURSE OUTCOME

CO1: Understanding natural defense mechanism of plants in controlling pathogens.
CO2: Understanding genetics of plant disease and the factors responsible for wide spread of disease around the globe.
CO3: Development of eco-friendly disease control methods.
CO4: Collection of plant pathogens and preservation for further studies.

Unit I

History and Scope of Pathology, Nature and Concept of plant diseases, Parasitism, Disease symptoms, Plant pathogenic Organisms, Disease Triangle, and Plant disease Cycle, Phytopathological Methods.

Unit II

General aspects of plant diseases by Viruses, Mycoplasmas, Bacteria, Fungi, Protozoa, Nematodes – symptoms, Etiology, Transmission and Life Cycle, Non Parasitic diseases, Management of Plant Disease by Physical, Chemical and Biological Methods, Cultural Practices, Plant Quarantine, Integrated Disease Management Concepts.

Unit III

Host –Parasite Interactions, Mechanism of Penetrance and Infection, Pre penetration and Infection, Invasiveness – Bio trophic and Neotrophic Pathogens, Effect of Infection, Physiological Functions of Hosts, Translocation of Water and Mineral Nutrients, Organic Nutrients, Respiration and Permeability.

Unit IV

Structural and Biochemical Host Defence Mechanisms. Genetics of Host – Parasite Interaction, Genes and Variability in Pathogens, Genetics of Virulence and Resistance, Gene to Gene concept, Horizontal and Vertical Resistance, Development of Epidemics, Disease Forecasting, Post-Harvest Diseases, Seed Borne diseases.

Note: Each unit is for 10h

Soft Core

MBS-458: Geomicrobiology 40h

OBJECTIVES

1. To study various types of soil available on earth and their significance.
2. To understand role of microbes in various global cycles in the mineralization and assimilation of metals.
3. Role of microbes in solid waste treatment, degradation of toxic molecules and bioremediation technology in pollution management.

COURSE OUTCOME

CO1: Implementation of Bioleaching process in the extraction of gold, silver, copper etc.
CO2: Understanding role of microbes in petroleum product formation.
CO3: Employability in environmental boards.
Co4: Understanding importance of microbial activity in agriculture.

Unit I

Horizons of soil, Microorganisms in different soil horizons, Classification of microorganisms Molecular approaches to study microbial diversity, Role of Microbes in Geochemical cycling of Carbon, Nitrogen, Sulfur and Phosphorus. Studies on extremophiles in different geological spheres, Microorganisms in aquatic ecosystem and their role. Role of microbes in weathering of rocks, Lichens, the events that led to the emergence of life, evolution of metabolic processes, and the diversification of the biosphere.

Unit II **13h**

Role of microbes in organic solid waste treatment, subterranean microbes. Biodegradation: Role of microbes in degradation, Biodegradation of Xenobiotics, hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper; Biosorption/bioaccumulation of heavy metals. Bioremediation of soil, air and water: various methods, advantages and disadvantages, composting. N_2fixing Microbes and Phosphate solubilizing microorganisms.

Unit III **13h**

Bioleaching of iron, copper, gold and uranium, Chemical reactivity of the cell surface, metal sorption, microbiological mineral formation and fossilization. Diversity in anoxic eco system. Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Geomicrobiology of fossil fuel, peat, coal and petroleum. Removal and Disposal of Heavy Metals and Pollutants.

Note: Unit I : 14h, Unit II & III for 13h

Open Elective

MBE- 459: Microbial Diversity 40h

OBJECTIVES

1. Study of various microbes and their significance.
2. Interaction of microbes with other living and nonliving ecosystems.
3. Microbial life in extreme environments like low temperature, high temperature, low and high pressure and oxygen
4. Bioleaching and biodegradation of aspects of microbes.

COURSE OUTCOME

CO1: Study of various microbial disease of human and their control measures.
CO2: Significance of microbes in various ecosystems like soil, water, forest, air etc.
CO3: Production of antibiotics from microorganisms.
CO4: Understanding phylogenetic relationship between microorganisms.

UNIT I

Classification of microbes: Virus, Bacteria, Fungi, Algae and protozoans Microbial interaction: Algae & Plants, Plants & fungi, Bacteria & Animals, Plants & Bacteria. Parasitism: Bacterial, Fungal and Viral diseases. Rhizosphere and Phyllosphere microflora. Microbial life in extreme environment.

Unit II

Indicator organisms and Bioleaching, biodegradation, bioremediation and phytoremediation. Ecological and Evolutionary diversity (Genetic diversity) of microbes. Intestinal microflora, Biofilms, Rumen Microbiology. Conventional and molecular methods of studying microbial diversity.

Unit III

Bacterial diseases: Cholera, Typhoid, Tuberculosis, Salmonellosis, Anthrax, Shigellosis. Fungal Disease: Candidiasis, Dermatitidis, Aspergillosis, Mycotoxicosis. Viral Diseases: AIDS, HIV, Rabies, Hepatitis, Poliomyelitis, Small pox, Chicken pox.

UNIT IV

Importance of microbial diversity in environment: Forest ecosystem, Aquatic ecosystem, Soil ecosystem, Marine ecosystem, Air microflora. Antibiotics and its importance: Streptomycin, Ampicillin/ Penicillin, Tetracycline.

Note: Each unit is for 10h

Open Elective

MBE- 460: Bio fertilizers and Biopesticides 40h

OBJECTIVES

1. Study of various agricultural importance microbes and their significance.
2. Role of microbes in the agricultural field.
3. Significance of nitrogen fixation and its mechanism.
4. Preparation of biofertilizers and biopesticides.

COURSE OUTCOME

CO1: Understand advantages of bio-fertilizers and Bio-pesticides.
CO2: Learn mass production of bio-fertilizers and Bio-pesticides.
CO3: Screening for new agricultural important microbes.
Co4: Establishment of own industries.

Unit I

Biofertilizers- Definition & types, Biological Nitrogen fixers- symbiotic and non- symbiotic- *Gluconoacetobacter, Rhizobium, Frankia, Azatobacter, Azospirillum, Azolla,* Blue green algae.

Unit II

Phosphate solubilizers- mechanisms, examples. Phosphate Mobilizers- Mycorrhizae- Ecto and Endomycorrhizae- Orchid, Arbutoid, Ericoid and VAM. Compost making: Decomposition of Agroresidues

Unit III

Biopesticides- Definitions, Importance in management of crop pests- *Numorearelays, Verticillium, Metarrhizium, Beaveria.* Biofungicides: *Trichoderma* and its importance in Biocontrol of plant diseases.

Note: Unit – I – 14h, Unit II & III 13h

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III SEMESTER
Hard core

MBH- 501: MolecularBiology 56h

OBJECTIVES:

1. Isolation of DNA, RNA, Protein and their expression from Escherichia coli, yeasts.
2. To equip students with molecular events such as DNA replication, Transcription and Translation.
3. Understanding the molecular basis of life.
4. Learning of various techniques for molecular analysis such as Agarose-gel electrophoresis, SDS-PAGE, southern blotting, northern blotting, western blotting.
5. Analysis of environmental hazards affecting DNA stability, cell transformation studies.

COURSE OUTCOME

CO1: Able to understand molecular aspects of life
CO2: Knowledge on Prokaryotic and Eukaryotic Cell characteristics, replication, transcription, and translation.
CO3: Evaluate Cellular DNA content, its structural and functional stability
CO4: Students trained to analyze protein synthesis, gene expression and its implications in various diseases
CO5: Students equipped to render service as research scholars, teachers in various institutes in molecular biology divisions and Pharmaceuticals Company.

UNIT- I

Definition, concepts: genes, chromosome, genetic code, prokaryotic and eukaryotic genomic organization structure and types of nucleic acids. Central Dogma of Molecular Biology: transcription and translation in prokaryotes and eukaryotes. Genetic recombination: transformation, transduction & conjugation. Organelle DNA- mitochondrial, chloroplast, Bacterial genome.

UNIT- II

Replication enzymes, factors involved in prokaryotic and eukaryotic Initiation, Elongation and termination of replication, Transcription, DNA proof reading, Activators and inhibitors of replication. Enzymes: activators, transcription factors, prokaryotic acndeukarytic promoters. Post transcriptional modifications- splicing, adenylation, capping, polyribosomes, polycistronic and monocystronic mRNA, Transcriptional inhibitors, Translation and Post Translation modifications.

UNIT- III

DNA damage repair mechanisms: Photo reactivation, Excision, Recombinant, SOS & Mismatch repair. Gene regulation in prokaryotes and eukaryotes: operon concept, catabolic repression, control by attenuation. Constitutive and Induced Gene expression. Protein splicing, Inter and Intracellular Protein translocation.

UNIT- IV

Molecular Biology of Cancer: Mechanism of transformation of cells, Physical and chemical carcinogens, role of carcinogens & oncogenes in cancer, Oncogene proteins- Protein Kinases, growth factors, the *ras* proteins, Tumor repressor genes, Protein Kinases and transformation Viral oncogenes: Structure & detection of integrated viral DNA.

Note: Each unit is for 14h

Hard core

MBH- 502: Industrial Microbiology 56h

OBJECTIVES:

1. Microbial characteristics for industrial applications
2. Mass culturing of microbes for biomolecules productions
3. Isolation techniques, maintenance of important microbial cultures
4. Types of Fermentation techniques, advantages and disadvantages

COURSE OUTCOME

CO1: To make students understand the potentials of microorganisms in industries
CO2: To create awareness on the processes and production of important biomolecules such as Antibiotics, organic acids, enzymes using microbes
CO3: To learn techniques of downstream processing and purification of biological compounds
CO4: Fermentation optimization techniques for microbial products
CO5: Isolation, maintenance and preservation of Industrial important microbes.

UNIT I

Modern era of industrial fermentation technology, Primary and Secondary metabolites. Fermentation: aerobic and anaerobic fermentation processes and their application. Substrate and oxidative phosphorylation and their energy yield, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications), Fermentation economics and feasibilities.

UNIT II

Industrial Microorganisms: Screening, selection & Isolation. Identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres and their importance.

UNIT III

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization. Downstream processing: Steps in recovery and purification of fermented products.

UNIT IV

Production of amino acid, Enzymes, Biopolymers- Xanthans, chitin and pullulan. Production of beer, wine, alcohol. Production of organic acids- Citric acid, Lactic acid, vinegar and gluconic acid. Biopesticides- Production and formulation, Production of Biofertilizers, Bioethanol production.

Note: Each unit is for 14h

MBH- 503: Practical V (Molecular Biology)

1. Isolation of Genomic DNA from *E.coli* and Yeast
2. Isolation RNA
3. Qualitative and Quantitative analysis of DNA and RNA
4. Agarose gel Electrophoresis
5. Southern Blotting
6. Northern Blotting
7. Western Blotting
8. *E.coli* gene expression (Lactose Metabolism)
9. *E.coli* cell transformation (preparation of competent cells and foreign DNA uptake)
10. Gene expression in *S.cerevisiae*
11. Plasmid isolation from *E.coli*
12. Gel documentation studies
13. Polymerase chain reaction
14. In vitro translation

MBH- 504: Practical VI (Industrial Microbiology)

1. Isolation of Amylase Producing Microbes
2. Isolation and Production of Citric acid from microorganisms
3. Production of Wine
4. Production of Penicillin and Estimation of antimicrobial activity
5. Study of Pilot Scale Fermenters
6. Production of Amino acid through Microbial fermentation
7. Production and Estimation of Bacteriocin
8. Mushroom Cultivation
9. Production of Biofuel from algae
10. Mass cultivation of Biofertilizers

Soft core

MBS- 505: Pharmacognosy & Pharmacology 40h

OBJECTIVES:

1. To prospect various plant based drugs
2. Utilization of various solvents and extraction procedures
3. Comparison of known herbal products with unknown products
4. Importance of patents

COURSE OUTCOME

CO1: Natural products importance
CO2: Herbal extraction procedure, traditional and modern age utilization for different ailments
CO3: Understanding patenting procedures of herbal extracts
CO4: Traditional usage of different Indian herbs and their products

Unit I

Good Agricultural and Harvesting Practices, Commercial cultivation, post-harvest care, processing technology and utilization of medicinal and aromatic plants. A brief account on Phytochemical and Pharmacological aspects and uses of medicinal plants. Study of biosynthetic pathway of Atropine, Morphine Cardiac glycosides, Terpenes and Flavonoids. Definition of Functional foods and Neutraceuticals. Classification of Neutraceuticals. Medicinal uses and health benefits of Neutraceuticals / Functional foods - Spirulina, Soya bean, Garlic, Turmeric, Tea and Coffee. Photochemicals as Neutraceuticals: uses in pharmacy, medicinal and health benefits - Carotenoids, α and β Carotene, Lycopene, Xanthophyll and Flavonoids. Vegetable Bitters: Definition; bitter principles, actions and therapeutics. A brief account of natural products derived from Marine source with special reference to Cardiovascular, anti-cancer, anti-viral, anti-microbial anti-parasitic, anticoagulant and anti-inflammatory agents.

Unit II

HERBAL EXTRACTS: Types of extracts; Extraction methods such as Maceration, Percolation, Super critcal fluid extraction, Distillation Methods; Methods for drying of extracts. Selection and purification of solvents for extraction. Ointment bases, Suppository bases and Hardening agents: Lanolin, Beeswax, Cocoa Butter, Hard paraffin, Petroleum jelly. As Flavours and Perfumers: Cardamom oil, Vanilla, Lemon oil, Orange oil, Sandal wood oil. Natural sweeteners: Definition of Nutritive and Non-nutritive sweeteners with examples. Sweetness potency. Herbal drugs industry: International Scenario. Cultivation of medicinal and aromatic plants. Names of different companies manufacturing different herbal extracts, standardized extracts with the concentration of marker compounds, active principles and claims regarding their uses.

Unit III

Patent laws, proposed amendments as applicable to herbal/natural products and processes; important points to be kept in mind while drafting and filing a patent. Herbal Cosmetics: General method of preparation and evaluation of Herbal Cosmetics such as Skin care products. A brief account of Herb extracts or Herbal products of cosmetic importance such as *Aloe vera*, Neem, Henna, *Acacia concinna* pods, *Citrus aurantium* peel, Liquorice, Sandal

wood, Olive oil, Wheat germ oil, Almond oil. Herbal products intended for treatment of GIT, CVS, Respiratory systems, CNS. Examples of Disorders of a) GIT – Diabetes, Liver, Constipation, Diarrhea, Dysentery. B) CVS – Hypertension,Anginac)RS– Bronchitis,Asthama,Tussived)CNS–Pain,Fever,AnxietyConvulsions
e) Musculo – Skeletal – Rheumatism, Cramps, f) Skin – Leucoderma g) GUS-Oedema, Urinary calculus, Leucorrhoea Dysmenorrhoea.

Unit IV

Industrial and Research aspects of Pharmacognosy. Alternative systems of medicine such as Ayurveda, Unani, Siddha, Homeopathy as a source of information regarding natural drugs. Examples of various plants/plant parts/plant products and their form for treatment of different ailments. A brief account of some of the technologies developed by different research institutes and companies of both national and international status like CIMAP, RRL, CDRI, NBRI, CSIR. National centre for development of natural products (NCDNP).

Note: Each unit is for 10h

Soft core

MBS- 506: Microbial Biotechnology 56h

OBJECTIVES

1. To train towards practical approaches of recombinant DNA principles.
2. To isolate novel microorganisms with biotechnological potential
3. To control various microbial infections and other diseases by tapping biotechnological potentials of beneficial microbes
4. Novel research into Biofertilizers and Bio-pesticides production

COURSE OUTCOME

CO1: Understanding of DNA recombinant tools and principles
CO2: Role of Microbial restriction enzymes, antibiotic resistance genes in recombinant DNA Technology
CO3: Promoter selection for useful product productions
CO4: Biotechnological screening of microorganisms for useful products for industrial, Agricultural and pharmaceutical applications
CO5: Regulations of biotechnological innovations, environmental concerns and patentability

Unit I

Recombinant DNA Technology, Prokaryotic Gene Expression, Promoter Selection, Construction of Vectors, Fusion Protein, Over Expression of Recombinant Proteins in *E.coli* driven by lac, T7 and Tet regulatable Promoters, Expression in *B. subtilis*, Gene Expression in other Microorganisms, cDNA, Saccharomyces cerevisiae expression systems, Secretion of Heterologous Proteins, Baculovirus over expression system.

Unit II

Screening of Microorganisms for Novel Products – protein pharmaceuticals, human interferons, optimizing gene expression, Vaccines, small biological molecules. Synthesis of L- Ascorbic acid, Amino Acids, Secondary Metabolites
– Antibiotics Penicillin, Bacteriocins, Chloramphinicols, Streptomycin. Biopolymers – Polyhydroxy alkanoates, Polyhydroxy butyrates. Monoclonal Antibodies, Aromatic compounds, Single Cell Proteins, Functional Foods, Probiotics.

Unit III

Principles of Bioprocessing, Optimization of Fermentation Process, Microorganisms in Production of Biofuels / Biogas from Solid and Liquid Wastes. Patenting of Biotechnological Inventions, Copy rights, IPR, National and International Patent Laws, Patentability Requirements, Rights, Infringement, applying, obtaining, patent protection.

Unit IV

Regulations in Biotechnological Research, NIH-RAC. Genetically Engineered food. Food ingredients, Deliberate release of GEOs, EPA, Public concerns, Good Manufacturing Practices(GMP) and Good Laboratory Practices (GLP). Quality control, quality assurance, ISO, WHO Certifications.

Note: Each unit is for 14h

Soft core

MBS- 507: Medical Microbiology 40h

OBJECTIVES

1. To understand types of human pathogens, occurrence, transmittance
2. To analyze distinctive characteristic of bacterial and fungal pathogens
3. Mode of entry, pathogenicity studies and mechanism to control
4. Antibiotic resistances, mechanism developed by microbes
5. To prospect novel antibiotics, understanding on new vaccine development

COURSE OUTCOME

CO1: Overview of microbial viz., Fungal, bacterial infections
CO2: Human pathogens, mode of infections, mechanism of emergence
CO3: Cell-Cell interactions, bacterial toxins, membrane and intracellular targets
CO4: Molecular techniques to diagnose infections
CO5: Understanding antibiotic resistance, prospect for novel antibiotics
CO6: Development of newer vaccines

Unit-I:

An overview, obligate intracellular bacteria, Non sporulating extracellular bacteria, sporulating extracellular bacteria, parasites, yeasts and molds, Infection: Definition, Types, stages of infection, portal of entry, process of infection.

Unit II:

Important human pathogens: *Mycobacterium tuberculosis, Klebsiella pneumonia, Proteus vulgaris, Shigella dysenteriae, Vibrio cholera.* Emerging and re-emerging pathogens, mechanism of their emergence. Rapid diagnostic principles, Nucleic acid probes, Real Time PCR, diagnostic sequencing and mutation detection, molecular typing, array technology.

Unit III:

Microbes-Host cell interaction, cell organization, signal transduction and cell adhesion, cell surfaces and bacterial interactions: lectins, proteoglycans, mucins, glycolipids,
Routes of Invasion, selection of intracellular niche, tissue damage, cell-cell spread (metastasis) of intracellular pathogens, role of enzymes, proteins and toxins during invasions
Bacterial toxins: Types, superantigens, pore-forming toxins, membrane perturbance and permeabilization, soluble toxins, toxins acting on signal transduction,

Unit IV:

Antibiotics, Mechanisms of antibiotic resistance, extended spectrum β- lactamases. Inhibitors of enzymes, novel antibiotics from natural resource, strategic mechanism and interference between host cell and pathogen interaction and control of pathogenesis. Mechanisms of antimicrobial therapeutic molecules AMPS, Newer vaccines: Recombinant vaccines, subunit vaccines, DNA vaccines, BCG & HIV- vector basedvaccines.

Note: Each unit is for 10h

Soft core

MBS- 508: Microbial Ecology 40h

OBJECTIVES

1. To explore functional ubiquity and diversity of microbes in particular ecosystem
2. Isolation of micro and macro microorganisms, growth, colonization, succession
3. Interaction analysis of microbes with algae, plants, humans, animals
4. Quorum sensing, antibiotic production
5. Natural and engineered microorganisms and their role
6. Applications such as bioremediation, culture collection centers, role in agriculture

COURSE OUTCOME

CO1: Concepts of microbial ecology, natural and manmade habitats
CO2: Applications and productivity of microbes in different ecological niches
CO3: Microbial functions in ecosystems, interactions with biotic and abiotic factors
CO4: understanding microbial habitat and characterization
CO5: Marine ecosystem, Fresh water Ecosystem, Terrestrial Ecosystem, Extreme Environments

Unit I

Concepts of ecology applied to microorganisms; methods in microbial ecology; interactions of microbes with their living and non-living environment; microbial habitats and functions. Roles and regulation of microbes in natural and man-made environments, from cellular to community level. Microbial ecology and environmental microbiology to explore the functional ubiquity and diversity of microorganisms

Unit II

Introduction to microbial ecology: overview, motivation, history, applications etc. Aut- and synecology of macro and microorganisms: definitions, terminology, concepts. Individuals and populations: productivity, growth, distribution, activity. Communities: colonization, succession, diversity, structure. Microbial functions in ecosystems and global cycles. Methods in microbial ecology. Habitat characterization

Unit III

Interactions of microorganisms with their physical and chemical environment. Microbial guilds and biogeochemical cycles. Interactions with the biotic environment: symbiosis, competition, parasitism, predation. Interactions within microbial communities: quorum sensing, syntrophy, antibiotics. Interactions of microorganisms with algae and plants. Interactions of microorganisms with animals and humans. Ecology of natural and engineered microbial habitats

Unit IV

Marine ecosystems: ocean surface, tidal flats, deep-sea, methane seeps, estuaries, anoxic basins. Freshwater ecosystems: lakes, rivers, swamps, bogs, Terrestrial ecosystems: rocks and soil, prairie, forest, tundra, Extreme environments: deserts, hot springs, glaciers, deep subsurface, mine drainage, Landfills, wastewater treatment reactors, bioremediation Culture collections, food ecosystems, agricultural systems, aquaculture.

Note: Each unit is for 10h

Open Elective

MBE- 509: Applied Microbiology 40h

OBJECTIVES

1. Study on fermented food and dairy products
2. Analysis of food spoilage, Food borne pathogens
3. Probiotics as functional foods
4. Microbes as pollution indicators
5. Mass culturing and Formulation of Biofertilizers
6. Clinically important microbes and control

COURSE OUTCOME

CO1: Role of microbes in Food industries, Dairy products, microbes as functional food
CO2: Role of microbes in waste water treatments, biofuel productions,
CO3: Bioleaching, reclamation of mine sites
CO4: Biocontrol agents, Biopesticides, Biofertilizers role in agriculture systems
CO5: Control of infections, role of microbes in Pharmaceutical industries.

UNIT- I

Primary sources and growth of microbes in food and dairy products, Spoilage of fruits, vegetables, meat, poultry, fish & sea foods, milk, cheese, canned foods. Microbiology of fermented foods- sausage, vinegar, shoyu, tofu, idli. Microbiology of fermented dairy products- butter milk, sour cream, yoghurt, cheese. Food borne Infections and intoxication, Food and milk borne pathogens- *Bacillus, Brucella,Clostridium, E. coli, Listeria, Salmonella, Staphylococcus, Vibrio, Yersinia.* Microbial foods: Functional foods, probiotics.

UNIT- II

Distribution of microorganisms in soil, Factors influencing the soil microflora, Role of microorganisms in soil fertility. Interactions among microorganisms- mutualisms, comensalism, competition, amensalism, parasitism, predation - Interactions between microbes and plants - rhizosphere, phyllosphere, mycorrhizae. Microbial interactions in animals- Rumen microflora, Microbial contribution to fooddigestion.

UNIT- III

Role of microorganisms in waste water treatment, Microbes as pollution indicators, Microbial degradation of herbicides, Biofuel production- biogas, biohydrogen, bioethanol, bioether. Bioleaching, Bioreclamation of mines. Biopesticides Biocontrol organisms Biofertilizers for sustainable agriculture, Significance of biofertilizers.

UNIT- IV

History and basic concept of Medical Microbiology. Infections, Sterilization, and disinfection, Normal microflora of human body. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases caused by *Staphylococci, Bacillus, Clostridium, Corynebacterium, Escherichia, Salmonella, Shigella, Klebsiella, Vibrio, Pseudomonas, Mycobacteria, Spirochaetes, Rickettsia.* Medically important viruses - *Pox, Herpes, Hepatitis, Adeno*, *Picorna, Orthomyxo, Paramyxo, Rhabdo*and HIV virus.Vaccines.

Note: Each unit is for 10h

Open Elective

MBE- 510: Techniques in Microbiology 40h

OBJECTIVES

1. Study on microbes, isolation and characterization
2. Culture preservation and maintenance
3. Microbial analysis by microscopy techniques, staining methods
4. Biochemical characterization of microbes by using the principles of Spectroscopy, centrifugation chromatography and electrophoretic procedures.

COURSE OUTCOME

CO1: Isolation techniques in microbiology
CO2: Maintenance and preservation of pure cultures
CO3: Importance of culture collection centers
CO4: Microscopy techniques, Compound microscopy and advances in microscopy: Electron Microscopy
CO5: Understanding on centrifugation types, Spectrophotometers, Chromatography, Electrophoresis techniques.

Unit-I

Isolation techniques of microorganisms: Isolation of pure cultures; dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures. Maintenance and preservation of pure cultures, culture collection center-national and international. Direct microscopic count, standard plate count, membrane filtration.

Unit II

Microscopy- Principles and Applications of Bright field and Dark field Microscopy. Fluorescent Microscopy, Phase contrast Microscopy, Confocal Microscopy. Electron Microscope-Principles and Applications of Transmission Electron Microscope, Scanning Electron Microscope, Sample preparation for Electron Microscopy.

Unit III

Centrifugation- Basic principles of sedimentation, Types of centrifugation and their Applications, Rotors, Ultracentrifugation. Principle and applications of spectrophotometer-UV/visible, fluorescence. Electrophoresis, SDS-PAGE, Isoelectric focusing, 2D gel Electrophoresis, PFGE. Principles and applications of Chromatography.

Note: Unit I – 14h, Unit II and III 13h

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IV SEMESTER

Hard core

MBH- 551: Agricultural Microbiology 56h

OBJECTIVES:

After studying this course, the learners will be able to –

1. To study the importance of Microorganisms in Agriculture.
2. Agriculture crop improvement and protection by using Microorganisms.
3. To understand the recycling of nutrients through biogeochemical cycles.
4. To understand the agricultural waste management by using microorganisms.

COURSE OUTCOME:

CO1: Students are trained to establish agriculture industries for the production of biofertilizers and biopesticides.
CO2: Students understand agriculture crop diseases and control measures.
CO3: They are trained to develop a genetically modified agricultural crop.
CO4: Understanding in agricultural waste management and recycling.
CO5: Obtain knowledge about Current research and developments.

Unit I

Microbial diversity in Soil, Qualitative and quantitative analysis of Soil microflora. Rhizosphere and non-rhizosphere microorganisms and their importance. Soil- Types, Physical, chemical and Biological properties, Soil horizons and Microbial distribution. Microorganisms in nutrients recycling- Nitrogen, Sulphur, Phosphorus and Carbon cycles.

Unit II

Nitrogen fixation- Symbiotic and Non-Symbiotic Nitrogen fixation, Biochemistry of nitrogen fixation. Phosphate solubalization, VAM- Endomychorhizae and Ectomychorhyzae, PGPR and role in agriculture, Cyanobacteria. Biofertilizers- Microbial inoculants, *Rhizobium, Azospirillum, Azotobacter.*

Unit III

Diseases of important crop plants-Bacterial, fungal and Viral diseases and its management, Biopesticides- *Bacillus thuringiensis*, *Bacillus papillae*, *Beauveria bassiana*, *Metarhiziumanisopliae*. Bio control agent - *Trichoderma.* Genetic engineering technology for crop improvement, Harvesting, transportation and storage of Agricultural products. Global Environmental Problems Ozone depletion, UV-B, greenhouse effect, acid rain, their impact and biotechnological approaches for management. Global warming and climate change.

Unit IV

Bioremediation of Contaminated Soils, ISI Standards and Quality tests, Nursery Inoculants, Impact of Heavy Metals on Soil Microbial communities. Biodeterioration: Definition and concept, biodeterioration of woods. Biomagnification: concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides. Biotransformations: metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene. Biodegradation of plastics. Concept of phytoremediation and applications.

Note: Each unit is for 14h

Hard core

MBH- 552: Biostatistics and Bioinformatics 56

OBJECTIVES:

After studying this course, the learners will be able to –

1. To study the importance of bioinformatics and statistics in Microbiology.
2. To understand the usage of advanced technologies by using bio-informatics.
3. To understand the interpretation of large scale samples.
4. To understand the collection and storage of research data.

COURSE OUTCOME:

CO1: Interpretation of research and dissertation data.
CO2: Development of scientific models.
CO3: Understanding on bioinformatics.
CO4: Understanding on biostatistics.

Unit I

Introduction to basic statistics, Types of data, primary and secondary Collection and Classification of Data, tabulation, Types of Numerical Data, Frequency Distribution, Population and Sampling, Representation of Data. Line chart, Bar diagramme, Pie chart, Histograms, Frequency Polygons.

Unit II

Measures of Central Tendencies, mean, median, mode Measures of Dispersion, Standard Deviation, Coefficient of Variation, Probability, Tests of Significance, ANOVA. BINOMIAL, POISSON, NORMAL DISTRIBUTION. Tests of significance: normal, t, F tests, chi square test, goodness of fit, statistical packages.

Unit III

Basics of Computer, Spread Sheet Application, Data Storing, Generating Charts / Graphs and other features, Molecular Modelling, Presentation tools, Basics of Internet, Search Engines, Citation Search, H Index, Literature Search Techniques, Statistical Data Analysis using Computer and Software, TOOLPAK, COSTAT,SPSS, Sequence Analysis, Homology, Analogy, BLAST, EMBL,GENEBANK, FASTA,

Unit IV

INTRODUCTION TO BIOINFORMATICS: Search engines, molecular modelling, phylogeny, Genomics and Proteomics, Protein Structure Prediction, Molecular Modelling and Docking, Computer Aided Drug Designing.

Note: Each unit is for 14h

MBH- 553: Project work

Soft core

MBS- 554: Fermentation Technology 40h

OBJECTIVES:

1. Basics of fermentation process and their applications.
2. Optimization of Microbial fermentation process.
3. Understanding of production process.
4. Fermentation Media formulations.
5. Different types of Fermentation techniques.

COURSE OUTCOME

CO1: To make students understand the fermentation process and its importance.
CO2: Students are trained to establish own production units.
CO3: To understand techniques of production process and purification of compounds.
CO4: Students are trained to understand the stain improvement methods.
CO5: Isolation and preservation of Industrial important microbes.

UNIT-I **10h**

Fermentation: Batch and Continuous process, Design of a basic fermenter: body construction, aerators, agitators, baffles, foam separators, valves & steam traps. Types of Reactors: Tower fermenter, CSTR, Photobioreactor, airlift fermenter. Control: Online and Offline control. pH probe, temperature probe, DO probe, Tacchometer, Load cells.

UNIT- II **10h**

Rheological Properties of Feed Stock, Intermediate, Biological, Newtonian and Non-newtonian fluids, Plastic fluids, Thixotrophic and Rheoplexic nature of fluids, Characteristics of Foam and Antifoam, Heat transfer co-efficient, Mass transfer co-efficient, oxygen transfer co-efficient, determination of KLa, factors affecting KLa,

UNIT-III **10h**

Fermentation Process: Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, Monod kinetics, Specific growth rate, steady state condition, fed-batch fermentation, Yield of biomass & productivity, media formulation for industrial process. Response Surface Methodology in feed stock design and optimization of fermentation parameter, Scale- up of fermentation.

UNIT- IV **10h**

Fermentation economics: Expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration, agitation. Cost of plant and equipments, batch process cyclic time, continuous culture. Control of Bioreactor, Types of control- Feed forward control, Cascade control, Adaptive control, Complex control systems, PID control systems. Computer applications on the control of Bioreactor, Recovery and effluent treatments, Cost recovery due to waste usages andrecycling.

Note: Each unit is for 10h

Soft core

MBS- 555: Cancer Biology 40h

OBJECTIVES

1. To understand the causes of cancer.
2. To understand stages in cancer.
3. To learn diagnosis techniques of cancer.
4. To learn cancer therapies and treatments by microbiological approach.

COURSE OUTCOME

CO1: Concepts of molecular events of cancer and diagnosis.
CO2: Understanding reasons for cancer causes.
CO3: Understanding chemotherapy, side effects
CO4: Exploration of new anticancer drugs from microbes and plant-microbe interactions
CO5: Awareness towards prevention and cure of cancer.

Unit-I

Origin and Terminology, Cancer induction, cell transformation, genetic and environmental factors, causes and prevention, benign and malignant tumors, immortalization, metastasis, Characteristic traits, chemical carcinogenesis, Ames test, radiations, oncogenes: viruses & cellular oncogenes, tumor suppressor genes, accumulation of mutations, immune system, Evasion.

Unit-II

Introduction, Cell cycle progression, control points, Checkpoints, Protein phosphorylation and dephosphorylation, DNA damage, cdk subunits, Hematopoiesis, Apoptosis in normal cell and canecr cells, morphological and biochemical events, tumor suppressor $p^{53,}$Fas receptor, Caspases, Angiogenesis, oxygen and nutrients supply, activators andinhibitors

Unit –III:

Chemotherapeutic agents, monoclonal antibodies, radioactive elements, toxic effects on cancerous and normal cells. Role of microorganisms in cancer therapy, Bioprospecting of anticancer molecules from microbial origin, antimicrobial peptides as anticancer agents, antiangiogenic compounds.

Note: Unit 1 - 14h, Unit II & III13h

Soft core

MBS- 556: BioNanotechnology 40h

OBJECTIVES

1. To understand unique properties of nanomaterials.
2. To learn different methods of nanomaterials synthesis.
3. To learn nanoparticles characterization techniques.
4. To understand applications of nanomaterials in various fields.
5. To understand toxicity of nanomaterials.

COURSE OUTCOME

CO1: Students are trained to synthesis of nanoparticles.
CO2: Students are trained to develop anefficient methods for nanoparticles synthesis.
CO3: Understanding principle and mechanism of synthesis.
CO4: Screening for various applications like cancer treatment, drug delivery, antibacterial therapy, agricultural and environmental applications.
CO5: Development of new nanoparticles for various applications.

Unit-I

Nanomaterials- Definition of nanomaterials, Nanoparticles and types of nanoparticles. Properties of nanoparticles and metallic nanoparticles. Properties and Characterizations: Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zeta potential), Surface and Vibrational (FTIR and RAMAN), SERS Magnetic, Electrical and Electrochemical.

Unit II

Green Nanotechnology: Green Synthesis, need for green synthesis of nanoparticles. Extracellular and intracellular nanoparticles. Biological synthesis of nanoparticles using bacteria, fungi,actinomycetes, yeast, virus and plants. Principles of nanoparticles synthesis, Biopolymeric nanoparticles.

Unit III

Applications of Nanoparticles- Antimicrobial activity, targeted drug delivery, combination chemotherapy (cancer therapy), Antooxidant and haemolytic properties, applications in water and waste water treatment and catalytic properties., in food preservation. Nano medicine and its developments.

Unit IV

Nanomaterials and Toxicity Evaluation: Cytotoxicity, Genotoxicity, *in vivo* tests/assays etc. Toxicological Hazards of Nanoparticles: Current data on toxicology of engineered Nanoparticles.

Note: Each Unit 10h

Soft core

MBS- 557: Genetic Engineering 40h

OBJECTIVES

1. To understand basic concepts and importance of genetic engineering.
2. To understand the structure and function of gene.
3. To learn properties and role of plasmids in genetic engineering.
4. To learn Different methods and techniques in genetic engineering.
5. Different methods and protocols to transfer genes into host.
6. Importance of genetic engineering in production of desired products.

COURSE OUTCOME

CO1: Understanding of gene expression concept.
CO2: Learning of construction of recombinant vectors and insertion methods.
CO3: Selection of successful recombinants for industrial applications.
CO4: Development of new recombinant vectors.
CO5: Understanding of basic concepts for futureresearch and higher studies.

UNIT- I

Genetic Engineering- Definition, concepts and scope of Genetic Engineering. Historical perspectives and milestones in Recombinant DNA Technology (rDNA technology). Importance of gene cloning and future perspectives. Tools in Genetic Engineering- Enzymes in genetic engineering. Cloning vectors and their properties- Ti Plasmid, pBR322, pUC, Lambda, M13 Phage vector, Cosmids- Phasmids, Phagemids, Shuttle vectors, YAC and BAC vectors, Mammalian expression vectors. Isolation and construction of vectors.

UNIT- II

rDNA Technology- the basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells – Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion, Shotgun cloning. Genomic and c-DNA Libraries. Cloning and expression in bacteria, yeasts. Identification and selection ofrecombinants

UNIT- III

Analysis of products, Nucleic acids staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR. Blotting techniques- Southern, Northern and Western blotting techniques. PCR- Principles, types and applications. Synthetic genes of microbes. Microbial genome sequencing projects- DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays. Nest Generation sequence.

UNIT- IV

Application of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisence technology. Restriction and regulation for the release of GMOs into Environment, Ethical, Legal, Social and Environmental Issues related to rDNA technology.

Note: Each unit is for 10h

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