

M.Sc. MICROBIOLOGY SYLLABUS
DDD Gorakhpur University, Gorakhpur

CHOICE BASED CREDIT SYSTEM (CBCS)

CODE	TITLE OF PAPER	TYPE OF PAPER	CREDITS
SEMESTER- I			
MB 1.1:	General Microbiology and Bacteriology	Core	4
MB 1.2	Virology	Core	4
MB 1.3	Microbial Physiology and Biochemistry	Core	4
MB 1.4	Biostatistics and Instrumentation	Core	4
Practical	Based on MB 1.1 to MB 1.4		8
Seminar	Based on MB 1.1 to MB 1.4		1
Total:			25
SEMESTER- II			
MB 2.1:	Molecular Biology and Genetic Engineering	Core	4
MB 2.2:	Immunology and Cellular Microbiology	Core	4
MB 2.3:	Medical and diagnostic Microbiology	Core	4
MB 2.4:	Food Microbiology	Core	4
Practical	Based on MB 2.1 to MB 2.4		8
Seminar	Based on MB 2.1 to MB 2.4		1
Total:			25
SEMESTER- III			
MB 3.1:	Environmental Microbiology	Core	4
MB 3.2:	Soil and Agriculture Microbiology	Core	4
MB 3.3:	Microbial genomics and Bioinformatics	Core	4
*MB 3.4A:	Biofertilizers	Elective	4
*MB 3.4B:	Intellectual Property Rights (Any one of the two)		
Practical	Based on MB 3.1 and MB 3.3		6
Practical	Based on MB 3.4A/3.4B		2
Seminar	Based on MB 3.1 to MB 3.3		1
Total:			25
*Students will opt for one paper out of MB 3.4A and MB 3.4B:			
SEMESTER- IV			
MB 4.1:	Industrial Microbiology	Core	4
MB 4.2:	Microbial Diversity and Extremophiles	Core	4
MB 4.3:	Microbial Technology	Core	4
Practical	Based on MB 4.1 to MB 4.3		6
Project Training			2
Dissertation and Viva	Based on MB 4.3		4
Seminar	Based on MB 4.1 and MB 4.3)		1
Total:			25

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SEMESTER- I

MB 1.1: General Microbiology and Bacteriology

UNIT 1

Historical development of Microbiology and its Scope. Brief account of classification of microorganisms. Basis and history of bacterial classification Haeckel's three kingdom concept, Whittaker's five kingdom concept, Bergey's manual of determinative bacteriology.

UNIT 2

Overview of bacterial cell structure (Size, Shape, cell membrane and cell wall), cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis and endospore.

UNIT 3

Microbial growth and life cycle of bacteria. Population growth and its measurement, effect of environmental conditions on growth (pH, temperature, aeration). Continuous and batch culture, diauxic synchronous growth culture and anaerobic cultures.

UNIT 4

Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent, physical methods of sterilization- dry heat, moist heat, filtration, radiation, chemical controls- dye alcohols, alkali, halogen, heavy metal, formaldehyde, phenols its derivatives ethylene oxide, detergents.

Suggested Books:

1. Microbiology by Lansing M Prescott, Donald A Klein, John P Harley, McGraw Hill
2. Microbiology: Principles and Exploration by Jaquelyn Black.
3. Microbiology by Michael J Pelczar.
4. Foundations in Microbiology by KP Talaro, McGraw Hill
5. General Microbiology by Powar and Dagainwala, Himalaya publishing house.

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SEMESTER- I

MB 1.2: Virology

UNIT 1

General characteristics of virus, Nomenclature and classification, morphology, ultrastructure, capsid and its arrangement, types of envelopes and its composition, viral genome, its type and structure. Viroids, virusoids, cyanophages and mycoviruses. Prions and its diseases.

UNIT 2

Bacteriophages: structural organization, multiplication cycle, eclipse phase, phage production, burst size, lytic and lysogenic cycle with special reference to T₄, λ, Ø×174 and M13 phage. Bacteriophage typing, application in bacterial genetics and uses.

UNIT 3

Plant viruses and Animal viruses: classification and nomenclature, disease symptoms, histology, physiology and cytology of plants. Diagnostic techniques and transmission of plant viruses.

Animal viruses: ICTV (International Committee on Taxonomy of Viruses). Baltimore system of classification, families of animal viruses, Human viruses, life cycle, pathogenicity, diagnosis and treatment of viral diseases.

UNIT 4

General methods of viral diagnosis and serology, activation of viruses in embryonated eggs, cell culture, cell lines, serological methods, haemagglutination, complement fixation, assay of viruses, physical and chemical methods (protein: nucleic acid and radioactive tracer, infectivity assay (plaque method, end point method))

Suggested Books:

1. Text book of Virology by A J Rhodes, William and Wilkins
2. Matthew's Plant Virology by Roger Hull, Elsevier
3. Understanding Viruses by Shors, J & B
4. Principles of Virology by Fling
5. Clinical Virology Manual by Specter, ASM

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SEMESTER- I

MB 1.3: Microbial Physiology and Biochemistry

UNIT 1

Nutrition and Metabolism: Concepts and nutritional categories. Transport of nutrients (diffusion, active transport, group translocation). Introduction to oxidative and substrate level phosphorylations, brief account of metabolism of carbohydrates, EMP, ED, TCA and glyoxylate cycle.

UNIT 2

Bacterial photosynthesis: type of photosynthesizing bacteria and their characteristic features, photosynthetic pigments, metabolism in photosynthetic bacteria, photosynthetic electron transport system; Dark reaction (Calvin Benson cycle), chemolithotrophy (energy from oxidation of inorganic electron donors), hydrogen oxidizing bacteria, sulphur bacteria, iron oxidizing bacteria, Ammonium and Nitrate oxidizing bacteria.

UNIT 3

General classification and properties of amino acids and proteins, primary, secondary, tertiary and quaternary structure of proteins, Enzyme, inhibition, mechanism of action, Enzyme kinetics, allosteric enzymes and its kinetic analysis and regulation.

UNIT 4

Fat and phospholipid hydrolysis: Carbohydrates; structure, classification, inter-conversion of carbohydrates.

Suggested Books:

1. Lehninger Principle of Biochemistry by Nelson & Cox
2. Biochemistry by Lubert Stryer
3. Plummer, An Introduction to Practical Biochemistry
4. Biochemistry by Harper
5. Microbiology by Stuart Walker and Saunders

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SEMESTER- I

MB 1.4: Biostatistics and Instrumentation

UNIT 1

Type of culture, Preservation and maintenance. Brief principle and working of major instruments used in Microbiology: Centrifuge, Colorimeter, Spectrophotometer, Autoclave, Incubator, Laminar air flow.

UNIT 2

Microscopy; Principles and application in microbiology, brightfield microscopy, dark field microscopy fluorescence and immune fluorescence microscopy, phase contrast, electron (SEM & TEM) microscopy. Staining for microscopy.

UNIT 3

Diagnostic tools in bacteriology- Biochemical techniques, molecular tools used for microbial diagnostics. Uses in academic industrial, pathological and medical fields. Response- Dose metameter. Delusion assays, Direct and Indirect assays. Quantal Responses probit, logit, LD50, ED50, PD50.

UNIT 4

Definition of statistics, population, sampling interval data construction of histogram and its interpretation, mean, median, mode and standard deviation, comparisons of means of variances, ANNOVA.

Suggested Books:

1. Instrumentation by Chatwal and Anand
2. DA Skoog, Instrument method of Analysis
3. Modern experimental Biology by Boyer
4. Biostatistics and Microbiology: A survival Manual by DS Paulson, Springer Verlag
5. Principle and techniques of Biochemistry, Wilson and Walker, Cambridge University Press.

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SEMESTER- I

Experiment List

1. Calibration of ocular micrometer for different objectives of a microscope.
2. Counting of Bacterial population by spectrophotometer.
3. Demonstration of citrate utilization.
4. Demonstration of HIV DOT BLOT test.
5. Demonstration of starch hydrolysis.
6. Demonstration of sugar fermentation.
7. Isolation of bacteria from sewage water by serial dilution technique method.
8. Gram's staining of bacteria.
9. Methyl- Red and Voges- Proskaus (VP) test.
10. Negative staining of bacteria.
11. Test for catalase activity in bacteria.

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SEMESTER- II

MB 2.1: Molecular Biology and Genetic Engineering

UNIT 1

Organization of DNA in eukaryotic cell; functions, replication DNA damage and repair. Structure and types of RNA, super helicity in DNA, modern concept of torsion angles in DNA, DNA replication. Transposons; types and mechanism on transposition. Recombination in Bacteria and its uses.

UNIT 2

Transcription, Translation- charging of tRNA. Salient features of gene expression: lac and trp operon. Translocation, RNA turnover.

UNIT 3

Molecular cloning- Techniques, types of vectors ex plasmids, λ - phages, cosmids. Phagemids. Ti plasmids, other viral vectors; used for construction of library, artificial chromosomes; BAC vectors, YAC vectors, cloning and selection of individual genes; gene libraries, cDNA and genomic libraries.

UNIT 4

PCR- principle variations and applications, sequencing of DNA and protein in brief. Recombinant products.

Suggested Books:

1. Molecular Genetics of Bacterial: Snyder & Champnes
2. Molecular Biology by Friefelder
3. Genomes 3: TA Brown
4. Principles of Gene Manipulation by Old and Primrose
5. Molecular Biology by Lodish, Baltimore.

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SEMESTER- II

MB 2.2: Immunology and Cellular Microbiology

UNIT 1

Types of immunity, innate adaptive, features of immune response, immunological memory, specificity and recognition of self and non- self. Lymphoid cells, heterogeneity of lymphoid cells, T- cells, Null cells, monocytes, polymorphs, primary and secondary lymphoid organs. HLA tissue typing, MHA: Immuno-diffusion immunoelectrophoretic technique, ELISA and its types.

UNIT 2

Humoral and cell mediated immunity. Antigen antibody interaction, Antigens and antibodies: structure and properties, haptens, adjuvants, antigen specificity. T- cell subsets and surface makers, T dependent and T- Independent antigens, recognition of antigens by T cell and role of MHC, structure of T- cell antigen receptors, TCR, BCR.

UNIT 3

Complement pathways, Hypersensitivity- anaphylaxis, cytotoxic reaction. Autoimmunity, transplantation immunology and tumor immunology. Immunological disorders, etiology, diagnostics, prognosis and prophylactic aspects. AIDS.

UNIT 4

Cell signalling mechanism signal transduction pathway,: Eukaryotic cell to cell signalling, prokaryotic signalling, cell- cell interaction, bacterial adherence, effect of adherence on bacteria, effect of adhesion on host cells, mechanism of bacterial invasion on host cells, consequences of Invasion, survival after invasion.

Suggested Books:

1. Immunology by Janis Kuby
2. Essential immunology by Roitt
3. Immunology: A short course by Eli Benjamin, Wiley
4. Laboratory Immunology & Serology, Neville J Bryant
5. Foundations in Microbiology by KP Talaro, McGraw Hill

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SEMESTER- II

MB 2.3: Medical and diagnostic Microbiology

UNIT 1

History and early discovery of pathogenic microorganisms. Classification of medically important microorganisms. Role of resident flora, normal flora and the human host Epidemiology: Disease cycle (sources of disease, reservoirs and carriers). Transmission of pathogens, route of infection. Primary and secondary infections, epidemic, endemic, pandemic.

UNIT 2

Establishment, spreading, tissue damage and antiphagocytic factors. Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of adhesins, depolymerising enzymes, organotransports, variation and virulence.

UNIT 3

Classification clinical features, diagnosis, treatment and prevention of disease caused by *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Corynebacterium*, *Bacillus*, *Clostridium*, *Vibrio*, *Yersinia*, *Hemophilus*, *Mycobacterium*, *Spirochaetes*, *Actinomycetes*, *Rickettsiae*, *Chlamydiae*.

UNIT 4

Fungal diseases- Dermatophytes, opportunistic fungal infections. Protozoal infection: *Plasmodium*, *Trypanosoma*, *Entamoeba*, *Balantidium*, *Pneumocystis*. Laboratory control of antimicrobial therapy- various methods of drug susceptibility testing, action of antibiotics and drug resistance, antibiotic assay in body fluids. Brief account on available vaccines and schedules, passive prophylactic measures. Nosocomial infections, common types of hospital infections and their diagnosis and control, DPT Vaccination. Vaccine schedule of hepatitis and AIDS.

Suggested Books:

1. Medical Microbiology by C Mims, J Playfair and I Roitt, Mosby- Wolfe
2. Textbook of Microbiology by Ananthnarayan and Panicker
3. Sherris Medical Microbiology: An Introduction to Infectious disease by K Ryan, McGraw Hill

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SEMESTER- II

MB 2.4: Food Microbiology

UNIT 1

Food as substrate for microorganisms: Microorganisms important in food microbiology. Principles of food preservation. Asepsis- Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Chemical preservatives and food additives. Canning, processing for Heat treatment D% and F value.

UNIT 2

Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products. Milk and milk products- Fish and sea products. Spoilage of canned foods. Detection of spoilage and characterization.

UNIT 3

Food borne infections and intoxications: Bacterial with examples of infective and toxic types- *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia*, Nematodes, protozoa, algae, fungi and viruses.

UNIT 4

Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products. Food produced by Microbes: Fermented foods, microbial cells as food (single cell proteins), mushroom cultivation. Oriental foods: Mycoprotein, Tempeh, Soya sauce, Idli, Natto, Poi.

Suggested Books:

1. Food microbiology by WC Frazier, TMH
2. Food Microbiology by Dams and Moss, Springer Verlag
3. Basic food Microbiology by Banwart, CBS Publishers & Distributors
4. Principles of Microbiology by RM Atlas
5. Fundamentals of Bacteriology, AL Salle

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SEMESTER- II

Experiment List:

1. To study the immuno diffusion technique by Single Radial Immuno diffusion.
2. Quantitative slide agglutination test to detect the presence of *Salmonella* genus causing Typhoid fever.
3. Determination of Blood Group and Rh factor by agglutination test.
4. To determination the concentration of antigen in unknown sample.
5. Quantitative analysis of milk by Standard Plate Count (SPC) method.
6. Antibiotic Sensitivity test by well diffusion method.
7. Test for antimicrobial property disc method.
8. Detection of Mastitis through milk test.

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SEMESTER- III

MB 3.1: Environmental Microbiology

UNIT 1

Aerobiology: Droplet nuclei, aerosols, assessment of air quality, solid, liquid impingement methods. Brief account of air borne transmission of microbes- viruses, bacteria and fungi. Aeroallergy and Aeroallergens.

UNIT 2

Aquatic Microbiology: Water ecosystem- types- fresh water (ponds, lakes, streams)- Marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Potability of water- microbial assessment of water quality- water purification- brief account of major water borne disease and their control measures.

UNIT 3

Waste water treatment: physical, chemical, biological- aerobic- anaerobic- primary- secondary- tertiary. Solid waste treatments- Saccharification- gasification- composting, utilization of solid wastes. Trickling-activated sludge- oxidation pond- oxidation ditch. Subterranean microbes and bioremediation.

UNIT 4

Positive and negative roles of microbes in environment: biodegradation of recalcitrant compounds- lignin- biodeterioration of paper, leather, wood, textiles, cosmetics, metal corrosion, mode of deterioration, organisms involved, its disadvantages and mode of prevention.

Suggested Books:

1. Environmental Microbiology by RM Maier, IL Pepper, C. P Gerba, Academic Press
2. Principles of Microbiology by RM Atlas
3. Fundamental of Bacteriology, AL Salle
4. Microbiology: Principles and Explorations by Jaquelyn Black
5. Microbiology by Michael J Pelczar

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SEMESTER- III

MB 3.2: Soil and Agriculture Microbiology

UNIT 1

Soil Microbiology: Soil as a habitat for micro-organisms, microflora of various soil types. Nitrogen fixation: Asymbiotic and symbiotic nitrogen fixation systems, root nodulation symbiotic bacteria (process of root nodule formation), Leghemoglobin. Microbial interactions symbiosis, mutualism, commensalisms, amensalism, competition, antibiosis; Actinorrhiza; Mycorrhizal fungi and its effect on plants.

UNIT 2

Production of biofertilizers and biopesticides- Quality control, BIS norms of biofertilizers; Biofertilizers (rhizobial inoculants, mass production and method of application); biopesticides (viral, bacterial and fungal biopesticides); Biopolymers- Polyhydroxybutyrate (PHB), xanthan gum, BT gene and its uses.

UNIT 3

Rhizosphere and rhizoplane microorganisms: reasons for increased microbial activity in rhizosphere. Composition of root exudates, factors affecting exudation, rhizosphere effect. Effect of microflora on host plants. Factors affecting microbial community in soil- soil moisture, organic and inorganic chemicals, soil organic matter.

UNIT 4

Organic matter decomposition, factors affecting litter decomposition; Biogeochemical cycling of C, N, P and S; Microbial biomass and soil fertility.

Suggested Books:

1. Microbial Ecology by Ronald M Atlas and Bartha
2. Soil Microbiology by Subba Rao.
3. Microbiology: Principles and Explorations by Jaquelyn Black.
4. Microbiology by Michael J Pelczar.
5. Microbial Ecology by Campbell, Blackwell science.

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SEMESTER- III

MB 3.3: Microbial genomics and Bioinformatics

UNIT 1:

Introduction to Science of Omics, Structural, Functional and comparative genomics, An overview of genome projects of model microorganisms, Mapping of genome: genetic and physical maps, map-based cloning, molecular markers in genome analysis; RFLP, RAPD, STS, Microsatellite, SCAR (Sequence characterized amplified regions), SSCP (single strand conformational Polymorphism), and AFLP analysis, FISH and GISH for genome analysis.

UNIT 2:

DNA sequencing techniques (Sanger, Maxam & Gilbert, automated DNA sequencing), Next generation sequencing (NGS) techniques, Strategies for genome sequencing, ordered genomic libraries (Cosmid, YAC, BAC libraries).

UNIT 3:

Introduction to Bioinformatics, use of Internet and search engines (WWW, HTML, URLs, Netscape, Explorer, Google, PUBMED). Database management system, database browsing, data retrieval, sequence and genome database, databases such as GenBank, EMBL, DDBJ, Swissprot, PIR, TIGR, TAIR, Searching for sequence database like FASTA and BLAST algorithm, multiple sequence alignment, phylogenetic analysis and detection of open reading frames (ORFs).

UNIT 4:

Molecular evolution and phylogenetic tree, Genome annotation, Gene predictions, Introduction to computational structural biology, *in-silico* methods for structural predictions, Validation of *in-silico* determined 3D structures of proteins, Computer aided drug design-tools and applications.

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SEMESTER- III

MB 3.4A: Biofertilizer

UNIT- 1

Soil as microenvironment, Distribution of soil microorganisms in soil and different zones of soil. Factors influencing the soil microflora-role of microorganisms in soil fertility. Interactions among microorganisms; Interactions between microbes and plants- rhizosphere organisms and phyllosphere. Introduction to biofertilizers- definition, types of biofertilizers; Characteristic features of the following biofertilizer organisms: *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium*, *Frankia*, *Anabaena* and *Nostoc*

UNIT- 2

Plant nutrients- Essential plant nutrients, Criteria of essentiality, Forms of nutrients in soil, Functions, deficiency symptoms. Soil fertility, Role of microorganisms in soil fertility, Microbial successions, Biological control, Biopesticides an overview, Composting, vermicomposting

UNIT- 3

Biofertilization process- soil organic matter, decomposition of soil organic matter, C:N ratio. humus formation, Microbial transformation of Nitrogen, Phosphorus and Sulfur in soil, Phosphate solubilization and mobilization. Biological Nitrogen fixation-symbiotic and asymbiotic

UNIT- 4

Mycorrhizae- Ecto and endomycorrhizae and their importance in agriculture. Organic manures: Preparation, properties, and use in crop production, nutrient enriched compost, green manure; Plant growth promoting rhizobacteria, BGA- Application methods of biofertilizers-significance of biofertilizers.

Text and Reference Books:

1. Paul EA. (2007). Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.
2. Gaur A.C. (2006) Handbook of organic farming and biofertilizer, Ambika book agency, Jaipur
3. Alexander M. (1977). Soil Microbiology. John Wiley
4. Kosuge T and Nester EW. (1989). Plant-Microbe Interactions: Molecular and Genetic perspectives.vols I-IV, McGraw Hill
5. Pradhan S. (2007). Soil health improvement by biofertilizer,biotech book,Ansari road New Delhi
6. Pand H. and Hota D. (2007). Biofertilizer and organic farming, Gene tech book Ansari road New Delhi
7. Sharma A.K. (2009) Biofertilizer for sustainable agriculture, Agrobios, Jaipur

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SEMESTER- III

MB 3.4B: INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP

UNIT- 1

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

UNIT- 2

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

UNIT- 3

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

UNIT- 4

Entrepreneurship: Selection of a product, line design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

Text and Reference Books:

1. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
2. Singh I. and Kaur B, Patent law and Entrepreneurship, Kalyani Publishers (2006).
3. Desai V, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).
4. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.

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SEMESTER- III

Experiment List

1. Determination of dissolved oxygen (DO) of water.
2. Determination of total Alkalinity of water.
3. Determination of total dissolved solids (TDS) in water.
4. Isolation of Aquatic fungi by baiting technique in the laboratory.
5. Isolation of phylloplane microflora by serial dilution plate method.
6. Isolation of phylloplane microflora by leaf impression method.
7. Isolation of Rhizosphere microflora by serial dilution method.
8. Isolation of VAM (Vesicular-Arbuscular Mycorrhizae) spore from soil.

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SEMESTER- IV

MB 4.1: Industrial Microbiology

UNIT 1

Importance of microbes in industries, methods of isolation of microbes. High throughput screening (HTS) of microbes Metagenomic libraries for industrially important enzymes, anticancer, anti- inflammatory and antimicrobial compounds.

UNIT 2

Strain development by mutagenesis, protoplast fusion and transformation, methods for cloning the genes, system biology (genome transcriptome, proteome, metabolome, fluxome) in strain development.

UNIT 3

Important microbial products and technology for production of beer, bioethanol from cellulose waste, citric acid, amino acids, enzymes, vitamins, steroids, lovastatin penicillin. Industrially important biotransformations, immobilization of whole cells and enzymes.

UNIT 4

Production of recombinant proteins (Hepatitis vaccines, HGH) protein engineering, metabolic engineering, combinational chemistry. Intellectual property rights (IPR) and patent laws in Industry.

Suggested Books:

1. Manual of Industrial microbiology and biotechnology by Demain and Solomon, ASM
2. Principles of fermentation technology by Stansbury and Whittaker, Pergmon
3. Biotechnology by Crueger and Crueger, Panima
4. Industrial Microbiology: An Introduction; Waites *et. al*; Blackwell Pubs.
5. Fermentation Microbiology and Biotechnology by Mansi and Bryee, CRC

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SEMESTER- IV

MB 4.2: Microbial Diversity and Extremophiles

UNIT 1

Molecular characterization of organisms. Overview of phylogenetic tree and diversity. Principal of molecular phylogeny, methods in taxonomy of Bacteria, Archae and Fungi, chemo taxonomy, rRNA sequencing.

UNIT 2

Methodology of identification of unknown pure cultures: Strategy and methods. Newer approaches for explaining unculturable bacteria from environmental samples. Culture independent molecular methods.

UNIT 3

Chemoheterotrophy: Methanogenises, acetogenesis, hydrocarbon utilisers, Iron and sulphate reduction.

UNIT 4

Purple and green bacteria, cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, Mycobacteria and Mycoplasma, Archaea; halophils, Methanogens, Hyperthermophilic Archaea, Thermoplasma, pscychrophiles, acidophiles, thermophiles, barophiles.

Suggested Books:

1. Bergey's Manual of Systematic Bacteriology by Breed and Buchanan, (Vol. 1-5).
2. Microbial biodiversity by Cook, T., Harvard Science
3. Pace, N (1997) A molecular view of Microbial Diversity and Biosphere, Science, 276 (734- 740).

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SEMESTER- IV

MB 4.3: Microbial Technology

UNIT 1

General considerations: Metabolic pathways and metabolic control mechanisms, primary and secondary metabolites. Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis, efficiency of growth and product formation, growth stoichiometry, maintenance of energy requirement and maximum biomass yield. P/O quotients, metabolite over production and growth efficiency.

UNIT 2

Shake flask cultures. batch cultures, microbial growth kinetics, measurement of growth (cell number, direct, and indirect methods), growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration). Media formulation, kinetics of thermal death of microorganisms, stirred tank, airlift. Fermenter design, instrumentation and control.

UNIT 3

Aeration and agitation, oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids. Plastic fluids, apparent viscosity, foam and antifoam. Industrial strains. Strategies for selection and improvement, preservation and maintenance. Aseptic operation and containment of recombinant organisms. Scale up, large scale production using recombinant microorganisms. Product recovery (down streaming).

UNIT 4

Fermenter design, instrumentation and control. Production of microbial products- strain improvement of microorganism and their use in microbial processes- Alcohol production, malt beverages, organic acid and antibiotics.

Suggested Books

1. Biochemistry by Stryer, Berg
2. Techniques in Biochemistry and Molecular Biology by Wilson and Walker
3. NMR Spectroscopy by Keerer, Wiley
4. Principles of X ray crystallography, Drenth

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SEMESTER- IV

Experiment List:

1. Isolation of microbes from soil.
2. Isolation of microbes from water.
3. Isolation of microbes from air.
4. Isolation of *Rhizobium* from soil root nodules.
5. Isolation of *Azotobacter* from soil/ roots.
6. Detection of phenol coefficient of disinfectants.
7. Estimation of protein by Lowry's Method.