

Detailed Syllabus:

Fundamentals of Microbiology

- Historical developments in microbiology, contributions of Leuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming and Edward Jenner.
- Differences between eukaryotes and prokaryotes, Diversity of microbial world, types of microorganisms, classification of bacteria,
- Bergey's manual, biochemical and molecular identification of bacteria, archaebacteria and eubacteria.
- Ultrastructure of bacterial cell, parts of bacterial cell, cell wall components, cell membrane, inclusion bodies and surface structures.

Culture Methods, Staining, control of microorganisms

- Culture media and culture methods, isolation of pure cultures. Stains – acidic, basic, and neutral stains.
- Staining techniques - simple staining, differential staining- Gram stain and acid-fast stain. Structural staining- endospore, flagella, capsule granule and negative staining.
- Sterilization – Principle and methods, physical and chemical methods.
- Disinfectants – mode of action. Testing of disinfectants.

Microscopy

- Parts, working principle and applications of Bright field, Dark field, Phase contrast, Fluorescence, Confocal and Atomic Force Microscopy, Scanning Electron Microscopy and Transmission Electron Microscopy.
- Specimen preparation for electron microscopy- ultra Sectioning, shadowing, negative staining and freeze etching.

Bacterial Physiology and Metabolism

- Bacterial Nutrition, nutritional types of bacteria, Preservation and transport of bacteria.
- Growth requirements and conditions influencing the bacterial growth, Bacterial growth curve- lag phase, log phase, stationary phase, death phase, growth kinetics, cell division, sporulation, germination. Enumeration and quantification of bacteria.
- Microbial photosynthesis.
- Microbial life in extreme environments.

- Enzymes, factors affecting enzyme activity, transition state in enzyme catalysed reactions, high energy compounds- ATP and GTP, role of NAD and NADPH.
- Bacterial metabolism- Carbohydrate metabolism glycolysis, alcoholic fermentation, TCA cycle, electron transport chain, substrate level and oxidative phosphorylation, pentose phosphate pathway. Transamination and Nitrogen fixation.

Antibiotics and antibiotic resistance

- Antibiotics – classification, mode of action, drug resistance mechanisms, antibiotic sensitivity tests, Public health measures for the prevention and control of bacterial infections: sanitation, hygiene, surveillance. Importance of antimicrobial stewardship in healthcare settings. Mechanisms of antibiotic resistance transfer in bacteria.

Microbial Genetics

- Bacterial chromosome- structure, Experiments to prove DNA as genetic material, DNA replication, Extrachromosomal genetic material, Plasmids – structure and replication, Transposons –types, mechanism of transposition.
- Genetic exchange mechanisms in bacteria, -Conjugation, Transformation and Transduction.
- Gene expression in prokaryotes - Central Dogma, Mechanisms and enzymes involved in transcription and translation.
- Control of gene expression in Prokaryotes – Induction, Repression, Positive Control, Negative Control –Lac operon. Mutation – Spontaneous and Induced, Mutagens- Physical and Chemical agents. Auxotrophs. Reversion and suppression. Ames test
- DNA repair mechanisms in bacteria- Excision Repair and SOS repair.
- Methods to study unculturable bacteria – metagenome, Microbiome

VIROLOGY

- Properties and classification of RNA & DNA viruses
- Principles of virus structure, Replication of viruses- RNA and DNA viruses
- Animal Virus-cell Interactions
- Ultra Structure of Animal Viruses (Influenza, SV40, Vaccinia) Adenovirus, Influenza, Hepatitis B and Vaccinia growth cycles.
- Retroviral Multiplication- Structure and replication of cancer viruses eg. Retro-virus with reference to R S V and Adeno-associated virus. Methods and techniques used in viral diagnosis
- Development of Viral Diagnostic kits. Viral Vaccines and Antiviral Chemotherapeutic agents. Interferons- induction, types and functions, IFNs as Therapeutics

Mycology

- Classification, , structure and morphology, mode of transmission, pathogenesis, epidemiology, immunology, prophylaxis, laboratory methods for the diagnosis of fungal infections, various techniques used for the identification of fungi culture media in mycology, stains in mycology, serological tests for mycotic infections, preparation of fungal antigens & their standardization, superficial mycoses, subcutaneous mycoses, systemic mycoses opportunistic mycoses, miscellaneous mycoses, mycotoxins, allergic fungal diseases.

Immunology

- Infection- types of infection, Immunity- types of immunity.
- Organs and cells with immune functions, Phagocytosis, innate and adaptive immunity - mechanisms, PAMPs and PRR Antigens, Epitopes, Antigenicity and Immunogenicity, Antibodies and paratopes, Immunoglobulin – structure, classes and functions.
- Cell types involved in cell mediated immunity. Cell-mediated effector functions Origin, biology and maturation of 'B' and T Lymphocytes (B-dependent and T independent)
- Antigen and antibody interactions: Agglutination, precipitation, complement fixation, neutralization, Immunofluorescence, Radioimmuno assay, ELISA, Western blotting
- Humoral and cell mediated immune response, T cell receptor and B cell receptor, MHC, Antibody production, Primary and secondary immune response, Clonal selection theory,
- Monoclonal antibodies – production and application, Antibody engineering. Complement system, Complement activation, Biological effects of complements, Antigen processing and presentation,
- Cytokines.
- Human microbiome and immunity Immunology of organ and tissue transplantation, Immunology of malignancy, Tumor antigens, Immunotherapy of cancer,
- Immunohematology, ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born

- Antibody mediated type II, anaphylactic reactions, Antibody mediated, type II cytotoxic reactions, Immune complex reactions Type – III, T-cell mediated delayed type hypersensitivity Type-IV, Immunological tolerance and tolerance induction

Food Microbiology

- Microorganisms associated with food, Factors influencing microbial growth in food, Intrinsic and extrinsic factors, implicit and processing factors, Probiotics, Prebiotics , Health benefit and mechanism of action of probiotics, SCP, Edible mushrooms, Microbial spoilage of food, Food preservation - physical and chemical methods of preservation, natural food preservation Hurdle effect, HACCP, Lactic acid bacteria, Homo and hetero fermentative lactic acid bacteria, Microbiology of cultured dairy products, Yogurt manufacture, cultured butter milk, Sour cream, Kefir and microbiology of kefir grains, cheese, structural model of casein micelle, role of chymosin, steps in cheese making with role of microorganisms, types of cheese and cheese ripening.
- Microorganisms in the preparation of traditional fermented food, vegetable fermentation, Microbial succession during production of fermented vegetables, Manufacture of sauerkraut, kimchi, cucumber fermentation, Soy sauce production, Temph fermentation. Microbial Enzymes in Food Industry Food borne infections and intoxications, Mycotic poisoning and mycotoxins, Prevention of food borne outbreaks, Laboratory testing of food borne outbreaks. Lab methods for the analysis of microbiological quality of milk and food. Methods for the detection of aflatoxin
- Principles of preservation and spoilage of • Fish, Poultry and meat products, Milk and Dairy products • Fruits and vegetables, Cereals and cereal products Canning and packaging of foods

Dairy Microbiology

- Milk – composition and classes of milk, Factors influencing microbial growth in milk, antibacterial properties and system of milk
- Defects and spoilage of milk Preservation of milk and milk products –methods used and principle involved, Asepsis, removal of microorganisms, anaerobic conditions, high and low temperature, drying, irradiation, chemical and bio preservatives and food additives
- Market milk and milk products, condensed and dry milk products, frozen desserts, Fermented Dairy Products, Starter cultures used, Products -cream, Cheese, yogurt,

butter and indigenous dairy products of India – probiotic dairy products Milk-borne diseases and pathogens transmitted through milk and milk products.

- Quality analysis of milk- SPC, MBRT, alkaline phosphatase test, Resazurin test, clot on boiling test, titratable acidity, butter fat content test - FSSAI standards of milk

Industrial Microbiology

- Fermentation, Industrial fermentations.
- Types of fermentation: Batch, fed batch, continuous, dual and multiple, submerged and solid substrate fermentation.
- Isolation and screening of industrially useful microorganisms, Primary and secondary screening, Strain improvement- methods used, Inoculum development, Fermenter parts, design and construction.
- Antifoam agents and devices. Bioreactors used for solid state fermentation, Sterilization of media and fermenters, Downstream processing-methods used, cell harvesting techniques, Solid –liquid separation, Cell disruption techniques, Purification of microbial products- methods used
- Microbial processes for the production of alcoholic beverages - ethanol, beer, wine, distilled liquors, processes for the production of acetone, butanol, citric acid, , lactic acid and baker's yeast.
- Microbial production of vitamins and amino acids. (Microbial Fermentations
 - Antibiotics (B – lactam, tetracycline), Organic acids (citric, acetic acid , lactic acid)
 - Amino acids (Lysine & Glutamic acid), Enzymes (Amylases & Proteases)
 - Vitamins (Vit-B12 & riboflavin), Alcohol, Acetone. Microbial processes for the production of penicillin and alkaloids)
- Scale up of fermentation. Methods for processing intracellular and extracellular products Cell disruption methods: mechanical and non-mechanical Enrichment Operations: precipitation methods with salts, organic solvents and polymers; Extractive separations; aqueous two-phase extraction; Counter current, supercritical extraction
- Microbial transformation of steroids. Microbes in mineral leaching and metal concentration, Microbial enhanced oil recovery, Microbial enzyme technology

industrially useful microbial enzymes. Immobilization of enzymes and cells- methods used

- Characterization of enzymes, Application of enzymes in bioprocess-application of lactase in dairy industry, use of proteases in food, leather and detergent industry. Diagnostic and therapeutic enzymes

Medical Microbiology

- Specimen collection, handling, processing, isolation & Identification of infectious agents from clinical specimens: Urine, Blood, CSF, Sputum, Faeces, Wound/Pus swabs and Genital swabs.
- Properties, Pathogenicity and laboratory identification of bacteria - Staphylococci, Streptococci, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium, E. coli, Proteus, Klebsiella, Shigella, Salmonella, Vibrio, Mycobacterium and Treponema
- Properties, Pathogenicity and laboratory identification of -Pseudomonas, Hemophilus, Brucella, Bordetella, Yersinia, Helicobacter, Leptospira and Actinomycetes. Properties, pathogenesis and laboratory diagnosis of diseases caused by important human viruses - V-Z virus, Polio, Rabies, Influenza, Hepatitis, HIV, Dengue and SARS-CoV-2. 4 Mycoses, pathogenesis and laboratory diagnosis of superficial, cutaneous, subcutaneous and systemic fungal infections. Opportunistic fungal infections. Life cycle and pathogenesis of protozoan diseases- Amoebiasis, Malaria and Leishmaniasis
- Mechanisms of Antimicrobial agents: Antibacterial agents: Inhibitors of cell wall synthesis, protein synthesis and nucleic acid synthesis. Anti-fungal, Antiviral, Anti-parasitic agents, Antimicrobial sensitivity tests, Antimicrobial resistance

Microbiology of air, water and soil

- Microbial contamination of air, Enumeration of bacteria in air, Air sampling devices.
- Microbiology of water, Water pollution and water borne pathogens, Bacteriological examination of water, Indicator organisms. Purification and disinfection of water,
- Microbiology of sewage, Waste water treatment, BOD, COD. Water sampling methods
- Microbial flora of soil and role of microorganisms in nitrogen, carbon, phosphorus, sulphur and iron cycles.
- Microbial interaction with plants, Endophytes, PGPR and their mechanisms of plant growth promotion, Plant Microbiome, Biofertilizers, Microbial control of pests and diseases, Composting, biogas, biodegradation, bioremediation, Bioleaching

Bioinstrumentation

- Principle, Instrument Design, Methods and Applications of UV-Visible spectroscopy, Infrared spectroscopy, Raman Spectroscopy, Fluorescence spectroscopy, Nuclear magnetic Resonance Spectroscopy.
- Principle, Instrument Design, methods and Applications of Chromatography- Paper chromatography, Thin layer chromatography, High Performance Thin layer Chromatography, Gel filtration chromatography, Affinity chromatography, Ion-exchange chromatography, High Pressure Liquid Chromatography. Reversed phase chromatography, Hydrophobic interaction chromatography, Chiral chromatography, Counter current chromatography, Fast protein liquid chromatography, Two dimensional chromatography. GC-MS, LC-MS/MS
- Principle, Instrument design, Methodology and Applications of Electrophoresis –Gel electrophoresis, Poly Acrylamide gel electrophoresis, SDS PAGE, Capillary electrophoresis, Isoelectric focusing
- pH meter, Centrifugation and Ultracentrifugation- Basic principles, Centrifugation, techniques- principle, types and applications.
- Principle and working of Compound microscope, Phase contrast microscope, Interference microscope, Fluorescence microscope, Polarizing microscope, Scanning and Transmission Electron Microscopy, Atomic force microscopy and Confocal microscopy.
- DNA finger printing techniques and their application, Detection of sequences at the gross level, single nucleotide polymorphisms (SNPs), importance of SNPs, forensic applications of VNTRs RFLP, RAPD, AFLP, in vitro mutagenesis and deletion techniques, signature-tagged mutagenesis Southern blot, Western blot diagnostics, RNA interference and siRNA technology; Micro RNA; gene silencing and applications. Suicide gene therapy, Gene replacement, Gene targeting; Gene Therapy and its applications. Principle and application of gene silencing. Immuno electrophoresis: rocket immunoelectrophoresis; RIA, Flow cytometry, FACS, ELISA, RIA and immunoblotting. ELISA – Principle, Methodology and applications. Polyclonal and Monoclonal antibodies Production and applications in diagnosis.

Biochemistry

- Structure and functions of monosaccharides, disaccharides and oligosaccharides, Polysaccharides – homoglycans and heteroglycans, Glycolipids, Glycoproteins and Lectins.
- Classification of lipids, structure and functions of lipids, Complex lipids phospholipids, Ceramides and sphingomyelins. Eicosanoids, prostaglandins, thromboxanes, leukotrienes, Types and functions of plasma lipoproteins. Amphipathic lipids - membranes, micelles, emulsions and liposomes. Steroids -cholesterol structure and biological role -bile acids, bile salts.
- Classification and functions of amino acids and proteins, Isolation, fractionation and purification of proteins. Denaturation and renaturation of proteins. Primary, Secondary tertiary and quaternary structures of proteins, Ramachandran plot, Structure and function of Collagen and Hemoglobin
- Enzymes- Different classes and functions. Enzyme structure, Classification of enzymes, mechanism of enzyme action, Enzyme kinetics, Estimation of enzyme activity, enzyme assays. specific activity, Allosteric enzyme, Enzyme Inhibition and Types of Inhibition
- Structure of DNA, types of DNA, Higher order organization of DNA. isolation and purification of DNA, Cot value curve, Reassociation kinetics, Structure and types of RNA, Structure and function of mRNA, tRNA and rRNA, Si RNA and micro RNA,
- Vitamins, deficiency diseases and daily requirements

Molecular Biology

- DNA replication, Okazaki fragments, DNA polymerases of eukaryotes and prokaryotes, Primosome, SSB, Helicase, Ligase, repetitive DNA sequences, DNA protein interaction, DNA Linking number and topoisomerase, Inhibition of replication.
- Transcription, RNA polymerases of prokaryotes and eukaryotes, sigma factor, Rho dependant and Rho independent termination. Enhancers, Transcription factors, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications, Polyadenylation, capping, r-RNA processing, Splicing-Spliceosome, Rihozyme, inhibitors of Transcription. Gene regulation in prokaryotes, Transcriptional regulation in prokaryotes; Inducible and repressible system, Operon concept, structure

of Lac, Trp, Arc operon, Catabolic repression, Attenuation. Role of Hormones in gene regulation.

- Translation, genetic code, ribosomes in eukaryotes and prokaryotes, aminoacyl t-RNA synthetases, initiation complex, peptidyl transferase, releasing factors, prokaryotic and eukaryotic translation, inhibition of translation. Post translation modifications, Protein targeting.

Genetic engineering

- Core techniques of gene manipulation, Construction of c-DNA and genomic libraries. Generation of DNA fragments. Isolation and purification of RNA, DNA (genomic and plasmid), Introduction of cloned genes into host, Screening and detection of recombinant clones – genetic and immunochemical methods Expression of cloned genes in prokaryotes, Gene expression, factors influencing gene expression of cloned genes. Problems associated with heterologous gene expression Antisense technology -Gene silencing techniques. Application of recombinant DNA technology in Biology, Agriculture and Medicine.
- Recombinant DNA Technology, enzymes used in genetic engineering, TA cloning, and homopolymer tailing, prokaryotic vectors, Construction of genomic libraries and cDNA libraries, recombinant selection and library screening, PCR and types of PCR, synthesis of DNA. Plant genetic transformation methods, Use of transgenic Technology for improving quality, quantity and storage life of fruits and vegetables. Engineering metabolic pathways, Animal cell culture and methods used, Animal cloning, Ethics of cloning.
- Genomics & Proteomics Genomics- Transcriptomics, proteomics, metabolomics and omic data bases. Sequencing by conventional, automated and next generation sequencing approaches-advantages and limitations. PCR dependent approaches of DNA amplification RFLP, AFLP, T-RFLP, ARDRA,