



SCIPRO'S ASSISTANT PROFESSOR
MICROBIOLOGY

Early Learning Program Detailed Syllabus

SCIPRO
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Module I - GENERAL MICROBIOLOGY

History of Microbiology

Historical developments in microbiology, contributions of Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister Alexander Fleming and Edward Jenner.

Classification of bacteria and Archaea according to the Bergey's Manual of Systematic Bacteriology. Tools for Systematics: Numerical taxonomy, Phylogenetic analysis, Polyphasic approach; Modern methods of studying microbial diversity; Microbial culture collections.

The prokaryotic cell

The Size, Shape, and Arrangement of Bacterial Cells, Structures External to the Cell Wall, Glycocalyx, Flagella - flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis, Fimbriae and Pili, The Cell Wall - Composition and Characteristics, Cell Walls and the Gram Stain Mechanism, Damage to the Cell Wall, Structures Internal to the Cell Wall -The Plasma (Cytoplasmic) Membrane, The Movement of Materials across Membranes, Cytoplasm, The Nucleoid, Ribosomes, Inclusions, Endospores

Important groups of prokaryotes; photosynthetic bacteria; chemoautotrophic bacteria, spore forming bacteria, actinomycetes, heterotrophic bacteria, nitrobacteria, nitrogen-fixing bacteria, cyanobacteria, lactic acid bacteria, halophiles, thermophiles, acidophiles and methanogens.

Eukaryotic cell structure and function

The Plasma Membrane and Membrane Structure, The Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules, Organelles of the Biosynthetic-Secretory and Endocytic Pathways, Eukaryotic Ribosomes, Mitochondria. Comparison of eukaryotes and prokaryote. Archaeobacteria and eubacteria.

Archaea- Archaeal Plasma Membranes, Different Types of Archaeal Cell Walls, Cytoplasm, Nucleoid, Pili, Archaeella and Motility

Microbial growth

Factors influencing microbial growth. Environmental and nutritional factors. Nutritional types of bacteria. Microbial growth curve. Mathematical expression of growth- continuous and batch cultures. Diauxic and synchronous growth. Measurement of bacterial growth.

Cultivation of Bacteria

Culture media – requirements of bacterial culture media, types and uses

Isolation of pure culture: Spread plate, streak plate, pour plate etc., synthetic media, simple and complex media. Isolation of anaerobes and its culture techniques, slant culture and stab culture. Culture preservation strategies. Culture collection centers

Control of Microbial growth

Sterilization. Principles and methods, physical and chemical methods. Disinfectants – modes of action. Testing of disinfectants. Overview of CSSD

Staining techniques: Gram staining- Acid fast staining- Spore staining-Metachromatic granule staining, Flagellar staining, Capsule staining and Fungal staining (LPCB). A

Microbial Metabolism

The Role of ATP in Metabolism, Oxidation-Reduction Reactions, Electron Carriers, and Electron Transport Systems

Aerobic Respiration, The Breakdown of Glucose to Pyruvate, The Tricarboxylic Acid Cycle Electron Transport and Oxidative Phosphorylation,

Anaerobic respiration- Fermentation, alcohol fermentation by yeasts and bacteria, lactic acid fermentation, Methanogenic bacteria, Acetobacter and acetic acid fermentation

Catabolism of carbohydrates and intracellular Reserve Polymers, Lipid Catabolism, Protein and Amino Acid Catabolism, Chemolithotrophy, Phototrophy

Microbial photosynthesis, oxidative and substrate level photo phosphorylation, metabolism of xenobiotics, metabolism of C1 compounds.

Nitrogen Metabolism- Biological nitrogen fixation, symbiotic nitrogen fixation, components involved in the process of nitrogen fixation, Inorganic nitrogen metabolism, assimilation of inorganic nitrogen, Nitrogen cycle.

Antibiotics

Antibiotics and their Mechanism of action Antibiotics and synthetic antimicrobial agents. Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Bacterial resistance to antibiotics, drug targeting. Mode of action of bacterial killing by quinolones. Bacterial resistance to quinolones. Mode of action of non – antibiotic antimicrobial agents. Discovery and preclinical development of new antibiotics. Importance of antimicrobial stewardship in healthcare settings.

Antibacterial, antiviral, antifungal and antiprotozoan drugs

Module II- IMMUNOLOGY

Immunology: Infection, Source and methods of transmission, Immunity, Types of immunity. Mechanisms of innate immunity, pattern recognition receptors, types, scavenger receptors and toll like receptors, Phagocytes and Phagocytosis, Organs and cells with immune functions. Lymphocytes and lymphocyte maturation. Antigens, Epitopes and paratopes, B-cell and T-cell epitope, Antigenicity and Immunogenicity, Antibodies,

Immunoglobulin – structure, classes and functions. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements; recombination signal sequences and their role, somatic hypermutation and affinity maturation

Immune response: Humoral and cell mediated, Receptors on T and B cells for antigens, MHC, TCR mediated signaling, Signal transduction pathways associated with T-cell activation, Signal transduction by activated B- cell receptor, Antibody production, Primary and secondary immune modulation, Factors influencing antibody production, Clonal selection theory, Monoclonal antibodies – production and application, Antibody engineering. Complement system, Complement activation, Biological effects of complements, Antigen processing and presentation, Activation of T-cells, T-cell function, Cytokines.

Antigen – Antibody reactions

Antigen-Antibody reaction by precipitation, agglutination and complement fixation, ELISA, Immunofluorescence. Complement system: Classical, alternate, lectin pathway of complement activation. Radioimmunoassay, Western blotting

Immunology of organ and tissue transplantation: Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy, Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology, ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born, Immunological Tolerance, Autoimmunity, Mechanisms of autoimmunization, Autoimmune diseases. Inflammation, Hypersensitivity – immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis,

Vaccines –types of vaccines, DNA vaccine, recent trends in vaccine development

Module III- CLINICAL MICROBIOLOGY

Microbiology Laboratory Safety& the Laboratory Role in Infection Control

General Safety Principles, Handling of Biologic Hazards, Disposal of Infectious waste, Chemical Safety, General concepts in infection control practice, Outbreak investigation, education, emerging and re-emerging pathogens; General guidelines for establishing quality control, performance improvement, Analytical analysis of tests, clinical analysis of test, operational analysis of test, choosing a laboratory method, test validation.

Host-Parasite Interaction

Indigenous Microbial Flora- skin, mouth, Indigenous Microbial Flora - respiratory tract, gastrointestinal tract, genitourinary tract, Opportunistic pathogens, Pathogens, Virulence, Host Resistance Factors, Infectious Agent Factors, Routes of Transmission

Specimen collection and Processing

Basic principle of specimen collection, specimen receipt and processing, culture works up, Non routine specimens, Collection and processing of blood, and urine, Collection and processing of faeces, Collection and processing of sputum.

Microscopic examination of infected material & Antimicrobial Susceptibility

Testing Preparation of samples, examination of prepared sample, grading or classifying materials, quality control in direct microscopic examination, MIC, MBC, time - kill assay, measurement of antibiotic concentration in body fluids, automated antimicrobial susceptibility test, methods for detecting antimicrobial inactivating enzyme, quality control of antimicrobial susceptibility test,

Nosocomial infection

Nosocomial infections - Common nosocomial infections, source of nosocomial infection, Control of nosocomial infection, hospital hygiene

Module IV- ADVANCED TECHNIQUES IN DIAGNOSTIC MICROBIOLOGY

Introduction to diagnostic microbiology, laboratory safety, hospital epidemiology. Lab methods in Medical Microbiology, basic virology, basic mycology

Biochemical profile based microbial identification systems, Urea breath test, Rapid antigen tests, Enzyme-Linked Immunoassay, Western blot, Advanced antibody detection, Bacterial antimicrobial susceptibility test

Polymerase chain reaction, Principle, applications and types of PCR in medical diagnostic field, Microbial Identification Based on PCR amplification of 16S rDNA, Sequence analysis, Application of Real Time PCR in Diagnostic Microbiology, Microbial Strain Typing Using Repetitive Sequences Advances in the Diagnosis of Mycobacterium tuberculosis and methicillin resistant Staphylococcus aureus.

Probe-Based Microbial Detection and Identification, Southern Blot Hybridization, Microarray- Based Microbial Identification and Characterization, Recent advances in medical microbiology

Module V SYSTEMATIC BACTERIOLOGY

- General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of Gram positive cocci – Staphylococcus and Streptococcus
- General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of Gram negative cocci - meningitis, gonorrhea;
- General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of Mycobacteriaceae - tuberculosis, leprosy
- General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of toxigenic bacteria- Diphtheria, Clostridium, Bacillus, Vibrio,
- General overview, mode of transmission, clinical manifestations, and lab diagnosis of Coxiella, Rickettsia, Haemophilus, Treponema, Propionibacterium
- General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of Gram negative bacteria of family Enterobacteriaceae -Salmonella, bacillary dysentery, E.coli, UTI
- General overview, mode of transmission, pathogenesis, clinical manifestations, and lab diagnoses of - Helicobacter, Klebsiella, Proteus; sexually transmitted diseases (spirochaetes); Diseases caused by mycoplasma, Chlamydia, Bordetella, Legionella. Diseases caused by Pseudomonas.
- Zoonotic bacteria General overview, mode of transmission, pathogenesis, clinical manifestations, lab diagnosis, prevention and control of Brucella, Listeria, Yersinia

Module VI VIROLOGY

Classification and Cultivation of Viruses.

Introduction to virology and General properties of viruses. General characteristics of viruses, properties of viruses, viral multiplication and inclusion bodies, viral cultivation, cytopathogenic effects, antiviral vaccines

Animal virus replication (adsorption, penetration, uncoating, biosynthesis, maturation release).

Phages and Virus-related agents.

T4 Phage (structure, life cycle- lytic cycle) Lambda Temperate Phage (structure, life cycle lysogenic), Lysogenic repression. Prions- mechanism of Prion diseases (CJD, BSE, Mad cow, Slow viral infections), Viroids, Virusoids.

DNA viruses- General overview, mode of transmission, symptoms, lab diagnosis, prevention and control

Herpes viruses (herpes simples, Varicella zoster virus, cytomegalovirus, Epstein barr virus and others), Other DNA viruses (Parvovirus, Pox virus, Adenovirus, Bacteriophages)

RNA viruses- General overview, mode of transmission, symptoms, lab diagnosis, prevention and control

Myxoviruses and Rubella viruses- Influenza, Parainfluenza, Mumps, Measles, Respiratory syncytial virus, Nipah virus Picorna viruses (Polio and Coxsackie virus), Arboviruses (Dengue virus, Chikungunya virus, Japanese encephalitis virus, yellow fever virus, KFD virus), Rhabdo viruses, HIV, Miscellaneous virus (Hanta virus, Ebola and Marburg virus, Corona virus, Prions, Rota virus), Rhinoviral infections

Other group of viruses- Hepatitis (A, B, C, D, E, G). Discuss the pathogenesis, lab diagnosis and infection.

Oncoviruses

Viruses and cancer, Viral oncogenesis, Viruses implicated in the cancers of humans, Prophylaxis of viral diseases, Types of viral vaccines, antiviral agents and their mechanisms of action, Interferons

Module VII- MYCOLOGY

- Introduction to Mycology
- Describe basic morphology, physiology/characteristics and classification of fungi

- Superficial and subcutaneous mycoses- Tinea versicolor, T. nigra, Piedra, Dermatophytes, Mycetoma, chromoblastomycosis, sporotrichosis. Discuss the pathogenesis and lab diagnosis
- Systemic and opportunistic mycoses- Histoplasmosis, Blastomycosis, paracoccidioidomycosis, coccidioidomycosis, Aspergillosis, Zygomycosis, Candidiasis, cryptococcosis, Pneumocystis Jirovecii. Discuss the pathogenesis and lab diagnosis
- Miscellaneous- Mycotic poisoning

Module VIII- PARASITOLOGY

- Introduction to parasitology
- Describe basic morphology, physiology/characteristics and classification of parasites causing infection in man
- Protozoa- Classification
- Describe the morphology, life cycle and laboratory diagnosis of Entamoeba histolytica
- Describe the morphology, life cycle and laboratory diagnosis of free living amoebae
- Describe the morphology, life cycle and laboratory diagnosis of flagellate- giardia lamblia, trichomonas vaginalis
- Describe the morphology, life cycle and laboratory diagnosis of haemoflagellates- Trypanosoma, Leishmania
- Describe the morphology, life cycle and laboratory diagnosis of Malaria
- Miscellaneous sporozoa- Toxoplasma gondii. Cytoisosporea belli, cryptosporidium parvum, cyclospora -Describe the laboratory diagnosis
- Cestodes- classification
- Describe the morphology, life cycle and laboratory diagnosis of Tapeworms causing infection in man- T. saginata, solium, Diphylobothrium latum, Echinococcus, H.nana
- Trematodes- classification

- Describe the morphology, life cycle and laboratory diagnosis of flukes causing infection in man- Schistosoma, liver flukes, intestinal flukes, lung flukes Nematodes- classification
- Describe the morphology, life cycle and laboratory diagnosis of intestinal nematodes causing infection in man- Ascaris lumbricoides, Trichuris trichuria, strongyloides stercoralis, Hook worm, Enterobius vermicularis.
- Describe the morphology, life cycle and laboratory diagnosis of Filarial worms causing lymphatic filariasis
- Discuss briefly on other subcutaneous filariasis- loa. Loa, onchocerca volvulus, Mansonella
- Describe the morphology, life cycle and laboratory diagnosis of Guinea worm
- Protozoan parasites of medical importance including Entamoeba, Free living amoebae, Giardia, Trichomonas, Leishmania, Trypanosoma, Plasmodium, Toxoplasma, Sarcocystis, Cryptosporidium, Cyclospora, Isospora, Babesia, Balantidium, etc.
- Helminths of medical importance including those belonging to Cestoda (Diphyllobothrium, Taenia, Echinococcus, Hymenolepis, Dipylidium, Multiceps etc.), Trematoda (Schistosomes, Fasciola, Fasciolopsis, Gastrodiscoides, Paragonimus, Clonorchis, Opisthorchis etc.) and Nematoda (Ascaris lumbricoides, Ancylostoma duodenale, Enterobius vermicularis, Trichuris trichiura, Filariasis etc.)

Module IX- MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Microbial Genetics & central dogma of Molecular biology

Gene expression and regulation: Operons and regulons, repression and activation of Lac, trp, and, ara operon. Feedback inhibition and regulation of virulence genes in pathogenic bacteria. Extra chromosomal elements, Signal transduction in microbes. A brief account of genetic recombination in bacteria (transformation, conjugation and transduction), DNA replication, transcription, post transcriptional modifications, translation, post translational modification,

Mutagenesis

Molecular basis of mutations, Types of gene mutations, suppression of mutations. Radiation induced mutations, toxicity testing. Systems that safeguard DNA - DNA methylation and

DNA repair mechanisms – Daughter – strand gap repair (in lesions) bypass synthesis, transcription coupled DNA repair, Direct reversal of DNA damage, excision repair, mismatch repair, error prone repair by homologous recombination, end joining repair, SOS repair

Transposable elements and Genetic recombination

Transposition: Structure of Transposons, types of transposons, mechanism of transposition, transposon mutagenesis. Genetic recombination; Holliday model, Meselson- Radding model Genetic counselling

Molecular techniques

Blotting: Principles, types of blotting, immunoblotting- Southern, Northern, Western and Dot blots. DNA amplification: PCR, RT- PCR. DNA sequencing: Various methods of DNA sequencing. Gene silencing: RNA interference (RNAi). Mapping of genome: Molecular markers as tools for mapping- Restriction Fragment Length Polymorphism (RFLP), randomly amplified polymorphic DNA (RAPD), simple sequence length polymorphism (SSCP), amplified fragment length polymorphism (AFLP). Functional genomics: entire genome expression analysis microarrays, expressed sequence tags (ESTs), serial analysis of gene expression (SAGE), single nucleotide polymorphism (SNP). CRISPR, Gene/Genome editing

Module X- BIOCHEMISTRY

Biochemistry of Carbohydrates: Classification of Carbohydrates with examples; Detailed study on Polysaccharides - occurrence, structure, isolation, properties and functions of homoglycans- starch, glycogen, cellulose, dextrin, inulin, chitins, xylans, arabinans, galactans. Occurrence, structure, properties, and functions of heteroglycans – bacterial cell wall polysaccharides, glycoaminoglycans, agar, alginic acid, pectins, amino sugars and deoxv sugars, blood group substances and sialic acids. Glycoprotein and their biological applications. Lectins structure and functions.

Biochemistry of Lipids: Classification -saturated and unsaturated fatty acids, phospholipids-classification, structure and functions. Ceramides and sphingomyelins. Eicosanoids, structure and functions of 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. Sterols in microbial system: mycosterols

Protein structure and function: Classification of proteins on the basis of solubility and shape, structure, and biological functions. Isolation, fractionation and purification of proteins. Denaturation and renaturation of proteins. Primary structure -determination of amino acid sequence of proteins. Detailed study on structure and function with an example: Membrane protein (ATP synthase), Fibrous Protein (Collagen) Globular protein (Hemoglobin)

Nucleic Acid Structure: Watson -Crick model of DNA structure. A, B and Z DNA Cruciform structure in DNA, miscellaneous alternative conformation of DNA, Methods for nucleic acid sequence determination, isolation and purification of DNA, molecular hybridization, Cot value curve, ; Organization of the DNA Sequence: Genes, pseudogenes, extragenic regions (beta globin gene and gene family) duplicated genes; Reassociation kinetics, Repetitive DNA sequences: Tandem repeats (Satellites, minisatellites, and microsatellites), Interspersed repeats (LINE, SINEs) Single copy genes; RNA Structure: Types of RNA; structure of mRNA, tRNA and rRNA ,Si RNA, micro RNA with emphasis on importance of structure to its function

Biophysics: Laws of thermodynamics, enthalpy, entropy and free energy, thermodynamic equilibrium. Redox reactions, Redox potential and its calculation by Nernst equation, examples of redox reactions in biological system. Biological importance or redox reactions. Principle and biological importance of physical phenomena- osmosis, osmotic pressure, osmotic equilibrium diffusion, Fick's law, sedimentation, filtration, surface tension, dialysis, adsorption, Colloids- classification, properties and importances of colloids, Osmosis, Osmotic pressure, Osmotic equilibrium, Donnan equilibrium, Electroosmosis

DNA- protein interaction and RNA- protein interactions:. DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Electromagnetic spectrum Ionizing and nonionizing radiation. Properties and biological effects of ultraviolet radiation, lasers, microwave radiations and ultrasonic waves. Radioactivity, Interaction of radiation with matter. Units of Radiation. Biological effects of radiation. Applications of ionizing and non-ionising radiations in industry, agriculture and research. Radiation Hazards. Introduction to proteomics and Bioinformatics

Module XI- BIOINSTRUMENTATION

Spectroscopic techniques: Principle, Instrument Design, methods and Applications of UV-Visible spectroscopy, Infrared spectroscopy, Raman Spectra, Fluorescence spectra, Nuclear magnetic Resonance Spectroscopy.

Hydrodynamic techniques: Principle, Instrument Design, methods and Applications of all types of Adsorption and Partition Chromatography- Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Affinity chromatography, Ion-exchange chromatography and HPLC. Reversed phase chromatography, hydrophobic interaction chromatography, chiral chromatography, counter current chromatography, Fast protein liquid chromatography, two dimensional chromatography, Centrifugation – Principle, methods and application, Ultra centrifugation, Viscometry

Electro analytical techniques & Optical techniques: Principle, Instrument Design, methods and Applications of Free and zone Electrophoresis – Paper electrophoresis, Gel electrophoresis, Poly Acrylamide gel electrophoresis, SDS PAGE, Capillary electrophoresis,

Isoelectric focusing, Potentiometry, pH meter, conductometry. Principle, Instrument Design, methods and Applications of Polarimetry, ORD, CD, Light scattering, Refractometry, Flowcytometry, Cytometry

Microscopic techniques: Principle and working of Compound microscope, Phase contrast microscope, Interference microscope, Fluorescence microscope, polarizing microscope, Scanning and Transmission Electron Microscopy, CCD camera, Introduction to Atomic force microscopy, Confocal microscopy

Introduction to Biostatistics: Scope of Biostatistics, probability and probability distribution analysis. Variables in biology- collection, classification and tabulation of data- graphical and diagrammatic representation- scatter diagrams, histograms- frequency polygon- frequency curve-logarithmic curves. Descriptive statistics- measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean. Measures of dispersion, standard deviation, standard error, variance, coefficient of variation. Correlation and Regression

Test of significance: Basic idea of significance test- hypothesis testing, levels of significance. Testing of single mean, double mean, single proportion, double proportion in large sample. Testing of single mean, double mean and Paired- t in small sample. ANOVA- One way and Two way; Chi-square test of goodness of fit and Chi-square test of independence, comparison of means of two samples, three or more samples. Fundamentals of field experiments- randomization, replication and local control. CRD and RBD. Statistical packages

Module XII- RESEARCH METHODOLOGY AND BIOSTATISTICS

RESEARCH METHODOLOGY

Basic concepts - Knowledge, Information and Data - Science, Pseudoscience. Life Science - Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements. Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/ Qualitative, Conceptual/Empirical. Research and scientific method. Research Process. Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Hypothesis -Null and alternate hypothesis and testing of hypothesis Research Design -Basic principles, Meaning, Need and features of good design, Important concepts. Development of a research plan -Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs.

Data collection techniques. Scientific Documentation and Communication. Information Science, Extension and Ethics:

Sources of Information -Primary and secondary sources. Intellectual Property Rights Copy right, Patents, Trademarks, Geographical indications. Safety and precaution - ISO standards, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards. Extension: Lab to Field, Extension communication,

BIOSTATISTICS

Data and Variable (Collection, Types, Sources). Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias. Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table). Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs. Statistical Analysis Tools - Parametric and Non Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting, Characteristics, Merits and De merits of Mean, Median and Mode, Range, Quartile Deviation, Mean Deviation and Standard Deviation. Correlation, Regression, Probability analysis. Probability distributions Binomial, Poisson and Normal. Chi- Square Test Student's 't' test F-test and Analysis of Variance (ANOVA - One way)

Module XIII- FOOD MICROBIOLOGY

Introduction to Food Microbiology:

Microbiology of food, Factors affecting microbial growth and survival in food, Intrinsic, extrinsic and implicit factors. Hurdle effect. Sources of contamination and spoilage of vegetables, fruits, meat, seafood, milk and canned foods. Biochemical changes - fermentation, putrefaction and lipolysis. Microbiological examination of food.

Fermented food products and beverages:

Nutritional value of fermented foods. Lactic acid bacteria and their properties, lactic starter cultures & their biochemical activities. Types of fermentation, batch, continuous and fed batch. Production and preservation of the following fermented foods: Soy sauce fermentation by Molds; Fermented vegetables - Sauerkraut; Fermented Meat – Sausages; yeast for bread production, fermented milk products (acidophilus milk, yoghurt); Cheese production, types of cheeses; Role of microorganisms in beverages – tea, vinegar, wines, beer, vinegar fermentation, Application of microbial enzymes in food industry. Other fermented foods probiotics microbes, prebiotics, synbiotics, functional foods; Microorganisms as food: single cell proteins, Mushrooms. Use of genetically modified microorganisms in food processing. Low alcohol beer, lager beer.

Food poisoning

Food borne diseases, Foodborne infections and intoxications; Bacterial pathogens, clinical features, isolation, identification, association with food, and prevention measures with

examples of infective and toxic types - *Clostridium*, *Salmonella*, *Shigella*, *Staphylococcus*, *Campylobacter*, *Listeria*, *Vibrio cholerae*, *Vibrio parahaemolyticus*, *Enterohemorrhagic E. coli*; Mycotoxins in food

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

Microbiome

Normal microbial flora / human microbiome, Development of a Stable Microbiome. Microbiota vary by body site. Host-microbe interactions in health and disease. A functional core Microbiome is required for Host Homeostasis. Antibiotics and the human microbiome, Drug metabolism by the microbiome, Behavior and the microbiome (the gut brain axis), Many diseases have a Connection with Dysbiosis. Probiotic & Prebiotic. Microbiome research – gut microbiome. Human microbiome at various taxonomic levels

Principles of food preservation. Physical and chemical methods of preservation. Food Sanitation, good manufacturing practices, HACCP and personnel hygiene.

Module XIII- Recombinant DNA Technology

Introduction to transgenic technology: Enzymes for in vitro DNA manipulation – site specific recombinases, thermophilic polymerases, topoisomerases – specialized uses. Advanced vector systems for *E. coli* – vector S.S DNA production, Expression vectors, vectors amenable for protein purification and export. Shuttle vectors with special emphasis on GateWay® system. Vectors with combination features and artificial chromosomes and their usefulness.

Vectors: Vectors for bacteria other than *E. coli*, vectors for yeast and other fungi, Vectors for animal cell lines and animals. Genetic manipulation of animals – techniques usefulness and ethics of gene transfer with special emphasis on gene transfer to mice, chicken, frog and *Drosophila* Maximising protein expression in Bacteria, fungi and animal cells – Promoters, markers and reporter systems.

Inducible expression system: Control of transgene expression through naturally inducible promoters lac and tet. Steroid hormones as heterologous inducers. Chemically induced dimerisation (CID) as inducible transgene regulation. Site specific recombination for efficient gene targeting. Gene inactivation by methods other than gene knock out – Anti sense RNA, Ribozymes, Co suppression, RNA interference, Gene inhibition at protein level, Site directed mutagenesis

Applications of recombinant DNA technology: Applications of recombinant DNA technology, Nuclear transfer technology and animal Pharming- Production of Therapeutic proteins, Metabolic engineering, Animal models for human diseases, gene medicine, DNA vaccines and gene therapy. Genome Editing- CRISPR Cas 9, TALENS, ZFN and NHEJ for targeted knock ins and knock outs. Bio-safety and Ethics of gene transfer

Module XIV- Industrial Microbiology

Isolation. Screening. Selection and Identification: Isolation of Industrially important microorganism, various methodologies of Isolation Screening. Primary and secondary screening methods. Identification of the organism. Improvement of the industrially important organism, methods of improvement. Preservation and maintenance. Industrially important microorganisms and their products.

Microbial growth and growth kinetics: Batch culture, specific growth rate, substrate saturation constant, yield coefficient, Monod kinetics, substrate affinity, Continuous culture, Dilution rate, Washing out, Fed batch culture maintenance coefficient, Product yield, growth depended products non growth linked products. industrial sterilization, Direct, indirect methods, Death Kinetics

Bioreactor and its control: Bioreactor Parts, function of each part, probes, values, agitators aerators, baffles, Types of bioreactors, Reactor performance, oxygen transfer in reactor system, Resistances against oxygen transfer, K_La , methods to estimate K_La . Heat transfer in Bioreactor systems. Overall heat transfer coefficient. Heat exchangers, Instrumentation of bioreactor online and offline control. pH probe, temperature probe, DO probe, Tacchometer, Load cells Control of Bioreactor, Types of control, Feed forward control, cascade control, adaptive control, complex control systems, PID control systems. Computer application on the control of Bioreactor

Fermentative production: Primary metabolites, secondary metabolites. Fermentative production of alcohol, acetone butanol, citric acid, acetic acid, lactic acid, amino acids, vitamins. Antibiotics penicillin, streptomycin, cephalosporin, tetracycline. Microbial production of enzymes-amylase, protease, cellulose, pectinase, SCP production. Bread manufacturing, beer manufacturing, Cheese manufacturing, rennet preparation, fermented dairy products and production of distilled beverages

Enzyme technology: Enzyme structure, Classification of enzymes, mechanism of enzymatic action Enzyme kinetics, Estimation of enzyme activity, enzyme assays. specific activity,

Isolation and purification of enzymes, Allosteric enzyme, 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

Module XV- Environmental Microbiology

Industrial pollution causes, problems: Air, Soil and Water pollutants, Types of pollutants characterization, Persistence and Biomagnification of Xenobiotics, recalcitrant molecules, nitroaromatic polychlorinated, biphenyls and dioxans, synthetic polymers, alkylbenzyl sulphonates, Hydrocarbons, Pesticides, Phenolics, Anilines, Inorganic pollutants, Heavy metals. Detection and Quantification of pollutants.

Microbial detoxification and biotransformation of xenobiotic compounds. Bioremediation of polluted environment. Oil spills, heavy Metals and other xenobiotics. Microbial leaching and corrosion of metals.

Microbial biosensors for monitoring pollutants and their metabolism- microbial biosensors, whole-cell immunosensors.

Biodegradation, Process and application: Microbial infallibility, types of biodegradation, factors affecting biodegradation, enzymes involved in biodegradation, catabolic plasmids, Molecular Approaches, Biogeochemical cycles, Bioleaching. Biodegradation of Hydrocarbons, cellulose, lignin, Phenol and pesticides. Application of TOC, FT/IR, GC-MS analysis in biodegradation studies

Industrial wastewater: Types of industrial effluents, characterization of the wastewater. Chemical Oxygen Demand, Biological Oxygen Demand, Total organic carbon, Nitrogen contents, Suspended solids. Total heterotrophic bacterial population. Bacteriological analysis of drinking water, Presumptive, completed, and confirmed test. Treatment strategies primary, Secondary and tertiary treatment Physical, Chemical and Biological treatment. Floc based and film based strategies, aerobic and anaerobic methods

Biological treatment of industrial wastewater: Activated sludge process, different stages, Types. Oxic/Anoxic, Extended aeration methods, Nitrification and denitrification. Trickling filter process, Different stages Types, Biofilm applications, Rotating Biological contactor, UASB, Submerged aerobic filters, Fluidized Bed Reactor, Packed bed reactor, Oxidation lagoons. Bioreactors for wastewater treatment. Advanced treatment strategies. Tertiary treatment methods, Disinfection, Chlorination, Chlorination dosage chlorination derived byproducts

Solid waste management: Solid waste, Types, Problems, Characterization and sorting of wastes. Municipal and industrial waste management, Land fills composting, stages in composting, Types of composting vermicomposting. Methanogenesis, stages in anaerobic

digestion, methanogens Anaerobic reactors Biogas generation, Household treatment strategies, Present problem and Possible remedies

Bioremediation: Microbial degradation of pesticides, herbicides and other toxic chemicals in the environment, Biological control of pests and insects, Biopesticides *Bacillus thuringiensis*, bioherbicides; Plants used in metal remediation, plants and algae used in phytoremediation and their mechanisms Application of biotechnology in the production of biofertilizers and nitrogen fixation nitrogen fixing microorganisms, mycorrhiza

Soil Microbiology

Soil microorganisms: major groups, decomposition of organic matter, soil health. Root exudates (rhizodeposition) and rhizosphere effects. Exploration of rhizosphere microflora for plant productivity. Microbial biomass.

Nitrogen cycle: ammonification, nitrification and denitrification.

Biological nitrogen fixation-symbiotic, associative and a symbiotic. Biochemistry and genetics of nitrogen fixation.

Biogeochemical cycles - Carbon, Nitrogen, Sulphur, Phosphorus, Iron. Microbial transformations of phosphorus, potassium, Sulphur and other minor nutrients. Role of biofertilizers in agriculture and forestry. Bioremediation of problematic soils,

Microbe-microbe interactions: mutualism, synergism, commensalism, competition, amensalism, parasitism, and predation.

plant growth promoting rhizobacteria and their mode of action; Mycorrhiza and their associations.

Formation and composition of soil organic matter: ferulic acid, fulvic acid and humic acid.

Aeromicrobiology

- Microorganisms in outdoor atmospheric environment, nature of bio aerosols, their fate and transport. Microbial contamination of air, Enumeration of bacteria in air, Air sampling devices.
- Indoor and outdoor air. Droplet nuclei, aerosol, infectious dust. Microbiological sampling of air. Air borne transmission of harmful microbes and air borne infections.
- Microbial indicators of air pollution

Water Microbiology

- Sampling equipment: water samplers such as Niskin sampler, Hydro-Bios sampler, Rosette samplers; sediment samplers such as van Veen grabs and corers
- Aquatic environment, distribution of microorganisms in aquatic environment. Factors influencing their growth and distribution. Eutrophication and algal bloom
- BOD, COD.
- 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
- Microbial biofilms:, mechanism of microbial adherence, beneficial and harmful role of biofilms.

Module XVI- PLANT-MICROBE INTERACTIONS

- **Plant–Bacteria Interactions**
- Phytopathogens and overview of bacterial pathogenesis, Agrobacterium crown gall disease, exploitation of tumorigenesis, bacterial secretion systems, gene regulation and quorum sensing, beneficial bacteria, Rhizobium and host interactions, nodulation and nitrogen fixation.
- **Plant – Virus interactions**
- Plant–Virus Interactions- Interactions with viruses and reasons for susceptibility and requirements for virus resistance. RNA viruses: Tobacco mosaic virus and tobacco rattle virus, DNA viruses-Cauliflower mosaic virus, virus replication and movement, Plant virus vectors for gene silencing.
- **Plant–Fungal Interactions**
- Infection Processes-fungi and toxins, fungal elicitors/AVR proteins, Plant disease resistance genes and Genetic engineering for resistance, Induced resistance: Secondary product responses, Genetic control of host perception and fungal virulence Infection processes. Interactions with host plants and other soil microbes. control of fungal infections.
- **Microbial diseases of plants**---Common bacterial, fungal and viral plant pathogens. Transmission of plant pathogens and control measures. Biopesticide and biological control of plant diseases and pests. Integrated pest management. Microbial warfare on plants.