36 DAIRY MICROBIOLOGY

Unit 1: Scope and History of Microbiology

Scope and history of Microbiology; Diversity and taxonomy of microorganisms; Cell wall, structure, synthesis and inhibition, cell membrane, ribosomes, capsule, flagella, pili; Principles and functions of light, phase, fluorescent and electron microscopes; Fungi, viruses, viriods, prions; Bacterial growth: phases and kinetics, factors affecting bacterial growth, growth measurement; Bacterial nutrition and growth factors; Active and passive transport, Electron transport chain; Metabolism and bioenergetics, respiration and fermentation, bacterial photosynthesis.

Unit 2: Microbial Genetics

DNA and RNA, DNA structure and replication; Gene Expression and its regulation in Prokaryotes – Transcription, Genetic Code, Translation; Negative and positive regulation of gene expression; Operon Models; Mutations, physical and chemical mutagens, Damage and Repair; Plasmids, transposable elements, Insertion sequences; Bacterial Recombination; Recombinant DNA technology - Restriction enzymes, Plasmid Vectors, PCR and Real Time PCR, Application of genetic engineering in dairying.

Unit 3: Microbiological Quality of milk

Microbes in milk, sources of contamination, microbiological changes in milk during production and processing, mastitis; Antimicrobial systems in milk, Role of psychrotrophic, mesophillic, thermophilic and thermodurics in spoilage of milk; Microbiological defects and their control; Food poisoning, infections, toxi-infections and pathogens associated with milk and milk products and their prevention; Biofilms, their role in transmission of pathogens and preventive strategies, Microbiological standards and quality of dairy products (cream, butter, dried and evaporated milk, sweetened condensed milk, frozen dairy products, and indigenous dairy products).

Unit 4: Microbiology of Processed Foods

Microbiology of processed foods; Thermal processes for shelf stable-products, low temperature food preservation, concepts in irradiation technology; Biopreservation, Bacteriocins, antimicrobial and antifungal substances; Intermediate moisture foods and hurdle concept, stress induced injury, drug resistance in pathogens, industrial strategies for safe foods; Methods for controlling spoilage of foods; New emerging methods of preservation; Active/intelligent and antimicrobial packaging, modified atmosphere packaging; Milk derived bioactive proteins and peptides; Microencapsulation, GM foods, Functional foods and nutraceuticals.

Unit 5: Starter Cultures and Probiotics

Lactic Acid Bacteria, characteristics of dairy starter organisms : *Lactococcus*,*Leuconostoc*, *Streptococcus, Pediococcus, Lactobacillus, Bifidobacterium, Enterococcus, Propionibacterium*; lactose, galactose and glucose metabolism, homo- and hetero-lactic fermentation, citrate

metabolism and formation of flavouring compounds, proteolytic systems and protein metabolism, Phenotypic and genotypic characterization of LAB; Adjunct starter organisms; Genetics of starter cultures: plasmids; genetic modification of starter cultures; single, mixed, multiple strain, mesophilic, thermophilic starters, propagation and preservation, concentrated and super-concentrated starters, bulk culture systems; Inhibition of LAB by antibiotics, bacteriocins; immunoglobulins and bacteriophage; starter cultures of fermented milks: lactic, yeast-lactic, mould-lactic fermented milk products - dahi, lassi, yoghurt, acidophilus milk, cultured buttermilk, koumiss, kefir, starter cultures of cheeses, microbiology of fresh and ripened cheeses, accelerated cheese ripening, microbiological spoilage and safety of fermented dairy products, Nutraceutcials, probiotics and functional fermented foods (dairy and non-dairy), Mechanism of action of probiotics and their health benefits, and regulations

Unit 6: **Quality Assurance**

Microbiological criteria; Sampling methods; Establishment of microbiological standards, guidelines and specifications for milk and milk products; Indicator Organisms; Selection criteria -for -their -use as quality and safety indicators; Conventional and rapid detection methods including commercial kits for indicator and pathogenic bacteria; Characteristics, classification and components of microbial bio-sensors; detector system; Application of microbial bio-sensors in monitoring pathogens, antibiotic and pesticide residues and aflatoxin Ml; Quality assurance in dairying; Bio-safety levels; Standard microbiological practices.

Unit 7: **Fermentation Technology**

Fermenter/ Bioreactor design, Types of fermentation, submerged/solid state, Batch/ continuous fermentation, Fermentation kinetics, Product recovery, Immobilization, Downstream processing, Industrial production of Lactic acid, Industrial production of Penicillin, Industrial production of enzymes, Beta- galactosidase, amino acids, vitamins, ethanol and SCP.

35.b. FOOD SAFETY & QUALITY

Unit 1: **Basic Concepts of Food Safety and Quality Assurance**

Definition and Terminology; Current changes in global food safety standards and their harmonization; HACCP concept, principle and application in food industry; General Principles, Fundamentals and Standards requirements of QMS (ISO: 9000:2000); TQM tools and techniques; Biosafety concept, principles and safety levels; EMS/Laboratory Management System-ISO: 17025; NABL Accreditation of Food Laboratory; Statistical Quality Control.

Unit 2: **Concept of Risk Analysis**

Microbiological risk profile of pathogen/toxins, ICMSF Risk Ranking of Dairy Products; Risk Management Issues and Control Strategies for dairy products; Food infection, intoxication and toxi-infection; Growth /survival of pathogens, their pathology of illness, mode of transmission, virulence and infectivity.

Unit 3: **General Principles of Food Law**

Integrated Food Law and its harmonization; Standards, Specifications and guidelines; 2 and 3 class sampling plan; FSSAI Microbiological criteria for different foods including dairy products; Conventional / rapid detection methods/commercial kits for hygiene and safety indicators; Bio-sensors and their current application in food safety evaluation.

Unit 4: **Food Microbiology**

Classification of food related microorganisms, Sources of contamination, Types of food spoilages of raw and processed fruits, vegetables, meat and fish and milk products, preservative principle, microbial defects and their control measures, Role of different Bacteria in food fermentation; Clean milk production and antimicrobial systems in raw milk; Microbiological aspects of bactofugation, thermization, pasteurization, sterilization, boiling, UHT, non-thermal processes and membrane filtration techniques; Microbiological quality of cream and butter, ice cream, evaporated and condensed milk, dried milks, infant dairy foods, heat desiccated, acid coagulated, fermented and frozen products.

Unit 5: **Chemistry of Milk and Milk Products**

Definition, composition and level of various constituents of milk; Physical properties of milk; Chemistry of major milk constituents- carbohydrates; proteins, enzymes, lipids, vitamins and salts; Effect of various processing variables on the constituents of milk; Chemistry of milk products; Composition and legal standards of milk and milk products; Reaction kinetics; Role of enzymes as a biological catalysts; Water activity and its role on shelf-life of milk products; Chemistry of oxygen in relation to auto-oxidation of milk fat, thermal oxidation; Emulsions,

foams, gels-their formation, structure and stability; Functional properties of major food ingredients- starch, proteins and lipids; Hydrocolloids and interactions with proteins; legal requirements for food colorants.

Unit 6: **Research Techniques**

Principles, theory and applications of spectroscopy - visible, infrared and ultraviolet; Chromatography - thin layer, gas liquid, high pressure liquid chromatography (HPLC), gel filtration, ion exchange and affinity; Electrophoresis (PAGE, SDS-PAGE); iso-electric focusing, ultra-centrifugation, potentiometry - pH meter and ion selective electrodes