

**PG COURSE DETAILS FOR M. Sc. (DAIRY MICROBIOLOGY)**

**Aim of the Department:**

Dairy Microbiology Department is currently engaged in teaching & research, in specialized field of Dairy Microbiology. The faculty is also involved in imparting teaching and guidance for both undergraduate and post-graduate programmes of its own college and other constituent colleges of university. The Department offers Ph.D programmes in Dairy Microbiology. Besides, department is also contributing in teaching Microbiology courses for IDD (DT & DH), B. Tech (Dairy Technology), B.Sc Food Technology, M.Sc (DT), M.Sc (FT) and M.Tech (DT) students. Department regularly organizes need based specialized short term trainings / seminars covering basic and applied areas of dairy microbiology including quality assurance, food safety, starter cultures and fermented health foods.

**Total Intake: 10 students**

**Eligibility criteria for admission:**

**BSc Agriculture/ BSc (ZBC) / BSc Microbiology/ BSc Industrial Microbiology/ BSc Food Technology**

## Course curriculum and Syllabus

Course	Course Code	Title of Course	Credits
<b>Major Courses (25 Credits)</b>	<b>DM-711</b>	Microbial Morphology and Taxonomy	<b>3</b>
	<b>DM-712</b>	Microbial Physiology	<b>3</b>
	<b>DM-713</b>	Microbial Genetics	<b>3</b>
	<b>DM-721</b>	Microbiology of starter culture and fermented dairy products	<b>3</b>
	<b>DM-722</b>	Microbiology of processed dairy foods	<b>3</b>
	<b>DM-731</b>	Probiotics and Functional foods	<b>3</b>
	<b>DM-732</b>	Fermentation technology	<b>3</b>
	<b>DM-733</b>	Microbiological quality assurance	<b>3</b>
	<b>DM-880</b>	Seminar	<b>1</b>
<b>Minor Courses (15 Credits)</b>	<b>DM-714</b>	Environmental Microbiology	<b>3</b>
	<b>DM-715</b>	Analytical Techniques in Microbiology	<b>3</b>
	<b>DC-703</b>	Dairy Chemistry	<b>3</b>
	<b>DT-820</b>	Processing of milk and milk products	<b>3</b>
	<b>DC-707</b>	Chemical quality assurance in dairy industry	<b>3</b>
<b>Supporting Courses (5 Credits)</b>	<b>CSIT-701</b>	Computer orientation	<b>3</b>
	<b>MAS-815</b>	Experimental Design	<b>3</b>
<b>Dissertation</b>	<b>DM-899</b>	Research work	<b>30</b>
<b>Deficiency Courses</b>	<b>DM-301</b>	Fundamentals of Microbiology	<b>3</b>
	<b>DM-302</b>	Microbiology of fluid milk	<b>3</b>
	<b>DT-303</b>	Traditional Indian dairy products	<b>3</b>
	<b>DT-402</b>	Fat rich Dairy products	<b>3</b>

## SEMESTER WISE ALLOTMENT OF COURSES:

SEMESTER I (18 Credits)	S.NO.	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	1	DM- 711	Microbial Morphology and Taxonomy	2-0-1	3
	2	DM-712	Microbial Physiology	2-0-1	3
	3	DM-713	Microbial Genetics		
	4	DM-714	Environmental Microbiology	2-0-1	3
	5	DM-715	Analytical techniques in microbiology	2-0-1	3
	6	DC-703	Dairy Chemistry	2-0-1	3

SEMESTER II (15 Credits)	S.NO.	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	1	DM- 721	Microbiology of Starter culture and fermented dairy products	2-0-1	3
	2	DM-722	Microbiology of processed dairy foods	2-0-1	3
	3	DC-707	Chemical quality assurance in dairy industry	2-0-1	3
	4	MAS-815	Experimental Design	2-0-1	3
	5	CSIT-701	Computer Orientation	2-0-1	3

SEMESTER III (13 Credits)	S.NO.	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	1	DM- 731	Probiotics and Functional Foods	2-0-1	3
	2	DM-732	Fermentation technology	2-0-1	3
	3	DM-733	Microbiological quality assurance	2-0-1	3
	4	DT- 820	Processing of milk and milk products	2-0-1	3
	6	DM- 880	Seminar	0-0-2	1

SEMESTER IV (30 Credits)	S.NO.	COURSE CODE	COURSE TITLE	L-T-P	CREDITS
	1	DM- 899	Dissertation	0-0-60	30

## **DM-711 Microbial Morphology and Taxonomy**

**Objective** - To educate students about the taxonomy and morphological features of the various microorganisms, viz., bacteria, fungi and viruses.

### **Theory**

**Unit I** Principles of classification and taxonomy of Eubacteria (Bacteria and Archaea): Major characteristics used in taxonomy: Cultural, Morphological, Biochemical, Physiological, Genetic and Molecular Characteristics; Numerical Taxonomy and Chemotaxonomy.

**Unit II** Cell ultra-structure (prokaryotes and eukaryotes) cell wall: structure, chemical composition, synthesis and inhibition, cell membrane, cytoplasmic inclusions, cytoskeleton, cell appendages, capsule, flagella, pilli, sporulation structure of endospore, composition and function of spore constituents, induction and germination

**Unit III** Fungi: Distribution, Importance and recent Classification, Study of Yeasts and Moulds in Dairy Foods

**Unit IV** History, Development and Scope of Virology. Classification and Nomenclature, General characteristics of Viruses , Viral Reproduction, Brief account of Viroids and Prions.

### **Practicals**

- Simple and differential staining; gram staining, spore, acid-fast staining, flagella, Capsule.
- Measuring dimensions of microorganisms (bacteria) using micrometry.
- Study of morphology of fungi.
- Electron microscopic observation of Ultra-structure of Microbial Cell(Demonstration)

**DM-712**

**Microbial Physiology**

**Objective** - To familiarize the students with the various aspects of growth and energy generating activities of bacteria.

**Theory**

**Unit I** Bacterial growth: growth phases and kinetics, synchronous, continuous, and associative growth; factors affecting bacterial growth; growth measurement.

**Unit II** Effect of environment on the growth of bacteria: temperature, air, osmotic pressure, pH, hydrostatic pressure, surface tension, metals, electromagnetic and other waves, sonics, various chemicals; their application in dairy industry; mechanisms of action of antimicrobials.

**Unit III** Bacterial nutrition; nutrient media; nutritional groups of bacteria; role of growth factors; active and passive transport.

**Unit IV** Electron transport chain: fermentation, respiration and photosynthesis

**Practicals**

- Measurement of bacterial growth by direct methods (cell number, SPC, DMC) and indirect methods (turbidometric methods, MPN, cell mass).
- Preparation of growth curve; determination of generation time.
- Determination of cell activity; carbohydrate fermentation; acid production/pH alteration; starch, lipid, casein and gelatin hydrolysis.
- Effect of different factors viz., physical (temperature, pH, osmotic pressure, surface tension), chemical (dyes, antibiotics, phenol) and nutritional (amino acid supplements, vitamin supplements, protein hydrolysates) on bacterial growth.

**DM – 713**

**Microbial Genetics**

**Objective** - To understand the basic principles of microbial genetics with regard to DNA structure, replication and expression as well as to expose the students to recombinant DNA technology.

**Theory**

**Unit I** : DNA structure and replication Macromolecules : DNA, RNA, their structure, types, organization, function and their properties, DNA replication

**Unit II** : Mutations, Spontaneous and induced mutations, Types of mutations, Mutagenic agents - Physical and Chemical; Damage and Repair systems operating in prokaryotes

**Unit III** : Plasmids and Gene transfer systems Plasmids and their properties; transposable elements; Bacterial Recombination - Transformation, Conjugation and Transduction

**Unit IV** : Recombinant DNA technology Fundamental aspects of Genetic Engineering / recombinant DNA technology - Restriction enzymes, Plasmid Vectors (cloning as well as expression vectors), PCR and Real Time PCR, Application of genetic engineering in dairy and food industry.

**Practicals**

- Isolation and quantitative estimation of chromosomal DNA from E. coli and Lactobacillus by mini prep method.
- Isolation of plasmid DNA from E. coli by miniprep method.
- Calcium chloride induced transformation of E. coli hosts with plasmids.
- Induction of random mutations in E. coli / Lactobacillus either by UV irradiation
- PCR based detection of microorganisms
- Demo of Real Time PCR machine
- Replica Plating techniques

**DM-714 Environmental Microbiology**

**Objective** - To understand the fundamentals of environmental microbiology and role of microorganisms in combating the organic pollutants in the environment.

**Theory**

**Unit I:** Microbes as component of environment Environmental microbiology; soil as a microbial environment, microbes in surface soils and subsurface environments; Aero-microbiology; airborne pathogens, toxins, aerosols, nature and control of bio-aerosols, aero-microbiological pathway, microbial survival in air, extramural and intramural aero-microbiology; Aquatic environments and microbial habitats.

**Unit II:** The extreme environment and sampling Extreme environments, low and high temperature, desiccation, UV stress, pH and environment based on chemoautotrophy; Environmental sample collection; strategies, methods, processing and storage of soil and water sample for the detection of bacteria and phages; Mechanism for the collection of air samples; Cultural methods for isolation and enumeration of bacteria and fungi.

**Unit III:** Biogeochemical cycling of elements Biogeochemical cycles; carbon cycles (fixation, energy flow and respiration), nitrogen cycle (fixation, ammonia assimilation, nitrification and nitrate reduction) sulfur cycle (assimilatory sulphate reduction, sulphur mineralization, oxidation and reduction), iron cycle (in soil, sediments and marine environment); Microbially influenced metal corrosion, acid mine drainage, metal recovery and desulfurization.

**Unit IV:** Biodegradation and bioremediation Microbes and organic pollutants; environmental laws and issues concerning release of genetically engineered microbes, biodegradation process, contaminant structure and toxicity (genetic potential and bioavailability), factors affecting biodegradation (redox conditions, organic matter composition, nitrogen etc); biodegradation of organic pollutants, bioremediation (addition of oxygen, nutrient, surfactant, microbes etc).

**Practicals**

- . Determination of composite micro-flora (i.e. total bacteria, coliforms, yeasts and moulds etc) of selected environmental samples from soil.
- Estimation of micro-flora (i.e. total bacteria, coliforms, yeasts and moulds etc) of selected environmental samples from water.
- Study of micro-flora (i.e. total bacteria, yeasts and moulds etc) of selected environmental samples from air.
- Isolation of dye degrading bacteria from the selected environmental samples.
- Enrichment and isolation of plastic degrading microorganisms from environmental samples.
- Visit to a sewage or an industrial effluent treatment plant.

**DM-715**

**Analytical Techniques in Microbiology**

**Objective** - To impart knowledge and skills related to microbiological analytical systems in microbiology and related sciences

**Theory**

**Unit I** Microscopy: principles, design and functions of bright field, dark field, phase contrast and fluorescence microscope; principle, design and application of transmission and scanning electron microscopes

**Unit II** Techniques for protein analysis and other molecular separation: electrophoresis, chromatography, centrifugation ultracentrifugation; Enzyme analyses and substrate determination methods

**Unit III** Aerobic and Anaerobic culturing techniques for isolation of obligate and facultative organisms, maintenance of pure cultures.

**Unit IV** Use of animal models in toxicity studies

**Practicals -**

- Familiarization with the construction and design of a compound microscope; use of light microscope accessories; microscopic analysis of different types of bacteria by bright field and dark field; phase contrast and fluorescence microscopes.
- Determination of bacterial growth by turbidity measurements.
- Demonstration of chromatographic techniques.
- Demonstration of aerobic and anaerobic culturing techniques.
- Demonstration of use of animal models in toxicity studies.
- Demonstration of PCR technique as a tool for identification and characterization of microorganism.

**DM-721 Microbiology of Starter Cultures and fermented dairy products.**

**Objective** - To familiarize the students with the starter organisms, their metabolism and genetics; different types of starters, propagation, preservation and applications of starters.

**Theory**

**Unit I** Introduction and annual utilization of starter cultures; History and taxonomy of starter cultures; Classification of starter organisms: Starter types: single, mixed and multiple strain starter cultures;

**Unit II** Propagation and preservation of starter cultures; commercial starter preparations: concentrated and superconcentrated starters Metabolism of starter Organisms: biochemical characterization of lactic acid bacteria; carbohydrate, citrate and protein metabolism of starter cultures.

**Unit III** Genetics of starter cultures: plasmids and plasmid instability; industrially significant genes and systems; genetic modification of lactic acid bacteria through transduction; conjugation; protoplast transformation; electroporation and chromosomal integration, transposons and insertion sequences.

**Unit IV** Role of starter cultures in the preparation of various fermented milk, Microbiology of fermented milk products: their nutritional and therapeutic significance.

**Practicals**

- Isolation of lactococcal cultures from fermented milks.
- Examination of purity and activity of starter cultures.
- Preservation of starter cultures by freeze drying and other methods.
- Preparation of concentrated starters and quality evaluation.
- Inhibition of starters by antibiotic residues and other inhibitors
- Plasmid profiles of some lactococcal cultures.
- Identification of lactic starters by molecular biology techniques (demonstration).
- Conjugal transfer of plasmids in lactococci. (demonstration).
- Production of bacteriocins by LAB.

**DM-722 Microbiology of Processed Dairy Foods**

**Objective** To understand microbiology of processed foods, significance of different food microorganisms, their control and other related aspects.

**Theory:**

**UNIT-I** Introduction to microbes in processed dairy foods, history and development of processed foods. Microorganisms important in processed foods: spoilage and pathogens, Food borne new emerging pathogens, Microbial ecology of processed foods and food ecosystem, biofilm formation, Factors influencing microbial growth in foods: Intrinsic factors, Extrinsic factors

**UNIT-II** High temperature food preservation, factors affecting heat resistance in microorganisms, thermal destruction of microorganisms, low temperature food preservation, food preservation by irradiation; food preservation by drying and fermentation, modern processing techniques ohmic heating, hpp, infra-red heating, cold plasma, pulse electric field, ultra sound etc., biopreservation of foods; concepts: metabolites of Lactic Acid Bacteria; bacteriocins, Antifungal substances etc., biopreservation of foods : protective cultures and other antimicrobials (herbs, spices and other natural antimicrobial compounds) microencapsulation.

**UNIT- III** Microbial stress response in the food environment; stress adaptation, sublethal stress & injury, antibiotic resistance in food bacteria, predictive modelling for food spoilage,

**UNIT-IV** Antimicrobial packaging; concepts and development, modified atmosphere packaging (MAP), intermediate moisture foods (IMF), hurdle technology in processed foods. Aseptic and vacuum packaging.

**PRACTICALS**

- Production of antimicrobial substances-bacteriocin,
- Production of antifungal substances,
- Application of bacteriocins for biopreservation of foods,
- Application of hurdle concepts for enhanced shelf stability of processed foods, induction of bacterial cell injury and recovery of injured cells,
- Antibiotic resistance of food pathogens, recent and rapid methods for food pathogen detection.

**DM-731**

**Probiotics and Functional Foods**

**Objective** - To impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits.

**Theory:**

**Unit I** Introduction and history of Probiotics, safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection.

**Unit II-** Tolerance to additives, stability during storage, stability during passage to intestinal sites, Role of probiotics in health and disease, minimum effective dose, maintenance of probiotic microorganisms.

**Unit III-** Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora, Prebiotics and health benefits: prebiotics in foods.

**Unit IV-** Functional Dairy Products: Definition, fermented milk products, functional dairy products, and therapeutic applications. Health benefits of functional fermented dairy products: such as dahi, lassi, yoghurt, kefir, cheese, kefir, koumiss, Yakult, fermented whey drinks, and dairy based cereal foods, soy based yoghurt containing probiotics.

**. Practicals.**

- Evaluation of LAB for probiotic attributes.
- Growth of probiotic LAB in broth, milk and whey.
- Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink.
- Effect of prebiotics on the growth of LAB in milk and broth.
- Survivability of probiotic organisms in fermented milks.
- Antimicrobial potential of the functional dairy products.
- Functional properties of probiotic containing fermented dairy products.

**DM-732**

**Fermentation Technology**

**Objective:** The aim of the course is to gain knowledge about fermentation techniques used in dairy industry, role of microorganisms in fermentation and to gain skills to control fermentation process.

**Theory :**

**Unit I-** Introduction to fermentation technology, basic principles of food fermentation, components & types (submerged surface & solid state fermentation), microbes in fermentation.

**Unit II-** Biological agents responsible for fermentation ( bacteria, yeasts, molds), Microbial growth kinetics, Criteria for selection of industrially important microorganisms, Anaerobic respiration and metabolism, anaerobic respiration and fermentation mechanism.

**Unit III-** Fermenter: types, functions, design and control, chemostat and turbidostat.

**Unit IV-** Production technology of various products: fermented alcoholic beverages( beer & wine ), fermented dairy products (yoghurt & buttermilk), fermented vegetable products (pickles & vinegar)

**Practicals :**

- Isolation of industrially important microorganisms from environment.
- Production of wine from grapes,
- Production of fermented whey beverages.
- Production of nisin and assaying the antimicrobial activity of the culture.
- Production of lactic acid from whey.
- Preparation of food based fermented products.
- Educational tour to food processing / fermentation industries.

**DM-733**

**Microbiological Quality Assurance**

**Objectives:** To impart current knowledge pertaining to Quality Assurance, Food Safety Standards, enumeration and legal product standards.

**Theory**

**Unit-I** General Principles for Establishment of Microbiological Criteria, Definition, purpose and components of Microbiological criteria; Mandatory and advisory criteria; Sampling methods - Two and three class sampling plan as per International council for microbiological standards for foods (ICMSF); Establishment of microbiological standards, guidelines and specifications for different dairy and other foods recommended by ICMSF, Codex, Prevention of Food Adulteration Act (PFA), Bureau of Indian Standards (BIS).

**Unit-II** Enumeration and Detection of Quality Indicators Definition; Selection criteria of Indicator Organisms as an index of Food Quality; Conventional detection methods for indicator organisms – Standard plate Count (SPC), coliforms, E.coli, Yeast and Mold Counts (YMC), and Detection of Safety Indicators Definition; Selection criteria of Indicator Organisms as Spore counts; Enterobacteriaceae count; faecal streptococci count; Dye reduction tests;

**Unit III** Enumeration an index of Food Safety; Conventional detection methods including commercial detection kits for safety indicator organisms– Staphylococcus aureus; B. cereus; pathogenic E.coli; Salmonella; Shigella; Listeria monocytogenes; Enterobacter sakazakii; Sulphite reducing Costridia (SRC) Campylobacter jejuni.

**Unit IV** Public health concern associated with milk and milk products; type of microbial spoilage, defects and control measures.

**Practicals**

- Aseptic technique and operation of in-built autoclave for ensuring sterility of media

- Conventional methods/ Tests for hygienic assessment of milk - SPC, coliform, E. coli, YMC, Spore counts, Enterobacteriaceae count, faecal streptococci count, Dye reduction tests.
- Rapid Tests for hygienic assessment of Dairy and other foods using 3M Petrifilm and D count - SPC, coliform, E.coli, YMC and Enterobacteriaceae count.
- Conventional methods for enumeration of safety indicators in Dairy and other foods- S. aureus; B. cereus; pathogenic E.coli; Salmonella; Shigella; L. monocytogenes; Campylobacter jejuni
- Rapid tests for detection of antibiotics, and pesticides in milk.