# Semester wise Distribution of Courses in M.Sc. Dairying (Dairy Microbiology)

<table>
<thead>
<tr>
<th>Course no</th>
<th>Course Title</th>
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<tbody>
<tr>
<td><strong>FIRST SEMESTER</strong></td>
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<tr>
<td><strong>Major Course</strong></td>
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<tr>
<td>DM 511</td>
<td>MICROBIAL MORPHOLOGY AND TAXONOMY</td>
<td>2+1</td>
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<tr>
<td>DM 512*</td>
<td>MICROBIAL PHYSIOLOGY</td>
<td>2+1</td>
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<tr>
<td>DM 513</td>
<td>METHODS IN MICROBIOLOGY</td>
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<tr>
<td>DM 514</td>
<td>ENVIRONMENTAL MICROBIOLOGY</td>
<td>2+1</td>
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<tr>
<td>DM 515</td>
<td>MICROBIOLOGY OF PROCESSED DAIRY FOOD</td>
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<td><strong>Minor course</strong></td>
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<td><strong>Supportive</strong></td>
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<tr>
<td>DES 511</td>
<td>DAIRY BUSINESS MANAGEMENT</td>
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<tr>
<td>DE 514</td>
<td>ENVIRONMENTAL ENGINEERING</td>
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<tr>
<td>DT 511</td>
<td>ADVANCED DAIRY PROCESSING</td>
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<tr>
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<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
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<tr>
<td>PGS 505 (e-Course)</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMER</td>
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<td>DM 521*</td>
<td>DAIRY STARTER CULTURES</td>
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<td>DM 522</td>
<td>MICROBIAL GENETICS</td>
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<td>DM 523</td>
<td>MICROBIAL FERMENTATION AND TECHNOLOGY</td>
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<td>FEED AND RUMEN MICROBIOLOGY</td>
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<td>DM 598</td>
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<td>DES 521</td>
<td>STATISTICS IN INDUSTRIAL APPLICATIONS</td>
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<td>DC 523</td>
<td>CHEMICAL QUALITY ASSURANCE</td>
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<td>DC 524</td>
<td>RESEARCH TECHNIQUES</td>
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<td>PGS 504</td>
<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
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<td>PGS 506</td>
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<td><strong>Major Course</strong></td>
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<td>DM 531*</td>
<td>MICROBIAL QUALITY AND SAFETY IN DAIRY INDUSTRY</td>
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<tr>
<td>DM 532</td>
<td>APPLICATION OF BIOTECHNOLOGY IN DAIRY INDUSTRY</td>
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<tr>
<td>DM 533</td>
<td>PROBIOTICS AND FERMENTED DAIRY PRODUCTS</td>
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<td>DM 599</td>
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<tr>
<td>DES 531</td>
<td>COMPUTER SOFTWARE</td>
<td>3+1</td>
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<td>TECHNICAL WRITING AND COMMUNICATION SKILLS</td>
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<td>INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE</td>
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<td>Masters Research</td>
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* Compulsory
DAIRY MICROBIOLOGY
Course Contents

DM 511 MICROBIAL MORPHOLOGY AND TAXONOMY 2+1

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

Theory
UNIT I
Evolution of life on earth, history and diversity of microorganism

UNIT II
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 (Taxometrics) and Chemotaxonomy. Assessing Microbial Phylogeny: Chronometers. Phylogenetic trees, r-RNA, DNA and proteins as indicators of phylogeny.

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

UNIT IV
Fungi: Distribution, Importance and recent Classification, Study of Yeasts and Moulds in Dairy Foods

UNIT V

Practical
- Simple and differential staining; gram, spore, acid-fast staining, cell wall, flagella, nucleoids, capsule, and inclusion/storage bodies
- Preparation of bacterial protoplasts and spheroplasts
- Measuring dimensions of microorganisms (bacteria) using micrometry,
- Study of morphology of fungi,
- Detection and enumeration of bacteriophages in Cheese whey
- Application of computer software in bacterial identification
- Electron microscopic observation of Ultra-structure of Microbial Cell(Demonstration)

Suggested Readings

DM 512* MICROBIAL PHYSIOLOGY 2+1

Objective
To familiarize the student with the various aspects of growth and energy generating activities of bacteria for the betterment of human life.

Theory
UNIT I
Bacterial growth: growth phases and kinetics, synchronous, continuous, and associative growth, Diauxic phenomenon; 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 such as antimicrobials.

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

UNIT IV
Electron transport chain: Electron transport chain; fermentation, respiration and photosynthesis

Practical
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, casamino acids) on bacterial growth.

Suggested Reading
http://www.sciencedirect.com/science/bookseries/00652911

DM 513 METHODS IN MICROBIOLOGY 2+2

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 for the study of sub-cellular organization and microstructure of dairy foods

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

UNIT III
Molecular Biology Techniques for nucleic acid analysis: amplification, investigation of mutations and gene expression

UNIT IV
Aerobic and Anaerobic culturing techniques for isolation of obligate and facultative organisms

UNIT V
Use of animal models in toxicity studies

Practical
• 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
• Disruption of bacterial cells by ultra-sonification
• 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

Suggested Readings

DM 514 ENVIRONMENTAL MICROBIOLOGY 2+1

**Objective**
To understand the fundamentals of environmental microbiology for overall effects of microorganisms in combating the pollution in the environment.

**Theory**

UNIT I
Microorganisms as components of the environment and their role in nutrient cycling; extreme environments and microbial ecology.

UNIT II
Microbes in aquatic and terrestrial environment; aero-microbiology; microorganisms as indicators of environment pollution; bio-organic pollution.

UNIT III
Microbial toxicants and pollutants and their biodegradation; organic pollutants and their degradation; biodegradation of plastics and polymers.

UNIT IV
Biofouling and biofilms; bioremediation and metabolic engineering; water pollution and control.

UNIT V
Biological treatments of food industry wastes; Issues concerning release of genetically engineered microorganisms in environment; environment laws.

**Practical**
Determination of BOD in industrial wastes; Determination of composite micro-flora of selected environmental samples; Detection of low levels of xenobiotics, microbial toxins and residual antibiotics in environmental samples; Isolation of bacteria capable of degrading organic and microbial pollutants from environmental samples; Isolation and characterization of bio-indicators from environmental samples; Visit to a sewage and sludge treatment plant.

**Suggested Readings**


DM 515* MICROBIOLOGY OF PROCESSED DAIRY FOODS 3+1

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

**Theory**

UNIT I
Developments in food microbiology, microbial ecology of processed food; factors that influence microbes in foods.

UNIT II
Thermal processes for shelf stable-products, low temperature food preservation, current concepts in irradiation technology; Biopreservation.

UNIT III
Stress induced injury to microorganisms, enumerations of stressed cells, predictive modeling for food spoilage; industrial strategies for ensuring safe foods.
UNIT IV
New methods for controlling spoilage of foods; active packaging and antimicrobial packaging (AMP), modified atmosphere packaging (MAP) and shelf life of processed foods, Intermediate moisture foods and Hurdle concept.

UNIT V
New prospects and problem in fermented foods, Nutraceuticals and Bioactive foods, Genetically Modified (GM) foods and their acceptance.

Practical
• Productions of antimicrobial substances.
• Application of bacteriocins, Biopreservation of foods
• Application of hurdle concepts for enhanced shelf stability of processed foods
• Induction of bacterial cell injury and recovery of injured cells
• Effect of MAP on quality and shelf life of processed foods.

Suggested Readings

DM 532 APPLICATION OF BIOTECHNOLOGY IN DAIRY INDUSTRY 2+1
Objective
To impart knowledge in the application of Biotechnology in Dairy / Food Industry to the students of Dairying at Master’s level

Theory
UNIT I
History and Development of Biotechnology; Status of Biotechnology Industries in India to meet the demands of Dairy and Food Industry

UNIT II
Genetic improvement of lactic starters to enhance their technological functions for industrial applications e.g. acid, flavour, EPS, probiotic functions, Metabolic engineering of lactic acid bacteria, Production of recombinant dairy / food enzymes / proteins e.g. Chymosin, lactoferrin, lysozyme, lipases, proteases, immunoglobulins etc. Detection of GMOs and GM foods and their safety from public health point of view

UNIT III
Dairy based Functional foods/Health foods and Nutraceuticals. Value addition in dairy products through fortification/supplementation with bioactive components and probiotic cultures, Nutrigenomics

UNIT IV
Application of molecular tools, biosensors, etc. for detection of food borne and spoilage pathogens

UNIT V
Molecular tools for studying Biodiversity; Regulatory standards for GMOs and GM foods.

Practical
• Plasmid isolation from E. coli
• Agarose gel electrophoresis
• Transformation of E. coli with plasmid (Amp)
• Growth of Starter cultures on MRS for ‘lac’ marker
• Induction of ‘lac’ mutation using UV rays or ethidium bromide
• PCR assays for identification of LAB and food-pathogen detection

Suggested Readings

DM 521* DAIRY STARTER CULTURES 2+1
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: The genus Lactococcus; The genus Leuconostoc; The genus Streptococcus; The genus
Pediococcus, The genus Lactobacillus.

UNIT II
Adjunct starter organisms; The genus Bifidobacterium; The genus Enterococcus; The genus Propionibacterium;
The genus Brevibacterium. Miscellaneous microorganisms: Molds and yeasts.

UNIT III
Metabolism of starter organisms: biochemical characterization of lactic acid bacteria; carbohydrate, citrate and
protein metabolism of starter cultures.

UNIT IV
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 V
Starter types: single, mixed and multiple strain starter cultures; propagation and preservation of starter cultures;
commercial starter preparations: concentrated and super-concentrated starters;

UNIT VI
Growth inhibition of lactic acid bacteria by antibiotics, bacteriocins; immunoglobulins and bacteriophage: sources,
types and characteristics of phages associated with starters, phage control during starter handling and growth,
mechanisms of phage resistance in LAB.

UNIT VII
Probiotic cultures, health and nutritional benefits, requirements for ability to survive and grow in the intestine,
control of intestinal infections. Role of starter cultures in cheese making and ripening of different cheese varieties.

Practical
- 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.

Suggested Readings
UNIT III
Mutagenesis, mutation and mutants; Lambda phage and its gene organization.

UNIT IV
Plasmids and their properties, transposable elements; Bacterial Recombination- Transformation, Conjugation and Transduction.

UNIT V

Practical
- Isolation and quantitative estimation of chromosomal DNA from E.coli and Lactobacillus by mini prep method.
- Isolation of plasmid DNA from E.coli and Lactobacillus by miniprep method.
- Isolation of Eukaryotic (yeast) chromosomal DNA
- Calcium chloride induced transformation of E.coli hosts with plasmids
- Induction of random mutation in E.coli and Lactobacillus by UV radiations and chemical mutagens
- Curing of plasmids with chemical mutagens (Ethidium Bromide) and elevated temperature
- Preparation of chloroplast and their regeneration and uptake in bacteria
- Use of restriction enzymes cleavage and ligation of DNA fragments
- P.C.R. based detection of microorganisms.

Suggested Readings

DM 531* MICROBIAL QUALITY AND SAFETY IN THE DAIRY INDUSTRY 2+2
Objective
To impart current knowledge pertaining to quality and safety functions in dairy processing unit

Theory
UNIT I
Principles of Quality and safety systems including QMS, HACCP,SAFE, GMP, SSOP, personnel hygiene and food handling in dairy industry

UNIT II
Establishment of Microbiological standards, guidelines and specification for foods; microbiological criteria; two and three class attributes plan for sampling

UNIT III
Rapid detection methods including commercial detection kits; automatic detection techniques for hygiene indicators, pathogenic organisms, antibiotic/pesticide residues and aflatoxin M1 in dairy foods

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

UNIT V
Trends in food borne diseases and implications; method of diseases transmission; principles of safety in a food microbiological laboratory

Practical
Conventional and rapid techniques for Microbiological quality evaluation of raw and pasteurized milk and other dairy products for hygiene indicators i.e. aerobic plate count, Staph aureus, coliform, enterococci, enterobacteriaceae counts, yeast and molds count; detection of common dairy pathogens and other contaminants from milk and milk products i.e E.coli, B. cereus, salmonella, Listeria, antibiotic residues and aflatoxin M1; shelf life studies of dairy products; effect of storage condition and packaging material on microflora of dairy foods.
DM 524 FEED AND RUMEN MICROBIOLOGY 2+1

Objective
To understand the basics of microbiology of feed and rumen ecosystem for its outcome on dairy production, processing and management.

Theory
UNIT I
Biofertilizers; microbial inoculants for fodder crops; legume-rhizobium symbiosis; production and application of biofertilizers.

UNIT II
Silage fermentation: microbial and chemical changes; use of additives and inoculants; losses during ensiling.

UNIT III
Bioconversion of crop-residues by solid state fermentation; single-cell protein production; advantages and disadvantages.

UNIT IV
Rumen microbial ecosystem; numbers, types, characteristics and functions of rumen bacteria, fungi and protozoa.

UNIT V
Methods for isolation, enumeration and cultivation of rumen microbes; their role in rumen metabolism and fiber degradation; exploitation of fibrolytic microorganisms as direct-fed microbials/ microbial feed additives.

Practical
Isolation of rhizobium bacteria from fodder legume plants; preparation of rhizobium inoculant for fodder leguminous crops; estimation of moisture, NH₃-N and pH in silage; enumeration of silage microorganisms; estimation of lactic, acetic and butyric acids in silage; sampling technique of rumen liquor and direct microscopic count of bacteria and protozoa; anaerobic cultivation techniques for bacterial and fungal counts in rumen liquor; use of anaerobic jar, roll-tube technique, estimation of hydrolytic enzyme activities of rumen liquor/ rumen microbes; SCP production from cellulose in submerged fermentation; bioconversion of straw by solid state fermentation.

Suggested Readings

DM 533 PROBIOTICS AND FERMENTED DAIRY PRODUCTS 2+1

Objective
To impart knowledge on basic and applied aspects of probiotics and fermented dairy products.

Theory
UNIT I
Introduction and history of probiotics and fermented dairy products.

UNIT II

UNIT III
Microbiology of yoghurt and related products. Microbiology of acidophilus products, dahi, misti dahi, bhapa dahi, lassi, cultured butter milk, shrikhand, kefir, koumiss, yakult, villi, bifidus milk products, kishk, and milk based
products containing probiotic cultures.

UNIT IV
Factors influencing the quality and storage stability of fermented milks. Methods used in their manufacture, evaluation and quality control.

UNIT V
Nutritional and therapeutic value of these products in human diet. Use of fermented milks in diet and cancer control.

Practical
• Manufacture of different fermented milks and their microbiological and chemical analysis.
• Study of shelf life of fermented milks using different methods of preservation.
• Microbiological assay of vitamins or amino acids in fermented milk.

Suggested Readings

DM 523 MICROBIAL FERMENTATION TECHNOLOGY 2+1

Objective
To disseminate recent information on basic and applied aspects of fermentation technology and its industrial application to the students along with hands on training.

Theory
UNIT I
Introduction to fermentation. Historical perspective, Fermentation as a means for enhancing shelf life of foods and pickles.
UNIT II
Rate of microbial growth and death, Fermentation kinetics, mass transfer diffusion, membrane transport, dialysis, nutrient uptake.
UNIT III
Fermenter/ Bioreactor design, operation, measurement and control in fermentation. Aeration and Agitation in fermentation; Oxygen requirement, Adsorption coefficient bubble aeration, mechanical agitation, correlation between mass transfer coefficients and operating variables.
UNIT IV
Types of fermentation, submerged / solid state, Batch / continuous fermentation. In situ sterilization, Scale up in fermentation, Product recovery, Role of Immobilization, Downstream processing for Recombinant proteins and bio-assays
UNIT V
Industrial production of Lactic acid, Penicillin, Betagalactosidase, amino acids, vitamins, ethanol.

Practical
• Follow up of bacterial growth in batch culture.
• Different methods of microbial cultivation
• Fermenter operation and measurement.
• Production of starters, baker yeast culture, alcohol, alcoholic beverages.

Suggested Readings

DAIRY MICROBIOLOGY

List of Journals
• Advances in Microbial Physiology
• Antimicrobial Agents and Chemotherapy
• Antonie van Leeuwenhoek
• Animal Feed Science and Technology
• Annals of Clinical Biochemistry
• Advances in Microbial Physiology
• Advances in Applied Microbiology
• Annals of Microbiology
• Annual Review of Microbiology
• Applied and Environmental Microbiology
• Applied and Environmental Microbiology
• Applied Biochemistry and Microbiology
• Applied Microbiology and Biotechnology
• Archives of Animal Nutrition
• Archives of Environmental Health
• Archives of Microbiology
• Asian-Australasian Journal of Animal Sciences
• Bioscience, Biotechnology and Biochemistry
• British Journal of Nutrition
• British Medical Journal.
• Cellular Microbiology
• Clinica Chimica Acta
• Clinical Chemistry.
• Clinical Chemistry and Laboratory Medicine
• Clinical Microbiology
• Critical Reviews in Environmental Science and Technology
• Critical Reviews in Microbiology
• Current Advances in Clinical Chemistry
• Current Contents
• Current Genetics
• Current Microbiology
• Dairy Science and Technology (Le Lait)
• Ecotoxicology and Environmental Safety
• Environment International
• Environmental Microbiology
• Environmental Monitoring and Assessment
• Environmental Research
• Environmental Science and Pollution Research
• Enzyme and Microbial Technology
• Eukaryotic Cell
• European Journal of Clinical Microbiology and Infectious Diseases
• FEMS Microbiology Ecology
• FEMS Microbiology Letters
• FEMS Microbiology Reviews
• Food Microbiology
• Food Microbiology and food safety journals
• Food Research International
• Foodborne Pathogens and Disease
• Fungal Genetics and Biology
• Gene
• Genome
• Indian Journal of Animal Nutrition
• Indian Journal of Animal Sciences
• Indian Journal of Microbiology
• Indian Journal of Veterinary Science
• Indian Journal of Dairy and Biosciences
• International Dairy Journal
• International Journal of Dairy Technology
• International Journal of Environment and Pollution
• International Journal of Food Microbiology
• International Journal of Food Science and Nutrition
• International Journal of General and Molecular Microbiology
• International Journal of Probiotics and Prebiotics
• International Journal of Systematic and Evolutionary Microbiology
• Investigation
• Journal of Animal Science
• Journal of Animal and Feed Sciences
• Journal of Applied Animal Research
• Journal of Applied Microbiology
• Journal of Bacteriology
• Journal of Basic Microbiology
• Journal of Biological Chemistry
• Journal of Biotechnology
• Journal of Chromatography A
• Journal of Dairy Science
• Journal of Dairy Research
• Journal of Experimental Animal Science
• Journal of Food Protection Letters in Applied Microbiology
• Journal of Food Science
• Journal of Food Science and Technology
• Journal of Food safety
• Journal of General and Applied Microbiology
• Journal in Genetics and Genomics
• Journal of Industrial Microbiology and Biotechnology
• Journal of Microbial Food Safety Standards
• Journal of Microscopy
• Journal of Molecular Microbiology and Biotechnology
• Journal of Rapid Methods and Automation in Microbiology
• Journal of Virology
• Microbial Pathogenesis
• Microbial Ecology in Health and Disease
• Microbiological Research
• Microbiology: Bacteriology, Mycology, Parasitology and Virology
• Microbiology and Molecular Biology Reviews
• Molecular and Cellular Biology
• Molecular and Cell Biology
• Molecular Biology
• Molecular Genetics, Microbiology, virology
• Nature
• Nature Biotechnology
• New England Journal of Medicine
• Plasmid
• PNAS
• Process Biochemistry
• Scandinavian Journal of Clinical and Laboratory Science
• Science
• Science of the Total Environment
• Symposium on Microbiological Food Safety Management 2007
• Systematic and Applied Microbiology
• The Journal of Biological chemistry
• The Lancet
• Trends in Food Science and Technology
• Trends in Microbiology
• Veterinary Microbiology
• Veterinary Research
• World Journal of Dairy and Food Sciences
• World Journal of Microbiology and Biotechnology
Supportive Courses
Supportive Courses

DES 511  Dairy Business Management  2 + 1

Concept of dairy business management, managerial decision making, functions of management. Planning- objectives, classification of plans, planning related to finance, production and personnel aspects of the dairy. Organising- Fundamentals of organizational design, documentation, principles and delegation of authority, responsibility and accountability. Staff- Personnel management, planning, selection, introduction, orientation and training of unskilled and skilled personnel in dairy organizations. Control- Purpose and types of control, steps in control, characteristics of effective controls, control techniques and methods, programme evaluation review technique (PERT), inventory control. Project appraisal and monitoring- Standards and norms of appraisal, monitoring and its tools, management information systems, net present value and internal rate of return. Demand analysis- Determinants of demand of dairy products, responsiveness of demand, estimation of product and factor demand, types and approaches for demand forecasting. Cost analysis- Application of different cost concepts and functions in managerial decisions. Pricing- Determinants of price of dairy products, pricing under different objectives and market structures, product differentiation and product-mix decisions. Profit planning and control - Concept, profit planning and break even analysis in dairy industry.

Practical
Delineation of milk shed area
Case studies for solving problem situations; Demand forecasting
Estimation of cost of milk procurement and processing
Break-even analysis and breakeven charts; Use of PERT in dairy industry
Optimization of product-mix; Estimation of cost of inventory
Economic lot size and other quantity standards

Suggested Readings

DES 521  Statistics in Industrial applications  2 + 1

Statistical methods in industrial applications; analysis of variance; transformations; partial and multiple correlation and regression; Ranking techniques; introduction to discriminant analysis; statistical basis for drawing scientific inferences from experimental data; principles of experimental design-industrial experimentation; basic designs-CRD; RBD & LSD; missing plot technique; factorial experiments-main effects and interactions; 2n series and mixed factorial experiments; experimental designs in sensory evaluation; introduction to statistical quality control; control charts for variables; mean and range charts; statistical basis; rational sub-group; control charts for attributes 'np'; 'p' and 'c' charts; fundamental concepts of acceptance sampling plans; single; double and sequential sampling plans; use of sampling inspection tables for selection of single and double sampling plans; introduction to sampling techniques and their application to consumer preference studies.

Practical
Analysis of variance-one way and two way classification; partial and multiple correlation and regression; rank correlation and coefficient of concordance; analysis of industrial experiments - Use of CRD; RBD and LSD; missing plot technique; factorial experiments - 22 and 23; mixed factorial experiments; control charts for variables; control charts for attributes; single sampling plan- OC and AOQ curves; sequential sampling plan; use of sampling inspection tables; and different methods of selecting samples;
Suggested Readings
Grant and Leavenworth 1972 Statistical Quality Control, McGraw Hill, New Delhi

DES 531 Computer Software 2 + 1
General data analysis requirements in dairy research; introduction to statistical and other standard software packages (SYSTAT; SPSS; MS-Excel); data preparation and job control commands for statistical analysis of data pertaining to t-test; Chi-square test; analysis of variance (ANOVA); basic experimental designs - CRD; RBD & LSD; factorial designs; partial and multiple correlation and regression; discriminant analysis; linear programming; (using LINDO/LINGO) software packages; least-squares analysis

Practical
Statistical software packages and their operations; data preparation and data generation; import and export of data from spreadsheet and database packages; application of software packages to the problems related to: tests of significance (t; Chi-square and F-test); analysis of variance (ANOVA); partial and multiple correlation and regression; discriminant analysis; linear programming problem; and least-squares analysis.

Suggested Readings
Compulsory Non-credit Courses

PGS- 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; esources access methods.

PGS- 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

(e-Course)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
PGS-504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective
To acquaint the students about the basics of commonly used techniques in laboratory.

Practical
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

PGS-506 DISASTER MANAGEMENT 1+0
(e-Course)

Objective
To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory
UNIT I
Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II
Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III
Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings
PGS - 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS  0+1

Objective
To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accental pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings


PGS -503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE 1+0 (e-Course)

Objective
The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological
Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings