Semester-wise course distribution and syllabus

Food Science and Nutrition

M.Sc Course

Proposed courses

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course No.</th>
<th>Course Title</th>
<th>Credits (T + P)</th>
<th>Total Credits</th>
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<tbody>
<tr>
<td></td>
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<td>Major Courses</td>
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<tr>
<td>1.</td>
<td>FSN-611</td>
<td>Enzymes in Food Processing</td>
<td>2+1</td>
<td>3</td>
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<tr>
<td>2</td>
<td>AB-614</td>
<td>Food and Nutritional Biochemistry</td>
<td>3+0</td>
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<td>3</td>
<td>AB-613</td>
<td>Biochemical Techniques</td>
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<td>4</td>
<td>DC-614</td>
<td>Food Chemistry</td>
<td>3+1</td>
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<td>5</td>
<td>FSN-621</td>
<td>Human Physiology</td>
<td>2+0</td>
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<td>6</td>
<td>FSN-622</td>
<td>Nutrigenomics</td>
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<td>7</td>
<td>AB-621</td>
<td>Intermediary Metabolism</td>
<td>4+0</td>
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<tr>
<td>8</td>
<td>DM-624</td>
<td>Probiotics for Health Foods</td>
<td>2+1</td>
<td>3</td>
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<td>Minor Courses</td>
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<tr>
<td>1.</td>
<td>DT-618</td>
<td>Principles of Food Processing</td>
<td>2+1</td>
<td>3</td>
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<tr>
<td>1</td>
<td>DM-615</td>
<td>Microbiology of Processed Dairy foods</td>
<td>2+1</td>
<td>3</td>
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<tr>
<td>2</td>
<td>DC-623</td>
<td>Chemical Quality Assurance</td>
<td>2+1</td>
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<td>3.</td>
<td>DM-623</td>
<td>Microbiological Quality Assurance in Dairy Industry</td>
<td>2+1</td>
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<td>5.</td>
<td>DT-624</td>
<td>Functional Foods and New products Development</td>
<td>3+1</td>
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<td>Supporting Courses</td>
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<tr>
<td>1</td>
<td>CS-621</td>
<td>Software packages for Statistical Computing</td>
<td>2+1</td>
<td>3</td>
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<td>FSN-629</td>
<td>Seminar</td>
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</tbody>
</table>
Theory

Unit I


Unit II

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. Factors affecting rate of enzyme catalyzed reactions, cofactors, coenzymes - their structure and role, enzyme inhibitors, enzymic browning, immobilized enzymes.

Unit III

Applications of enzymes in food processing: Need for enzyme usage and sources of enzymes.

Application of enzymes in industrial production of starch, high fructose corn syrup, enzymes in sucrose industry.

Unit IV

Use of enzymes in beverages - fruit juices, beer, wine and distilleries, dairy, baking, oils and fats, plant and animal products.

Unit V

Malting and germination of grains - process, characteristics, nutritional benefits and use.

Practicals

- Enzyme assay by taking any model enzyme like alpha-amylase or alkaline phosphatase.
- Isolation and purification of any model enzyme like B-galactosidase or acid phosphatase.
- Study of the effect of enzyme and substrate concentrations and determination of Km and Vmax.
- Determination of pH and temperature optima of alkaline phosphatase.
- To study the effect of various inhibitors of enzymatic activity.
- Determination of the pH and temperature stability of alkaline phosphatase.
Objective

To impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration.

Theory

Unit I


Unit II

Nutritional requirements for different age groups, pregnancy, lactation, infancy and physiological status, factors effecting nutritional requirements. Biochemical and nutritional aspects of vitamins and minerals. Nutraceutical, antioxidants, food toxins, antinutritional factors, probiotics and cultured dairy products.

Unit III


Unit IV

Nutritional disorders, Role of lipids in obesity and cardiovascular diseases, role of calcium in hypertension, cancer and osteoporosis, iodine and iron deficiencies, Biological availability of calcium, Biochemical tests for nutritional disorders.

Unit V

Effect of cooking, processing and preservation of different food products on nutrients, Biochemical aspect of post-harvest storage specifically food spoilage. Food additives (coloring agents, preservatives etc.), biogenesis of food flavours and aroma.
Objective
To impart practical knowledge about various techniques used in purification and characterization and estimation of cellular constituents.

Theory
Unit I
Spectroscopy: Principles and applications of UV, Visible, fluorescence, NMR, ESR. X-ray diffraction, mass spectrometry.

Unit II
Chromatographic Techniques: Principles and applications of chromatographic techniques viz., TLC, HPLC, GLC, ion-exchange, gel-filtration, affinity, hydrophobic interaction chromatography, metal chelate chromatography.

Unit III

Unit IV
Principles and applications of Northern blot, Western Blot and Southern Blot: ELISA, RIA, PCR. Protein sequencing

Unit V

Practicals:
1. Determination of absorption maxima and molar extinction coefficient of p-Nitrophenol from its absorption spectrum.
2. Effect of pH and solvent polarity on absorption spectrum of p-Nitrophenol.
3. Effect of slit width on absorption spectrum.
4. Estimation of proteins using Bradford/BCA method
5. Separation of proteins and Mr Determination using SDS-PAGE.
6. Separation of Lipids using TLC
7. Separation of fatty acid methyl esters using GLC
8. Separation of proteins using gel filtration
9. Separation of proteins using Ion-exchange chromatography
10. Demonstration of HPLC for separation of Biomolecules
Objective: To impart knowledge on different aspects of food components

Unit I:
Forms of water in foods, water solute interactions, and food stability, solute mobility and food stability; role of ice in the stability of food at sub-freezing temperatures.

Unit II
Starch: Forms, swelling, gelatinization; food applications and role of starch in bread making; modification of starches for industrial applications, physico-chemical changes taking place during malting; properties and utilization of common polysaccharides-cellulose, hemicellulose, pectin, agar, alginate, carrageenan and gums.

Unit III
Functional properties of food proteins; structure-function relationship and their modifications, denaturation of food proteins; effect of pressure on food proteins.

Unit IV
Technical enzyme preparation, immobilized enzymes, individual enzymes & their utilization in food industry: physico-chemical properties of food lipids and their modifications.

Unit V
Changes taking place during fermentation; drying and roasting of chocolate and cocoa; chemistry of tea manufacture; composition of coffee beans; physico-chemical changes during roasting of coffee beans.

Practical:
Determination of level of artificial sweeteners and crude fiber in food products; starch in flour by polarization method; total amino acids and polyphenols in lemon juice; fat in grains; proteins in flour; tannins in coffee/tea, caffeine content in coffee; Detection of aspartame in dairy product using TLC and visit to a food industry.
Objective: To impart basic physiological concepts of human

Unit I
Introduction to physiology, Fluid-electrolyte Acid base balance, body temperature and metabolism, the senses, Physiological applications in cancer and tissue engineering.

Unit II
Musculoskeletal system: Function of skeletal system, Bone structure, development and growth, Nervous system: Functions of nervous system, action potential, Organization of nervous system such as CNS, PNS, sympathetic innervation, parasympathetic innervation

Unit III

Unit IV
The Respiratory system: Introduction to respiratory system, mechanics of ventilation, respiratory volumes and capacities, The Digestive system: Functions of digestive system, General structure of digestive system, Organs of digestive system: Mouth, Pharynx and esophagus, stomach, Small and large intestines, Accessory organs (Salivary glands, tongue, pancreas, liver).

Unit V
The Urinary System: Functions of urinary system, Components and function of the urinary system: Kidneys including nephron and collecting tubules, ureters, urinary bladder and urethra. Male reproductive system: Testes, duct system, accessory glands, penis and hormonal control. Female reproductive system: Ovaries, genital tract, external genitalia, hormonal control including lactation, mammary glands, menstruation.
FSN-622 NUTRIGENOMICS (2+0)

Objective: To impart the basics and applications of Nutrigenomics

Unit 1:
Genome organization: DNA, components of the genome, supercoiling of the DNA, chromatin and chromosome organization, DNA replication and recombination.

Unit 2:
DNA sequencing methods: Classical sequencing methods (e.g., Sanger, Maxam& Gilbert methods), Next generation sequencing methods (e.g., Solid, 454 etc), Genome projects of the human, animal, plant and microbial genomes.

Unit 3:
Genomics and Genomic Variation: Mutation, Types of mutations, SNP, SNP genotyping, Population measures, Linkage disequilibrium and haplotype maps, whole genome association analyses methods, Genomics importance in health and disease

Unit 4:
Nutrigenetics: Definition, role of nutrigenetics in the utilization of food in different human races, recent publications related to nutrigenetics and understanding the food recommendations specific to particular human populations.

Unit 5:

Unit 6:
Introduction to proteomics, metabolomics, Insilico genomics and their integration with nutrigenomics, and recent nutrigenomics studies on dairy and processed foods.
AB-621: INTERMEDIARY METABOLISM (4+0)

Objective To teach metabolic pathways, their regulation, and methods used in their elucidation.

Theory

Unit I

Introduction to metabolism, methods of studying metabolism, transport mechanism, bioenergetics, biological oxidation.

Unit II

Catabolic and anabolic pathways of carbohydrates: glycolysis, citric acid cycle, pentose phosphate pathway, glyoxylate cycle, gluconeogenesis, metabolism of glycogen.

Unit III

Fatty acid catabolism & biosynthesis, lipid biosynthesis, Electron transport and oxidative phosphorylation.

Unit IV


Unit V

Compartmentation of metabolic pathways, regulation of different metabolic pathways, major metabolic disorders, Integration of metabolism, metabolic profiles of major organs, regulation of body mass, altered metabolism in starvation & diabetes mellitus
**Objective:** To familiarize the students with the concept of probiotics and their application in human health

**Theory**

**Unit 1:** History and definition of Probiotics; Commercially available probiotic strains and probiotic dairy products

**Unit 2:** Selection and identification of new strains of probiotics

Isolation of probiotic organisms from different niches; selection on the basis of probiotic attributes as per FAO/WHO guidelines; Identification of probiotics by molecular tools like PCR and 16S rRNA sequencing; DNA Finger printing by RAPD and Ribotyping

**Unit 3:** Mechanism of action of probiotics

Colonization in the gut; Adhesion to intestinal mucosal surface – role of surface proteins; Production of antimicrobial substances – organic acids, hydrogen peroxide, bacteriocins; Pathogen exclusion; immuno-modulatory action; Impact on gut microbial balance; Host microbe interaction and their cross talk; Role of biomarkers for probiotic functionality

**Unit 4:** Application in Human Health and Disease

Probiotics for management of diseases - gastro-intestinal and antibiotic associated diarrhea; Inflammatory diseases such as Inflammatory Bowel disorder, Ulcerative colitis and Crohn’s; Respiratory, Urogenital, Life style, Allergy; Liver, AIDS / HIV, Cancer and antitumor effects

**Unit 5:** Dairy based foods as carrier of probiotics

Dairy based products as delivery vehicles – Stability towards manufacturing conditions, enhancing stability through encapsulation or drying strategies for lyophilized formulations etc., co-culture compatibility with starters, minimum effective dose, Large scale production of probiotic biomass through fermentation for application in foods and as drugs / supplements

**Unit 6:** Designer probiotics

Genetically modified probiotics as oral vaccines, enhanced adhesion properties and health promoting functions

**Unit 7:** Safety, human trials and regulatory guidelines

*In vitro* and *in vivo* safety assessment of probiotics; designing human trials; regulatory guidelines - US, Canada, Europe and India

**Practical:**

1. Isolation of probiotic organisms from human milk and faecal samples
2. Tentative identification by microscopic examination, catalase and biochemical tests
3. Identification of isolates by genus and species specific PCR
4. Evaluation of bacterial isolates for probiotic properties
   - Acid tolerance
   - Bile tolerance
   - Hydrophobicity
   - Antimicrobial activity

5. Survival of probiotic culture in fermented dairy products

6. Microencapsulation of probiotic bacteria
DT-618 Principles of Food Processing (2+1)

Unit I

Food raw material characteristics: Composition, physico-chemical properties, Pre & Post Harvest management, Factors affecting shelf-life of fresh produce

Unit II

Food preservation principles: Preservation by heat, drying, Low temperature preservation including cold storage, freezing preservation, application of preservatives

Unit III

Changes during processing of foods, Browning reactions, Oxidative reactions, loss of nutritional value, effect on anti-nutrients, PER, Biological value, NPU, loss of vitamins, minerals, bioactive components

Unit IV

Novel processing technologies for foods, Irradiation, High pressure processing (HPP), Pulsed electric field (PEF) and other novel preservation interventions of foods

Unit V

Processing technology of Cereal based processed foods – flour, bread, biscuit, cake, role of ingredients, Changes during baking

Unit VI

Fruits & vegetable based products – Pulp, Juice, Beverage, Jam, Jellies, Pickles, Technological aspects, role of ingredients and principles of manufacture

Unit VII

Food additives: classes, Class I & II preservatives, antioxidants, Hydrocolloids, emulsifier, vitamins, minerals

Unit VIII

Formulated foods: - Fortification, enrichment, Restoration, nutritionally modified foods, nutritionally enhanced foods, Analogue

Unit IX

Food Packaging: Role of packaging, Types of packaging materials, their properties, utilization of packaging materials for various foods products, Food-Package Interactions, migration of packaging compounds into food products, Advances in packaging
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.
Concept of quality assurance and quality control in relation to dairy industry; quality management systems - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP); role of international organisations such as ISO; IDF; CAC; AOAC; WTO and national organisations like BIS; CCFS; PFA and Agmark; significance of milk and milk products order (MMPO) and APEDA (Agricultural and Processed Foods Export Development Authority) in dairy industry; guidelines for setting up quality control laboratory; sampling of milk and milk products; instrumentation in analysis of milk and milk products; chemical residues: pesticides; antibiotics; heavy metals; radionuclides etc; in dairy products; dairy detergents and sanitizers; detection of adulterants in milk and milk products; calibration of milk testing glassware; preparation of standard reagents; packaging materials in relation to quality assurance of dairy products.

Practical: Preparation of standard solutions and buffers; testing of available chlorine content in hypochlorites/bleaching powder; determination of purity of common salt for butter and cheese making; detection of common adulterants in milk and foreign fat/oil in ghee; checking the calibration of lactometers; hydrometers; butyrometers; milk pipette and thermometer; qualitative colour tests to distinguish between azo dyes and natural dyes in butter; detection of pesticide residues and antibiotics in milk.
DM- 623  Microbiological Quality Assurance in Dairy Industry   (2+1)

Objectives:

To impart current knowledge pertaining to Quality Assurance, Food Safety Standards, Biosafety, product/process criteria, enumeration and legal product standards.

Theory

Unit I

Importance of Microbiological Quality and Safety Assurance System in Dairy Industry: Principles of quality and safety management systems; Process approach based QMS (ISO-9001) and applications of HACCP system in dairy industry; TQM tools and techniques including Six sigma, 5S principle, kaizen; Plant hygiene and sanitation in dairy industry.

Unit II

General principles for the establishment and application of microbiological criteria for dairy foods: Definition, purpose and components of Microbiological criteria; Mandatory and advisory criteria; Sampling methods; Two and three class attributes for sampling plan (ICMSF); Establishment of microbiological standards, guidelines and specifications for different milk and milk products recommended by ICMSF, Codex, PFA, BIS.

Unit III

Enumeration and detection of indicator organisms and dairy pathogens: Indicator Organisms; Selection criteria for their use as quality and safety indicators; Conventional and rapid detection methods including commercial detection kits for indicator organisms and pathogenic bacteria in milk and milk products.

Unit IV

Microbial bio-sensor for monitoring pathogens and non-microbial contaminants in dairy foods: Definition, history, basic characteristics, classification and components of microbial bio-sensors; Detector system i.e. Electrochemical; Optical; Mechanical devices; Application of microbial bio-sensor in monitoring pathogenic bacteria, antibiotic residues and aflatoxin M1 in milk and milk products.

Unit V

Establishment and accreditation of QA Lab in dairy processing unit: Introductory information on Quality assurance lab in dairy processing unit; Bio-safety definition, principle and safety levels; Standard microbiological practices, safety equipment (primary barrier), facility design (secondary barrier), medical surveillance criteria and biological waste disposal; FDA requirements for establishing biosafety laboratory in dairy industry and its accreditation as per ISO.

PRACTICAL

1. Conventional and rapid techniques for microbiological evaluation of dairy products for Aerobic plate count, Yeast & Mold Count, Psychrotropic, Thermudoric & Thermophilic count, Spore count, Dye reduction test, Direct Microscopic Count, Thermotolerant Coliform and Enterobacteriacea counts.
2. Bacteriological analysis of dairy water for Aerobic plate counts and Coliform counts (MPN).
4. Detection of antibiotic residues, aflatoxin M1 in milk using biosensor based micro-techniques.
5. Detection and enumeration of Staph.aureus, Bacillus cereus, E.coli, Salmonella, Shigella, Listeria monocytogenes in dairy products.
7. Evaluation of common sanitizing agents in dairy plant by capacity and suspension test.
8. Microbiological tests for assessing equipments and personnel hygiene by rinse and swab techniques.
**Objective** – To impart the knowledge of functional ingredients, nutraceuticals and their utilization in development of new food products including health foods, functional foods and specialty foods.

**Unit I**

Definition, classes of functional foods, status of functional foods in world and India. Classes of nutraceuticals and functional foods. Concept of new product development, economic analysis and costing of novel foods, Safety; marketing strategy and consumer response; recent advances in different categories and type of dairy product

**Unit II**

Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of dairy nutrients, Bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA and derived lipids, effect of processing on bioactivity of milk nutrients, Bioactive peptides: definition, preparation techniques, classes of bioactive peptides and mechanism of action

**Unit III**

Food fortification, techniques for fortifying dairy foods with minerals and vitamins (4 lectures), Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in dairy foods, High protein foods prospective nutraceuticals for fortification of dairy foods.

**Unit IV**

Infant nutrition and dietary Formulations for meeting normal and special needs of infants. Current status of infant foods, additives for infant foods, Foods for aged persons, design consideration, ingredients for geriatric foods, Technological aspects of reduced calorie foods, alternatives for calorie reduction, low calorie sweeteners, bulking agents and their application, Fat replacers and their utilization in low calorie dairy foods, Technology of Low calorie dairy products: processing interventions

**Unit V**


**Unit VI**

Delivery system for the bioactive components in functional foods. Prebiotic substances and their utilization in functional foods: GOS, FOS, Inulin and other dietary oligosaccharides, Technological aspects and recent development in probiotics, prebiotics and synbiotics (including microencapsulation and other delivery systems for probiotic organisms in dairy foods), Definition and various classes of Phytochemicals, their role in CVD, Cancer and immune system enhancer, utilization in functional foods., Phytosterol, phytoestrogens, Glucosinolates, organosulphur compounds, flavonoids, carotenoids etc Special foods/nutrients for CVD, Cancer, IBD, diabetics,
persons suffering with milk allergy and lactose intolerance with special emphasis on dairy nutrients and foods.

**PRACTICALS**

- Determination of total fiber, neutral detergent fiber in foods
- Manufacture of low calorie barfi/ice cream/mishti dahi
- Manufacture of fiber enriched milk beverage/dairy products
- Preparation of flavoured milk using artificial sweetener and its estimation
- Determination of antioxidant activity of food/food components
- Determination of bioavailability of nutrients (in-vitro experiments)
- Determination of β-galactosidase activity and application of lactases for lactose free dairy products
- Development of malted milk food and weaning food
- Determination of prebiotic potential of certain plant/milk components and their application in synbiotics dairy foods
- Preparation of sports beverage, herbal dairy drinks
- Preparation of high protein products using membrane processing
- Micronutrient fortification of milk and milk products (two classes)
- Determination of probiotic attributes of microbial cultures and application for probiotic dairy foods
- Preparation of infant formula
Theory

General data analysis requirements in dairy research; introduction to statistical and other standard software packages (SYSTAT; SPSS; MATLAB; and MS Excel); data preparation and job control commands for statistical analysis of data pertaining descriptive statistics; tests of significance - t-test, Chi-square test and F-test; analysis of variance (ANOVA); basic experimental designs - CRD; RBD and LSD; factorial experiments; Correlation; simple and multiple linear regression; curvilinear regression; stepwise regression; discriminant analysis; graphic features of the above listed software packages; linear programming using appropriate software packages; least-squares analysis; brief introduction to data mining techniques such as neural networks, genetic algorithms and fuzzy logic for predictive modeling.

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: descriptive statistics; tests of significance (t-test; Chi-square test and F-test); ANOVA; correlation; simple and multiple linear regression; curvilinear regression; stepwise regression; discriminant analysis; graphic features of the above noted software packages; linear programming problem; least-squares analysis; neural network and fuzzy logic models for prediction/classification.