

Department of Food Technology
Guru Jambheshwar University of Science and Technology,
Hisar, Haryana
CBCS Scheme and Syllabi Effective from 2017-2018
M.Sc. (Food Technology)

Program Core (PC)		Program Elective (PE)	Open Elective (OE)	Research Project	Total Credits
61		16	04	12	93
1st Year SEMESTER-I					
S. No.	Course Code	Nomenclature	Type	L + T + P	Credits/week
1	FT-501	Food Chemistry	PC	3 + 1 + 0	4
2	FT-502	Principles of Food Engineering	PC	3 + 1 + 0	4
3	FT-503	Food Microbiology	PC	3 + 1 + 0	4
4	FT-504	Food Processing and Preservation	PC	3 + 1 + 0	4
5	FT-505	Lab - I (Food Microbiology)	PC	0 + 0 + 4	2
6	FT-506	Lab - II (Food Preservation and Analysis)	PC	0 + 0 + 4	2
7		Open Elective/MOOC Course	OE	4 + 0 + 0	4
TOTAL= 24					
SEMESTER-II					
8	FT-507	Dairy Technology	PC	3 + 1 + 0	4
9	FT-508	Technology of Fruits and Vegetables	PC	3 + 1 + 0	4
10	FT-509	Packaging Technology	PC	3 + 1 + 0	4
11	FT-510	Lab - III (Dairy Technology)	PC	0 + 0 + 4	2
12	FT-511	Lab - IV (Technology of Fruits and Vegetables)	PC	0 + 0 + 4	2
13	FT-512	Lab - V (Packaging Technology)	PC	0 + 0 + 4	2
14	FT-513-516	Programme Elective-I	PE	4 + 0 + 4	6
TOTAL= 24					
2nd Year SEMESTER-III					
15	FT-517	Technology of Cereals, Pulses and oilseeds	PC	3 + 1 + 0	4
16	FT-518	Food Safety, Standards and Quality Control	PC	3 + 1 + 0	4
17	FT-519	Agri Business Management	PC	2 + 0 + 0	2
18	FT-520	Lab - VIII (Technology of Cereals, Pulses and oilseeds)	PC	0 + 0 + 4	2
19	FT-521-524	Programme Elective-II	PE	4 + 0 + 4	6
20	FT-525	In-Plant Training	PC	0 + 0 + 12	6
21	FT-526	Seminar	PC	0 + 0 + 2	1
TOTAL= 25					

SEMESTER-IV					
21	FT-527	Snack Food Technology	PC	3 + 1 + 0	4
22	FT-528-529	Programme Elective-III	PE	3 + 1 + 0	4
24	FT-600	Thesis/Research Project	PC	0 + 0 + 24	12
TOTAL=20					

PROGRAMME ELECTIVE-I

FT-513 Bioprocess Technology
 FT-514 Technology of Beverages
 FT-515 Lab - VI (Bioprocess Technology)
 FT-516 Lab - VII (Technology of Beverages)

MOOC Course

PROGRAMME ELECTIVE-III

FT-528 Food Biotechnology
 FT-529 Technology of Meat, Fish and Poultry

MOOC Course

PROGRAMME ELECTIVE-II

FT-521 Food Additives
 FT- 522 Nutrition and Health
 FT- 523 Lab – IX (Food Additives)
 FT-524 Lab – X (Nutrition and Health)

MOOC Course

Important Notes:-

1. The credit requirement for the M.Sc. degree in Food Technology is 93 credits inclusive of the 16 elective course credits.
2. The department will offer the following open elective courses in 1st semester for the students of other teaching departments:
 - i. FT-501 Food Chemistry
 - ii. FT-503 Food Microbiology
 - iii. FT-504 Food Processing & Preservation
 - iv. MOOC Course
3. One laboratory hour per week per semester will be assigned half credit.
4. No elective course will be run unless the number of students registered for the elective course is five or more.
5. Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.
6. After the second semester, the students will be required to undertake an In-plant training comprising 4-6 weeks in industry/organization/institute and shall submit an In-plant-training report for which seminar presentation and viva-voce examination will be held in the beginning of the third semester by a three member committee constituted by the department including the supervisor.
7. A student is required to undertake a Research Project of 12 credits on a topic approved by the supervisor and the Departmental Research Committee (DRC). The student is required to prepare his/her research project synopsis and should make a presentation to the DRC before the commencement of the final examination of third semester.
8. The research project shall be evaluated by the external examiner at the end of the Semester IV.
9. The student is required to register for one "Open Elective" paper (in Semester I) of his/her choice from any department other than the parent department.
10. A Supervisor will be allotted by the Chairperson for each student in the beginning of first semester.

Choice Based Credit System
Course Curriculum
for
M.Sc.
Food Technology

Objective

To acquaint the students about chemistry of various foods.

Outcome

After studying this course, the students shall be aware of the underlying chemistry, properties and effects of processing on food components.

UNIT-I

Scope, introduction, definition and importance of food chemistry.

Chemistry of carbohydrates: classification, functions, chemical and physical properties, pentosans, mannans and galactans, pectic substances, gums. Types of fibers and its constituents, Celluloses, hemicelluloses, soluble fibers, insoluble fibers and their important functions. Enzymes and starches- alpha amylase, beta amylase, modified starches, resistant starches, gelatinization of starches and starch blockers.

UNIT-II

Proteins and amino acids: types, chemical, physical and functional properties, denaturation of protein, gel formation. Proteins from milk, egg and meat. Allergens, toxic constituents and anti-nutritional factors of foods (enzyme inhibitors, trypsin and chymotrypsin inhibitor, amylase inhibitor, flatulence causing oligosaccharids, phytolectins).

UNIT-III

Fats and oils: classification, functions, physico-chemical properties, oxidation of oils and fats, rancidity. Chemistry of emulsifiers, antioxidants, stabilizers and additives used in food industry. Chemical properties and functions of minerals and vitamins. Chemistry of pigments and flavour compounds.

UNIT-IV

Enzymatic and non-enzymatic browning in Foods, reactions of aldehydes and ketones with amino compounds, caramelization, oxidative changes of polyphenols) and their applications in food products. Important chemical changes during storage and cooking of foods, with some suitable examples from cereals, pulses and fruits and vegetables.

Recommended Readings:

1. Wang, D. (2012). *Food Chemistry*: Nova Science Publishers.
2. Chopra, H. K. & Panesar, P. S. (2010). *Food chemistry*: Alpha Science International Ltd, Oxford, U.K.
3. Coultate, T. P. (2009). *Food: The Chemistry of Its Components* (5 ed.): American Chemical Society.
4. Newton, D.E. (2009). *Food Chemistry*: Facts On File, Incorporated.
5. Damodaran, S., Parkin, K. L., & Fennema, O. R. (2007). *Fennema's Food Chemistry*: CRC Press, Taylor and Francis group.

Note for Paper Setters:

Nine questions are to be set by the examiner. Question number one (01) is compulsory and will be based on entire syllabus i.e. all four units. It will contain seven (07) short answer type questions of two (02) marks each. Out of remaining eight questions, a candidate is required to attempt four questions by selecting one from each unit. All questions including compulsory question i.e. question number one shall carry equal marks i.e. fourteen (14) marks each.

Objective

The course provides principles of engineering mechanics applied to food processing operations.

Outcome

The students shall be able to understand the basics of mass and energy conservation, fundamentals of fluid flow dynamics as applied to food processing operations.

UNIT-I

Introduction to food engineering. Material and energy balances- Basic principles, total mass and component mass balance. Material balance calculations involved in dilution, concentration and dehydration. Heat balance calculations. Fluid flow theory and application - Fluid statics and fluid dynamics, mass and energy balances in fluid flow. Newtonian and non-newtonian fluids, streamline and turbulent flow. Fluid flow applications- measurement of pressure and velocity. Liquid transport system. Pipelines and pumps for food processing plants-positive displacement pumps, air-lift pumps, propeller pumps, centrifugal pumps and jet pumps.

UNIT-II

Heat transfer in food processing- Thermal properties of foods, modes of heat transfer, conductive heat transfer in a rectangular slab, tubular pipe, and multilayered systems. Natural and forced convection. Estimation of convective heat transfer coefficient in forced and natural convection. Estimation of overall heat transfer coefficient. Heat exchangers- Plate, tubular, scraped surface, and steam infusion. Thermal process calculation- Commercial sterility concept, Microbial inactivation rates at constant temperature. Effect of temperature on thermal inactivation of microorganisms. Calculation of processing time in continuous flow systems.

UNIT-III

Psychrometrics- Properties of dry air, composition of air, specific volume of air, specific heat of dry air, enthalpy of dry air, dry bulb temperature. Properties of water-vapor- Specific volume, specific heat and enthalpy. Properties of air-vapor mixtures- Gibbs-Dalton law, Dew-point temp, humidity ratio, relative humidity, wet bulb temperature. The psychrometric chart- Use of psychrometric chart to evaluate complex air conditioning processes.

UNIT-IV

Material handling- theory and classification of various material handling equipments. Conveyors (gravity and powered conveyors), elevators (bucket and screw-type elevators), trucks (high lift and pallet trucks), cranes and hoists. Sorting and grading- advantages and methods.

Recommended Readings:

1. Singh, R. P., & Heldman, D. R (2014). *Introduction to Food Engineering* (5th ed.): Academic Press, New Delhi.
2. Saravacos, G. D., & Maroulis, Z. B. (2011). *Food Process Engineering Operations*: CRC Press, Boca raton.
3. Toledo, R.T. (2007). *Fundamentals of Food Process Engineering* (3rd ed.): Springer, New York.
4. Gustavo, V. B-C., & Ibarz, A. (2002). *Unit Operations in Food Engineering*: CRC Press.
5. Lozano, J. E (2000). *Trends in Food Engineering*.

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Objective

To understand the role and significance of microbes of different categories, microbial inactivation and environmental factors that affect them in foods.

Outcome

The student shall be able to understand the principles involving food spoilage and preservation involving microorganisms.

UNIT-I

Introduction to microbiology: Historical developments, Classification – A brief account, basis of classification. Three and five kingdom classification, Prokaryotes and Eucaryotes. Microbial growth and nutrition. Introduction to food microbiology: Classification of microbes, Types of micro-organism normally associated with food- mold, yeast, and bacteria. Contamination of foods- vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing.

UNIT-II

Factors affecting microbial growth: Intrinsic and extrinsic factors, Biochemical changes caused by micro-organisms, deterioration of various types of food product. Microbiology of food preservation, heating process, irradiation, low temperature storage, chemical preservatives, high-pressure processing, control of water activity.

UNIT-III

Fermented and microbial foods: Fermented milk and milk products, fermented fruits and vegetables, fermented meat and fish products, fermented beverages (beer, vinegar and wine), single cell protein.

UNIT-IV

Food microbiology and public health: food poisoning and microbial toxins, types of food poisonings. Bacterial agents of food borne illness. Non-bacterial agents of food borne illness- poisonous algae, fungi and food borne viruses. Microbial standards for different foods. HACCP and food safety, hurdle technology and its applications.

Recommended readings:

1. Frazier, W. C. and Westhoff, D. C. (2015). *Food Microbiology*: Tata McGraw Hill Publication, New Delhi.
2. Adam, M. R. & Moss, M. O. (2008). *Food Microbiology*: Royal Society of Chemistry, Cambridge.
3. James, M. J. (2005). *Modern Food Microbiology* (5th ed.): CBS Publishers, New Delhi.
4. Stanier, R.Y. (1996). *General Microbiology* (5th ed.): MacMillan, Hampshire.
5. Creager, J. G., Black, J. G. & Davison, V. E. (1990). *Microbiology: Principles & Applications*. Prentice Hall, New Jersey.
6. Frazier, W. C. & Westhoff, D. C. (1995). *Food Microbiology* (4th ed.). TMH, New Delhi

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Objective

To impart knowledge on the causes of food spoilage and principles of different techniques used in processing and preservation of foods. To identify and select preservation methods appropriate for specific foods and to learn the effects of preservation methods on the quality of food.

Outcome

Students shall develop the knowledge of need of food processing and learn various preservation techniques.

UNIT-I

Scope and importance of food processing, Historical developments in food processing. Types of foods and causes of food spoilage. Heat preservation and processing: Heat penetration, heat resistance of microorganisms, thermal death curve, types of heat treatments and effects on foods. Canning of foods, cans and container types, spoilage of canned foods.

UNIT-II

Cold preservation and processing: Distinction between refrigeration and freezing. Refrigeration– introduction, components of refrigeration system and changes in food during refrigerated storage. Effect of low temperature on fresh food. Freezing- technological principles of freezing operations, freezing curves, freezing systems and methods, factors determining freezing rate, changes in food during freezing. Freeze drying– conventional drying vs freeze drying, equipments used and effects of freeze drying on food quality.

UNIT-III

Drying, Dehydration and concentration: Sun drying and solar dehydration, drying curves, drying methods and type of dryers. Food concentration- methods of concentration of fruit juices, liquid food concentrates, changes in food during dehydration and concentration. Water activity- role of water activity in food preservation. Intermediate moisture foods (IMF)- principle, characteristics, advantages and problems of IM foods.

UNIT-IV

Food Irradiation: Use of ionization radiations in food preservation, sources, units, effects, limitations, dose determination, safety and wholesomeness of irradiated foods, food irradiation techniques and recent applications of irradiation in food preservation.

Microwave processing: Properties, mechanism of heating, application of microwave in food processing and its effects on nutrients.

Preservatives: Uses and effects of class I and class II preservatives in foods.

Recommended readings:

1. Sivasankar, B. (2014). *Food processing and preservation*: Hall of India Pvt., New Delhi.
2. Fellows, P. J. (2009). *Food processing Technology: Principles and Practice*: Woodhead Publishing.
3. Brennan, J. G. (2006). *Food Processing Handbook*: Weinheim: Wiley-VCH.
4. Zeuthen, P. & Bøgh-Sørensen, L. (2003). *Food Preservation Techniques*: CRC Press, Boca raton.
5. Vonloesecka, H. W. (1998). *Drying and Dehydration of Foods*: Allied, Bikaner.

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Objective

To understand the microbial techniques and to develop skills related to microbial quality evaluation of foods using various techniques.

Outcome

The students shall acquire the practical skills for the sampling of foods and shall be able to carry out microbial analysis.

Introduction to microbiological techniques: Requirements of a microbiology lab, Safety rules to be followed in the lab, Cleaning and sterilization techniques, Preparation of different types of growth media.

Bright field microscopy and examination of living micro-organisms, Direct microscopic count of micro-organisms– use of Neubauer counting chamber. Staining techniques: Simple staining, Gram staining, spore staining and negative staining etc., Culture techniques- aseptic technique, dilution technique. Isolation of bacteria by serial dilution (streak plate), pour plating and spreading, bacterial population count- standard plate count.

Microbiology of food: Microbiological analysis of food products- bacterial count, Yeast and mold count, coliform count, Standard plate count of milk and direct microscopic count of milk, Reductase Test (MBRT). Microbiological testing of water- quantitative test, bacteriological quality testing (MPN).

Objective

To understand the effect of various preservation techniques on the quality and safety of food products.
To design and evaluate a processing procedure used to preserve a food product.

Outcome

The students will be able to understand and utilize different food preservation techniques.

Sampling techniques and preparation of test samples, Estimation of Water activity of food sample. Physical and Chemical evaluation of thermally processed food (Canned or Bottled), Test for adequacy of Blanching, pasteurization and sterilization. In-bottle pasteurization and sterilization of fruit juices, Standardization of the procedure for thawing of frozen food, Pickling and curing of foods, Determination of sodium chloride in brine, Determination of moisture content in fresh and dried food samples, Effect of pH on microbial stability of food, Dehydration of foods and preparation of fruit juice concentrates and powder, Physicochemical analysis of dehydrated food sample, Use of chemical preservatives in food, Estimation of crude fat in pickle samples.

Estimation of amount of preservatives in processed food sample, Determination of total minerals of fruit pulp. Freeze drying of food sample by Lyophilizer. Freezing point determination by freezing point apparatus.

Objective

To impart knowledge about processing of milk and its products and legislation for the quality control of milk and milk products.

Outcome

Students shall acquire knowledge about composition, processing, product development, organization and operations involved in milk processing unit.

UNIT-I

Dairy industry in India: scope, strengths and opportunities for dairy industry.

Definition, composition and nutritive value of milk, Environmental and biological factors affecting composition of milk. Physicochemical properties of milk. Milk lipids: chemical properties, structure, fat destabilization, functional properties. Milk proteins: types, protein precipitation (casein micellar structure and its aggregation). Milk enzymes, enzymatic and acid coagulation of milk.

UNIT-II

Storage and processing of fluid milk: pasteurization, sterilization, homogenization, UHT processing and aseptic packaging. Membrane processing of milk: types of membranes, principle of operation, applications of reverse osmosis, ultrafiltration and microfiltration. Technology of condensed and evaporated milk: composition, nutritive value, process of manufacture, defects - their causes and prevention. Technology of milk powders (WMP, SMP): composition, nutritive value, process of manufacture, defects - their causes and prevention, Instantization of milk powder.

UNIT-III

Technology of Milk products: Cheese- classification, composition, nutritive value, process of manufacture of cheddar, mozzarella, cottage and processed cheese, defects - their causes and prevention. Frozen milk products- composition, nutritive value, process of manufacture, defects (their causes and prevention). Indigenous milk products - dahi, butter, ghee, channa, paneer etc. Utilization of milk industry by-products- importance/need and food applications.

UNIT-IV

Milk and milk products standards and legislations in India, Grading of milk and criterion of grading. Dairy plant sanitation- hygiene in dairy industry, different types of cleansing and sanitizing agents, their applications, cleaning systems (cleaning in place, central cleaning system, self-contained cleaning system). Newer concepts in dairy products- cream powder, sterilized cream, butter spread, butter powder, cheese spread, caseinates, co-precipitates, WPC, lactose powder.

Recommended readings:

1. Sukumar, De. (1980). *Outlines of Dairy Technology*: Oxford University Press, Delhi.
2. Byron, H. W., Arnold, H. J. & John, A. A. (1987). *Fundamentals of Dairy Chemistry* (2nd ed.): CBS, Delhi.
3. Atherton, H. V. & Newlander, J. A. (1987). *Chemistry and Testing of Dairy Products* (4th ed.): CBS, New Delhi.
4. Wong, N. P. (1988). *Fundamentals of Dairy Chemistry* (3rd ed.): VNR, New York.
5. Cheke, V. & Sheppard, A. (1997). *Cheese and Buller*: Allied, Bikaner.

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Objective

To develop knowledge regarding biochemistry and physiology of fruits and vegetables and their role in pre- and post-harvest changes in product quality.

Outcome

The student shall understand biological, chemical and physical properties of fruits and vegetables and the technologies involved in the processing, preservation and value-addition of fruit and vegetable products.

UNIT-I

Current status of fruits and vegetables processing, classification and composition of fruits and vegetables and their nutritional significance. Pre-harvest factors influencing post-harvest physiology, post-harvest handling and precooling methods, post-harvest treatments, edible coatings, cold chain, and commercial cooling systems.

UNIT-II

Physical and chemical indices of fruit maturity, crop maturity and ripening. Biochemical changes during maturation, ripening, processing and storage. Methods of storage: refrigerated, controlled atmosphere and hypobaric storage. Modified atmosphere packaging- role of gases, and influence of MAP on microorganisms, advantages and disadvantages. Pre-processing operations- washing, blanching, peeling, sorting and grading of raw materials. Minimal processing of fruits and vegetables, quality factors for processing, fruit product order (FPO).

UNIT-III

Technology of production of jam, jellies and marmalades, specifications, role of pectin and theories of gel formation. Preparation of fruit juices, concentrates, fruit juice powders, specifications and packaging. Technology of juice extraction and clarification, tomato products, preserved and candied fruits, dehydrated fruits. Spoilage of processed products. Canning of fruits and vegetables, preparation of syrups and brines, can reforming and can seaming.

UNIT-IV

Stages of new product development, by-products from fruit and vegetable wastes, utilization and disposal of fruit industry wastes. Technology of mushroom: production, processing and its processed products. Technology of cashew and coconut: chemical composition, processing and processed products.

Recommended Readings:

1. Jongen, W. (2002). *Fruit and vegetable processing: Improving Quality*: Woodhead Publishing, Boca raton.
2. Thompson, A. K. (1996). *Post-harvest Technology of Fruit and Vegetables*: Blackwell, Australia.
3. Thompson, A. K. (2003). *Fruits and Vegetables- Harvesting, Handling and Storage*: Blackwell, Oxford.
4. Verma, L. R. & Joshi, V. K. (2000). *Post-harvest Technology of Fruits and Vegetables*: Indus, New Delhi.
5. Srivastava, R. P. & Kumar, S. (2001). *Fruit and Vegetable Preservation– Principles and Practices (3 ed.)*: International Book distributing Co., Lucknow (India).

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Objective

The course aims to develop the student's knowledge in packaging of foods.

Outcome

The students shall gain knowledge on the different types of materials and media used for packaging foods, hazards and toxicity associated with packaging materials, laws, regulation and the monitoring agencies involved in food safety.

UNIT-I

Introduction to food packaging: definition, factors involved in the evolution and selection of a food package, functions of food packaging. Paper and paper based packaging materials: types of paper (Kraft, bleached, greaseproof, glassine), paper products (paper bags, cartons, drums and moulded paper containers), and functional properties of paper. Testing of paper packaging materials. Plastic packaging materials: classification of polymers. Thermoplastic polymers- functional and mechanical properties, processing and conversion of thermoplastic polymers (extrusion, blow moulding, injection moulding, compression moulding, lamination and heat sealing). Testing of plastic packages.

UNIT-II

Metal packaging materials: container making processes (end manufacture, three-piece can manufacture and protective and decorative coatings), functional properties of metal containers and quality control tests of tin plate containers. Glass packaging materials: composition, manufacturing and nomenclature of glass containers. Glass containers- closure functions, closure terminology and construction. Properties of glass containers- mechanical, thermal and optical properties. Testing of glass containers.

UNIT-III

Aseptic packaging of foods: sterilization of packaging material, food contact surfaces and aseptic packaging systems. Active food packaging: definition, scope, physical and chemical principles. Edible films and coatings: use of edible active layers to control water vapour transfer and gas exchange, modification of surface conditions with edible active layers. Oxygen absorbents: classification and types of oxygen absorbents, factors influencing the choice of oxygen absorbents, application of oxygen absorbents for shelf-life extension of food and their advantages and disadvantages.

UNIT-IV

Ethanol vapour: ethanol vapour generator, uses of ethicap for shelf-life extension of food, effect of ethanol vapour on food spoilage/food poisoning bacteria, advantages and disadvantages of ethanol vapour generators. Safety considerations in food packaging: types of food safety problems associated with package, package labelling and food safety.

Packaging requirements of selected foods: cereal and snack food, beverages, milk and dairy products, poultry and eggs, red meat, frozen foods, horticultural products and microwavable foods.

Recommended readings:

1. Rooney, M.L. (1995). *Active Food Packaging*: Blackie Academic & Professional, Glasgow, UK.
2. Coles, R. & Kirwan, M. (2011). *Food and Beverage Packaging Technology* (2nd ed.): Wiley-Blackwell, UK.
3. Eiri Board of Consultants. (2007). *Food Packaging Technology*: Engineers India Research Institute, New Delhi.
4. Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2nd ed.): CRC Press, Boca raton.
5. Piringer, O. P. & Baner, A. L. (2000). *Plastic Packaging Materials for Food*: Wiley-VCH, Weinheim.

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Objective

Imparting knowledge about the general methods of quality evaluation, testing and processing fresh milk and milk products.

Outcome

The students shall be able to assess the quality of milk and milk products and to develop various milk products.

Sampling of milk and milk products, Platform tests of milk: Organoleptic test, Sediment test, COB test, Alcohol test, Alcohol-Alizarin test, Titratable acidity and pH milk.

Determination of specific gravity of milk, total solids and solid-not-fat using lactometer, Detection of milk adulterant- added water, starch, cane sugar, neutralizers and preservatives (formalin and hydrogen peroxide), synthetic milk (urea test, detergent test, common salt), Alkaline phosphatase test to determine adequacy of pasteurization.

Estimation of casein in milk, lactose, chlorides, Reichert-Meissel number and Polensky value, Moisture in butter (Dean and Stark distillation), Colouring matter in butter, Curd and salt in butter, Peroxide value, Iodine value of ghee, Acid value of ghee, Saponification value of ghee, Fat and total solids in cream.

Development of some indigenous dairy products- Standardization and preparation of khoa/ice cream/ rasogulla.

Objective

To equip students with skills required for preparation and evaluation of jam, jelly, marmalade, pickles, sauces and preserves.

Outcome

The students shall be able to assess the quality of fruit and vegetables and shall be able to develop various fruit and vegetable products.

Determination of maturity indices for fruits. Colour measurement of fruits and vegetables/products by disc colorimetry/tintometer.

Preparation of jam, cheese, preserved and candy, jelly and testing of jelly grade. Preparation of fruit juice products, Squash, Nectar/cordial, fruit bar, murabba, tomato puree, paste, sauce. Enzyme extraction and clarification of fruit pulp/juice. Dehydration of fruits, thermal processing of fruits/fruit products. Adequacy of pasteurization/sterilization/blanching.

Proximate analysis of fruits and their products- Estimation of TSS, moisture, total solids, titratable acidity, ascorbic acid, total and reducing sugars, non-enzymatic browning, pectin, total polyphenolic compounds, tannin, total carotenoids. Determination of enzymatic activity in ripe fruit sample. Estimation of minerals in fruits by spectrophotometry, flame photometry/AAS.

Objective

The course aims to develop the practical knowledge of testing of package, package material and packaging of foods.

Outcome

The students shall acquire knowledge of package identification, suitability, application and their quality evaluation.

Identification and testing of packaging materials, Determination of wax from wax paper; Testing of lacquered tin plate sheets; Determination of equilibrium moisture content; Determination of water vapour transmission rate of packaging material; Determination of Gas transmission rate of packaging material; Determination of COB value of Paper and CFB, Determination of Burst strength, Testing the compression strength of the boxes; Scuf Proff ness Test, To perform vacuum packaging of food sample and carry out its storage study; Packaging the food material in seal and shrink packaging machine and study its shelf life; Testing the strength of glass containers by thermal shock test; Testing the strength of filled pouches by drop tester, Head Space Gas Analysis Laboratory/ Practical. Preparation sorption isotherm curve and estimation of shelf life various packaged foods.

Objective

Acquaintance with importance of food fermentation and its application in food sector.

Outcome

Student shall be capable to understand working principle underlying fermentation and to optimize the parameters for fermentation.

UNIT-I

Overview of fermentation: fermentation as an ancient art, modern era of fermentation technology. Biology of industrial micro-organisms- isolation, screening and genetic improvement of industrially important micro-organisms.

UNIT-II

Fermentation systems: batch and continuous systems, fed-batch culture, feedback systems, fermenter design, solid substrate fermentation, Instrumentation and control. Fermentation raw materials- criteria used in media formulation, influence of medium, raw materials for process control.

UNIT-III

Downstream processing: objectives, steps, problems, separation processes. Microbial production of various primary and secondary metabolites- alcohol, amino-acids, organic acids (citric acid and acetic acid), enzymes, antibiotics (penicillin, cephalosporin). Principles of overproduction of metabolites.

UNIT-IV

Biomass production: microbial production of single cell protein, Baker's yeast. Immobilized enzyme technology- methods of immobilization and applications. Membrane technology- methods and applications in bioprocessing. Waste treatment- introduction, waste treatment systems, microbial inoculants and enzymes for waste treatments.

Recommended readings:

1. Crueger, W. & Crueger, A. (2000). *Biotechnology: A Textbook of Industrial Microbiology* (2nd ed.): Panima, New Delhi.
2. Rehm, H. J., Red, G. (1993). *Biotechnology: A Multi Volume Comprehensive Treatise* (2nd ed.): VCH, New York.
3. Stansbury, P. F., Whitakar, A. and Hall, S. J. (1997). *Principles of Fermentation Technology* (2nd ed.): Pergamen Press, Oxford.
4. Reed, G. (1987). *Prescott & Dunn's Industrial Microbiology* (4th ed.): CBS, New Delhi.
5. Mansi, E. M. T. E. L. & Bryce, C. F. A. (1999). *Fermentation Microbiology and Biotechnology*: Taylor and Francis, London.

Note for Paper Setters:

Nine questions are to be set by the examiner. Question number one (01) is compulsory and will be based on entire syllabus i.e. all four units. It will contain seven (07) short answer type questions of two (02) marks each. Out of remaining eight questions, a candidate is required to attempt four questions by selecting one from each unit. All questions including compulsory question i.e. question number one shall carry equal marks i.e. fourteen (14) marks each.

Objective

To provide an understanding of the science and technology for processing different types of beverages.

Outcome

Students shall have thorough knowledge of processing of fruit juice beverages, carbonated beverages, citrus beverages, tea and coffee.

UNIT-I

Beverages, importance of beverages in our diet, treatment of water for food industry. Technology of alcoholic and non-alcoholic beverages- wine, cider, brandy, perry, toddy. Fruit juice beverages- methods of production, preservation and packaging, physiological aspects of fruit juice production and methods of fruit juice clarification.

UNIT-II

Technology of soft drinks, mineral water, ingredients, and additives used in production of soft drinks. Manufacturing of carbonated and non-carbonated beverages, technology of carbonation, and application of CO₂ in juice preservation.

UNIT-III

Citrus beverages, whey beverages and utilization of whey in development of fortified drinks, use of low calorie sweeteners in beverages.

Equipments and machineries for juice pressing, methods of bottling, enzymatic clarification and debittering of juices. Fruit juice beverages, squash, cordial, crush, RTS, nectar, syrups, their types and production, blending of juices.

UNIT-IV

Production, processing and chemistry of tea manufacturing, tea products such as soluble tea, tea concentrate, de-caffeinated and flavoured tea. Production, processing, roasting and brewing of coffee, soluble coffee manufacture, standards and specifications of coffee products, de-caffeinated coffee, and coffee brew concentrate and chicory. Cocoa processing and cocoa beverages.

Recommended Readings:

1. Rao, L. J. M. & Ramalakshmi, K. (2011). *Recent trends in soft beverages*: AFST, India.
2. Priest, F. G. & Campbell, I. (1996). *Brewing Microbiology* (2nd ed.): Chapman and Hall, London.
3. Hui, Y. H. (2004). *Handbook of Food and Beverage Fermentation Technology*: Marcel Dekker, New York.
4. Varnam, A. H. & Sutherland, J. P. (1994). *Beverages: Technology, Chemistry and Microbiology*: Chapman, London.
5. Varnam, A. H. & Sutherland, J. P. (2009). *Beverages Technology, Chemistry and Microbiology*: Springer, UK.

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Objective

To educate students about industrial production of fermented foods and their analytical techniques.

Outcome

Student shall be well versed in methods for the production of fermented products and their quality assessment.

Isolation of yeast from natural sources, lactic acid bacteria from different sources, amylase/lipase/protease production from soil/samples. Production of industrial alcohol, Grape wine (Red wine/ white wine), lactic acid, Yoghurt, Acidophilus milk, Sauerkraut. Analytical assays in fermentation: Estimation of ethanol, lactic acid, total acids. Determination of cell mass. Analysis of COD in Distillery/Food industry effluent sample. Estimation of Hardness of water/ Bottled water/Potable water samples. Evaluation of antimicrobial activity/ efficacy of various sanitizers/ Disinfectants and preservatives.

Objective

To educate students various laboratory techniques for analysing and measuring the important physicochemical parameters of beverages.

Outcome

Student shall be able to assess various quality parameters of beverages.

Determination of water quality parameters for beverages, preservation and packaging of alcoholic and non-alcoholic beverages, determination of quality parameters for alcoholic and non-alcoholic beverages, standardization of method for fruit juice extraction and clarification, enzymatic clarification, process optimization of fruit juice beverages, effect of carbonation on shelf life of fruit beverages, extraction and debittering of citrus juice, evaluation of quality testing parameters of wines, chemical and sensory quality analysis of soft drink, preparation of whey based beverages.

Decaffeination and sensory evaluation of coffee beverages: Process optimization and sensory evaluation of cocoa beverages, Determination of brewing quality parameters of tea and coffee.

Objective

To create knowledge about the processing and quality evaluation of cereal grains.

Outcome

Student will acquire the understanding of the technologies used for processing of cereal grains.

UNIT-I

Current status and future scenario of world wheat production and uses. Criteria of wheat quality—physical and chemical. Chemical composition of wheat grain and its relation to processing quality. Molecular basis of wheat grain hardness/softness. Wheat milling – general principle, cleaning, conditioning and milling systems. Flour streams, extraction rates and their composition. Criteria of flour quality. Functionality of wheat proteins, carbohydrates and lipids in bakery products. Manufacturing techniques, uses and functionality of vital wheat gluten. Enzymes of wheat and their technological significance.

UNIT-II

Dough rheology and dough testing apparatus such as recording dough mixers. Bread making processes, importance of critical unit operations, development in bread making methods, functions of ingredients/additives such as fat, emulsifiers, oxidants, reducing agents, conditioners. Bread faults and remedies. Technology of biscuit, cake, cookie and cracker manufacture. Functions of ingredients in soft wheat products. Durum wheat- chemistry, quality and technology of pasta products.

UNIT-III

Rice grain structure and chemical composition. Milling of rice- types of rice mill (huller mill, sheller-cum-huller mill, sheller-cum-cone polisher mill, small capacity rice mill). Modern rice milling unit operations – dehusking, paddy separation, polishing and grading. Factors affecting rice yield during milling. Control and assessment of degree of milling. By- products of rice milling and their utilization. Cooking quality of rice. Parboiling of rice- traditional methods and their drawbacks. CFTRI process of parboiling. Properties of parboiled rice. Changes during parboiling. Advantages and disadvantages of parboiling. Rice convenience foods- precooked rice, canned rice, expanded rice, rice based infant food formulas, rice puddings and breads, rice cakes, rice noodles and fermented foods.

UNIT-IV

Chemical, technological and nutritional aspects of sorghum, oats and millets. Coarse grain based processed foods. Wet and dry milling of corn. Corn products and their uses. Malting of barley- steeping, germination and drying. Classification of malt products, nutritive value and food applications of malt. Pulses: composition and importance in Indian diet. Dal milling and processing of pulses. Oilseeds: Conditioning and oil extraction, significance of oil seeds processing in India, expeller pressing and solvent extraction of oil, oil refining, preparation of protein concentrate, isolates and their use in high protein foods.

Recommended readings:

1. Khatkar, B.S. (2010). *Baking Science and Technology*. Arihant Prakashan Pvt Ltd., New Delhi.
2. Samuel, A.M. (2014). *The Chemistry and Technology of Cereals as Food and Feed*: CBS Publication, New Delhi.
3. Khan, K. & Shewry, P. R. (2009). *Wheat: Chemistry and Technology*: St. Paul, U.S.A.
4. Champagne, E.T. (2004). *Rice: Chemistry and Technology*(3rd ed.): AACC, USA.
5. Dendy, D. A. V. & Dobraszczyk, B. J. (2001). *Cereals and Cereal Products: Chemistry and Technology*: Aspen, Maryland.
6. Pomeranz, Y. (1998). *Wheat: Chemistry and Technology* (3rded.): AACC, USA.

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Objective

To create understanding of quality control and assurance, risk assessments, GMPs, and regulations in the food sector.

Outcome

Student shall be well versed in aspects of food safety, safety management systems, standards and quality control.

UNIT-I

Definition, objectives and scope of food standards and quality assurance, including role of various national and international agencies. Total quality management– general awareness and role of management practices in quality control, concept of HACCP and ISO series and their importance. Plant/food industry sanitation, maintenance sanitary conditions and hygienic practices.

UNIT-II

Food adulteration, nature of adulterants, methods of evaluation of food adulterants and toxic constituents. Food inspection and safety measurements, food regulations and grades. Statistical analysis in quality control-sampling design of experiments and evaluation of results.

UNIT-III

Methods of sensory evaluation, introduction to sensory analysis. Sensory evaluation techniques for fresh fruits and vegetable procured products. Food testing– hedonic test, general acceptability tests and other desirable ranking tests of sensory evaluation of flavour, aroma, taste, texture, and overall acceptability of food products.

UNIT-IV

Various food standards and their regulating agencies. Methods of quality analysis: Moisture, proteins, carbohydrates, minerals, vitamins, fats, crude fibres and related substances. Raw material and finished products quality assurance– cereals, legumes, oil seeds, fruits and vegetables, laboratory methods for quality control.

Recommended readings:

1. Singh, S. P. (2009). *Food Safety, Quality Assurance and Global Trade: Concerns and Strategies*: International Book Distributing Co. Lucknow.
2. Metha, R. & George, J. (2005). *Food Safety regulation concerns and trade: A Developing Country Perspective*.
3. Pomeranz, Y. & Meloan, R. (1995). *Food Analysis: Theory and Practice*: AVI Publication, New York.
4. Askar, A. & Treptow, H. (1993). *Quality assurance in Tropical Fruit Processing*.
5. Mahindru, S. N. (2000). *Food Safety: A Techno-legal Analysis*: Tata Mc, India.

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Objective

To impart knowledge related to market types, the procurement, marketing and management of raw and processed agricultural produce meant for human consumption.

Outcome

Students shall be able to understand the basic concepts of marketing of food items.

UNIT-I

Introduction, definition, history, objectives, importance with respect to Indian economy and globalization. Agricultural and food policy, rural management. Management of agri-business. New product development: introduction, development and value analysis.

UNIT-II

Entrepreneurship Development Programs (EDP): introduction, importance, characteristics and functions of an entrepreneur, SWOT analysis of new industries and products. Government schemes and incentives for promotion of entrepreneurship. Financing and risk management in agri-business.

UNIT-III

Marketing management: role of management in agri-business, attributes and responsibility of manager. Marketing of agricultural produce. Market research for agri-business. Different types of management in agri-business: production, retail and supply chain and inventory management (introduction, need, attributes and function).

UNIT-IV

World trade agreements related with food business, export and prospects of food products in India. Consumer behaviour towards food consumption, consumer surveys by various institutes and agencies.

Recommended readings:

1. Kotler (1994). *Marketing Management*: Prentice Hall of India, New Delhi.
2. Baker, G. A., Grunewald, O. & Gorman, W. D. (2002). *Introduction to food and agribusiness management*: Prentice Hall of India, New Delhi.
3. Khanks, S. S. (1999). *Entrepreneurial Development*: Chand and company, New Delhi.
4. Jakobsen, G. & Torp, J. E. (2001). *Understanding business systems in developing countries*.
5. Ahmad, S. M. (2000). *Management Info Guide*.

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FT-520 LAB – VIII (TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS) 0+0+4

Objective

To familiarize the students with quality tests of wheat flour and yeast with reference to bread processing and to equip them with the necessary skills for bread, biscuits and cookies processing.

Outcome

Student shall be well versed with processing techniques of cereals and estimation of their quality parameters.

Estimation of different physicochemical characteristics of cereals grains. Milling quality evaluation of wheat grains. Functional quality test of wheat flour- wet & dry gluten content, SDS sedimentation maltose value, Falling number values of wheat flour, dough raising capacity of yeast.

Rheological tests of wheat flour- viscoamylographic characteristics, farinographic characteristics, extensographic characteristics, effect of different oxidizing & reducing agents on the farinographic & extensographic characteristics.

Test baking of bread, biscuits and cake, Milling of rice, effect of parboiling treatment on the milling quality of rice, Effect of degree of polishing on the milling quality of rice.

Objective

To impart knowledge about additives in food processing, types of food additives, chemical nature, their analysis and risk and benefits.

Outcome

Student shall gain a thorough knowledge of natural and synthetic food additives and their properties in food.

UNIT-I

General classification, types, uses, functions, legal aspects, risks and benefits. Preservatives-antimicrobial agents (types, mode of action and their application). Antioxidants (types and mechanism of oxidation inhibition). Anti-browning agents (types, functions and mode of action).

UNIT-II

Coloring Agents: synthetic food colorants, color chemistry, application and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), misbranded colors, color extraction techniques.

Flavoring agents: sweeteners (nutritive and non-nutritive), flavors (natural and synthetic flavors), off-flavor in foods, flavor enhancers, flavor stabilization. flavor encapsulation.

UNIT-III

Emulsifiers: types, selection of emulsifiers, emulsion stability, functions and mechanism of emulsifiers. Stabilizers: types, uses and functions.

Chelating agents and sequestrants: types, uses and mechanism.

Acidulents and pH control agents: types, uses and mode of action.

UNIT-IV

Nutritional additives: types and uses, Spices and condiments- chemical composition, uses and special attributes of important Indian spices, seasoning blends, extraction of spices, general processing of spices.

Recommended readings:

1. Emerton, V. & Choi, E. (2008). *Essential Guide to Food Additives* (3rd ed.): RSCP, UK.
2. Ashurst, P. R. (1995). *Food Flavorings* (2nd ed.): Chapman and Hall, Glasgow.
3. Crompton, T. R. (2007). *Additive Migration from Plastics into Foods: A Guide for Analytical Chemistry*: Smithers Rapra, Shawbury.
4. Brannel, A. L., Davidson, P. M. & Salminen, S. (1990). *Food Additives*: Marcel Dekker, New York.
5. Hirasa, K. & Takemasa, M. (1998). *Spice Science and Technology*: Marcel Dekker, New York.

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Objective

To understand the importance of various nutrients and effects of imbalance in human health.

Outcome

Student shall be able to understand the role of various nutrients, their utilisation, deficiency diseases and metabolic disorders.

UNIT-I

Foods and nutrients-basic definitions, functions of food and nutrients, levels of nutritional status, changing concepts of nutrition. Major world health problems- food supply and security, malnutrition, heart diseases, cancer, diabetes etc. Recommended dietary allowances (R.D.A.), ICMR standards, food guide, exchange lists, health promotion guidelines.

UNIT-II

Carbohydrates: classification, dietary importance, special functions of carbohydrates in body tissues, relationship between dietary fiber and various health problems. Fats- health needs of fat, health problems with fat, essential fatty acids, visible and hidden food fat, cholesterol, lipoproteins. Energy balance-food energy measure, energy control in human metabolism, basal metabolic rate (B.M.R.), factors affecting B.M.R., measuring B.M.R., energy requirements and its estimation.

UNIT-III

Proteins: nature and essentiality of amino-acids and proteins, functions of protein, concept of protein balance, factors influencing protein requirements, comparative quality of food proteins, biological value, net protein utilization, protein efficiency ratio, other methods of evaluation of protein quality. Vitamins-definition, general nature and classification, clinical applications, sources, requirements and functions of Vitamin A, D, E, K, C and B complex vitamins. Vitamin toxicity. Minerals: minerals in human health, functions, clinical applications, food sources and requirements, trace elements and their importance in diet.

UNIT-IV

Psychologic influences on food habits-motivation, perception, food misinformation, food faddist claims, vulnerable groups. Drug food interactions-drug effects on food intake, drug effects on nutrient absorption, vitamin antagonists. Nutrition and weight management- obesity and its causes, body composition, B.M.I., weight for height measures, health implications of obesity, and problems of weight management.

Recommended readings:

1. ICMR. (2011). *Nutrient Requirement & RDA*: ICMR, New Delhi.
2. Elia, M., Ljungqvist, O. & Stratton, R., J. (2013). *Clinical Nutrition*.
3. Hegarty, V. (1992). *Nutrition Food and the Environment*: Eagen Press.
4. Brian, A. F. & Allen, G. (1995). *Food Science, Nutrition & Health*: Edward Arnold, member of Hodder Headline Group London, Sydney, Auckland.
5. Macrae, R., Robinson, R. K. & Sadler, M.J. (1993). *Encyclopedia of Food science, Food technology and Nutrition*.
6. Williams, S. R. (1990). *Essentials of Nutrition and Diet Therapy*: Times Mirror / Mosby College Publishing.

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FT-523

LAB - IX (Food Additives)

0+0+4

Objectives

To acquaint students to the methods of determination of additives in food system.

Outcome

Student shall be able to acquire the techniques of analysis of food additives.

Determination of benzoic acid in the presence of saccharin in the Ready-to Serve beverages, estimation of nitrate and nitrite, aspartame, saccharine and caffeine, identification of natural colours, isolation and estimation of synthetic food colours, oil soluble colours, antioxidants, detection of brominated vegetable oils in soft drinks, magnesium carbonate in pan masala / gutka, food applications of emulsifiers, stabilizers, thickeners, favours and flavour enhancers.

Objectives

To train students in nutrient analysis and basics of meal planning.

Outcome

Student shall be able to understand as well as conduct nutritional quality evaluation of foods and shall have sufficient knowledge of health diet

Proximate analysis of foods– Moisture, protein, ether extract, fiber, starch, soluble sugars, ash content. Calorific value of foods using Bomb Calorimeter, Protein analysis by Spectrophotometric method, Protein quality evaluation (Protein digestibility *in vitro*), Starch digestibility (*in vitro*), Amylase inhibitor activity, Trypsin inhibitor activity, Estimation of polyphenols/tannins, phytic acid, calcium, phosphorus, iron content, Phytase activity determination in pulses, Mineral analysis using Atomic Absorption Spectrophotometer, Assessment of effect of processing method (e.g. Frying / Microwave cooking / Germination on nutritive value of foods. Nutritional assessment and dietary adequacy in terms of various nutrients. Planning a diet using “Food Composition Tables” (ICMR). Diet planning using “Food Exchange” method. Standardization of nutritious snacks (Protein rich / Energy rich / Low calorie / Calcium rich / Iron rich / Vitamin rich), nutritious snacks for specific physiological needs (Infant weaning / Pre-schooler / School children/ Old people).

Objective

To impart knowledge related to various snack foods and their manufacturing techniques.

Outcome

Students shall be able to understand various technological aspects of traditional and modern snack foods.

UNIT-I

Extrusion: Introduction to extruders and their principles, types of extruders. Extruders in the food industry: History and uses. Single screw extruder: principle of working, factors affecting extrusion process, co-kneaders. Twin screw extruder: Feeding, screw design, screw speed, screw configurations. Pre-conditioning of raw materials used in extrusion process: operations and benefits and devolatilization. Chemical and nutritional changes in food during extrusion. Addition and subtraction of materials, shaping and forming at the die. Post-extrusion processes- colouring, flavouring and packaging of extruded snack foods.

UNIT-II

Breakfast cereals: Introduction and classification (flaked cereals, oven puffed cereals, gun puffed cereals, shredded products). Breakfast cereal-manufacturing processes (traditional and modern methods), High shear cooking process and steam cookers. Texturized vegetable protein: definition, processing techniques. Direct expanded (DX) and third generation (3G) snacks: types. Concept of junk & fried foods and their impact on human health.

UNIT-III

Technology for grain-based snacks: Whole grains- roasted, toasted, puffed, popped, flaked. Coated grains- salted, spiced and sweetened. Formulation, processing and quality assessment of chips and wafers, papads, instant premixes of traditional Indian snack foods.

UNIT-IV

Technology for fruit and vegetable-based snacks- chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkies. Equipments for frying, baking, drying, toasting, roasting, flaking, popping, blending, coating and chipping.

Recommended Readings:

1. Booth, R. G. (1997). *Snack Food*: CBS, New Delhi.
2. Raymond, W. L. & Rooney, L. W. (2001). *Snack Foods Processing*: CRC. London.
3. Lusas, E. W. & Rooney, L. W. (2015). *Snack Foods Processing*: CRC. London.
4. Guy, R. (2001). *Extrusion Cooking: Technologies and Applications*: Woodhead, USA.
5. Riaz, M. N. (2000). *Extruders in Food Applications*: Technomic, Lanchester.

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Objective

Imparting knowledge about principles of genetic engineering, use of biotechnology in the production of modified foods, enzymes, vitamins and proteins.

Outcome

Student will acquire knowledge about genetic improvement of microorganisms for production of metabolites which can be used in field of food technology.

UNIT-I

Introduction to food biotechnology, basic principles of gene cloning, food safety and biotechnology. Impact of Biotechnology on microbial testing of foods. Immunological methods, DNA based methods in food authentication, real time PCR (polymeric chain reaction) based methods.

UNIT-II

Transgenic plants- current status, methods, prospects, risks and regulation. Transgenic Animals- methods and applications, ethical issues.

UNIT-III

Natural control of micro-organisms– bacteriocins of lactic acid bacteria, applications of bacteriocins in food systems. Aflatoxins– production, control and reduction using molecular strategies. Protein engineering in food technology– methods, objectives, limitations and applications of protein engineering (glucoseisomerase, lactobacillus β -galactosidase and peptide antibiotic nisin).

UNIT-IV

Biotechnology and food ingredients – biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, bioflavours and biocolors. Biosensors- principle, types and applications in food processing.

Recommended readings:

1. Joshi, V. K. & Pandey, A. (1999). *Biotechnology- Food Fermentation Microbiology, Biochemistry and Technology*: EPD, New Delhi.
2. Gutierrez, G. F. & Barbosa-Canovas, G. V. (2003). *Food Science and Food Biotechnology*: CRC Press, Boca raton.
3. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*: Oxford & IBH, New Delhi.
4. Chawla, H. S. (1998). *Biotechnology in Crop Improvement*: International, Lucknow.
5. Saha, B. C. (2003). *Fermentation Biotechnology*: ACS, Washington.

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Objective

This course shall educate students about the significance and necessity of organized animal products sector, humane slaughtering of animals and poultry and value addition of meat, poultry, egg and fish.

Outcome

Students shall be well versed of all aspects of meat, poultry, egg and fish industry, processing, preservation and quality control.

UNIT-I

Status and scope of meat industry. Traditional and scientific methods of slaughter of meat animals and birds, humane methods of slaughter. Structure, composition and nutritive value of meat. Conversion of muscle into meat. Factors affecting meat quality. Post-mortem changes in meat, thaw rigor, cold shortening, pre-rigor processing.

UNIT-II

Storage and preservation of meat, fish and poultry: chilling, freezing, curing, smoking, dehydration, freeze drying, irradiation, canning and glazing of fish. Eating quality of meat- color, flavor, tenderness, juiciness, water holding capacity, warmed over flavour in meats. Restructured meat products- sausages and comminuted meat products, ingredients used and their significance. Meat tenderization techniques. Ageing of meat.

UNIT-III

Quality of fresh fish. Processing of fish. Manufacturing of fish paste, fish sauces, fish oil, fish protein concentrate.

Structure, composition and nutritive value of eggs. Storage and preservation of shell eggs. Functional properties of eggs, factors affecting functional properties, mechanism and measurement.

UNIT-IV

Quality of eggs- internal and external quality evaluation, candling, albumen index, haugh unit, shape index, yolk index etc. Grading of eggs. Pasteurization, dehydration, freezing and desugering of egg. Liquid egg products, egg powder, value added egg products (e.g., meringues, poached etc.). Packaging of egg and egg products.

Utilization of meat, fish and egg industry by-products: importance, food and non-food applications.

Recommended Readings:

1. Varnam, A. H. & Sutherland, J. P. (1995). *Meat and Meat Products: Technology, Chemistry and Microbiology*: Chapman & Hill, London.
2. Lawrie, R. A. (1998). *Lawrie's Meat Science* (6th ed.): Woodhead, Cambridge.
3. Kerry, J., Kerry, J. & Ledward, D. (2002). *Meat Processing Improving Quality*: CRC Press, USA.
4. Hui, Y. H. (2010). *Handbook of Poultry Science and Technology*:
5. Fernandes, R. (2009). *Fish and Seafood*.

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