

CH. CHARAN SINGH UNIVERSITY, MEERUT

चौ० चरण सिंह विश्वविद्यालय, मेरठ

Department of Food Science & Technology

Ref. No.

CCSU/FST/393

Date: 01-04-2022

SYLLABUS

M. Sc. Ag. Food Science & Technology

Program Specific Outcomes

Food scientists and technologists are versatile, interdisciplinary, and collaborative practitioners in a profession at the crossroads of scientific and technological developments. As the food system has drastically changed, from one centered around family food production on individual farms and home food preservation to the modern system of today, most people are not connected to their food nor are they familiar with agricultural production and food manufacturing designed for better food safety and quality. The Post Graduate (Degree) Department of Food Science and Technology, endeavors to develop professionals skilled at advancing the science of food. The objectives of M.Sc. (Food Technology) are:

- *Provide students with theoretical knowledge and practical abilities required to work in the food industry, research centers, and food-related national and international organizations*
- *Contribute to a healthier population by imparting education and understanding of nutritional science*
- *Develop confident and competent individuals, able to adapt to the changing fabric of society through their professional expertise and personal traits*

The Program equips students for higher research leading to a Ph.D. Degree or to setting up an enterprise of their own, or for employment in Research Institutes, in teaching, and in Industry.



SYLLABUS

Proposed revised courses curriculum of M. Sc. Ag. Food Science & Technology

The M. Sc. Ag. Food Science & Technology is a full time four semester degree spread in four semester (Two Year). Following is the division of courses:

Course Type	Name of Course	Course Code	Credits L+P+T	Maximum Marks			
				Int.	Ext.	Prac.*	Total
SEMESTER I							
Theory courses	Food Chemistry		4+1+0	50	50		100
	Food Microbiology		4+1+0	50	50		100
	Statistical Methods and computer application		4+1+0	50	50		100
Practical-I	Practical based on above courses			75	75		150
	Total		15				450
SEMESTER II							
Theory courses	Principle of food analysis and sensory evaluation		4+1+0	50	50		100
	Technology of cereals and pulses and oilseeds		4+1+0	50	50		100
	Principles of Food processing		4+1+0	50	50		100
Practical-II	Practical based on above courses			75	75		150
	Total		15				450
SEMESTER III							
Theory courses	Food Beverages		4+1+0	50	50		100
	Technology of fruits and vegetables		4+1+0	50	50		100
	Principles of food engineering		4+1+0	50	50		100
Practical-III	Practical based on above courses			75	75		150
	Total		15				450
SEMESTER IV							
Theory Courses	Techniques of milk and milk products		4+1+0	50	50		100
	Food Biotechnology		4+1+0	50	50		100
	Food Additives and packaging		4+1+0	50	50		100
Practical-IV	Practical based on above courses			75	75		150
Project report	Based on Industry / Institution/ organization training		0+20+0				100
			25				550
	Total		80				1900

Note: Each theory paper will carry average 50 marks (50 + 50) marks of internal and external evaluation), Practical course 75 marks and the project of 100 marks.



Semester I

Course Objectives –

1. To acquaint students with the chemical constituents of food, their interactions during cooking, quantitative and qualitative evaluation of important compounds, and the taste characteristics of food.
2. To familiarize students with the classification of foods and nutrients, and their function and metabolism in the human body
3. To understand the basic techniques used in isolation and separation of different molecules.

L+T+P : **4+1+0**Credits: : **5**Contact hours : **50**Exam duration : **3 h**IAE : **50**ETE : **50**PRE : **0**Max Marks : **100**

Unit 1	Biochemical basis of life and need for the biochemical approach. Water: Structure, chemical properties, reactions and functions, concept of water activity.
Unit 2	Carbohydrates: Structure, classification, properties and nutritive aspects, sugars, starch, cellulose, hemicellulose, gums, pectin substances, polysaccharides.
Unit 3	Structure of proteins and Nucleic acids: Structure, classification, function, properties and nutritive aspects; purification and protein denaturation, changes in milk and muscle protein during processing.
Unit 4	Enzymes and their mechanism of action; Classification and properties of food enzymes, factors affecting enzyme activity, uses of enzymes in food industry; Enzymatic and non-enzymatic browning and its significance and use.
Unit 5	Lipids and fatty acids: Structure, classification, function, properties and nutritive aspects processing; of oil seeds including extraction, refining effect of food quality; hydrogenation and winterization of oil, auto-oxidation of lipids, different groups of fats and oils.
Unit 6	Minerals and vitamins: Structure, classification, function, properties and nutritive aspects. Fiber: Classification and importance in human diet; source of fiber. Food and energy: PEV and GEV of food constituents, Bomb calorimeter and its functioning.
Unit 7	Introduction to secondary metabolites: Alkaloids, vitamins, pigments (plant and animal); hormones : their structure and function.
Unit 8	Basic idea on techniques of absorption, spectroscopy, fluorescence spectroscopy, polarimetry, electron microscopy, NMR and X-ray scattering, X-ray crystallography, patch clamp technique, chromatography, electrophoresis (Agarose, PAGE and PFGE), centrifugation and tracer techniques.

Learning Outcomes -

1. The student will be able to relate the metabolic pathways of macronutrients to function in the body
2. The student will gain an understanding of macro- and micronutrient sources and functions in the human body.
3. The students will familiar with different techniques used for isolation and separation of different molecules.

Reference Books:

1. Harper. (2005). Bio -Chemistry C.B.S., Publication, Delhi.
2. Lubert Stryer. (2002). Bio -Chemistry Academic Press, Delhi.
3. Wilson & Walker (2000). Practical Bio –Chemistry- principles & techniques.
4. Fennema M. Dekk (2001). Food Chemistry. Oxford University Press.

Course Objectives –

1. To acquaint the students with different groups of microorganisms associated with food, their activities, destruction and detection in food
2. To familiarize the students with industrial standards concerning safe food production and the existent national and international systems that ensure food quality

L+T+P : 4+1+0

IAE : 50

Credits : 5

ETE : 50

Contact hours : 50

Unit 1	Microbes: Definition & classification, isolation and identification of microorganisms, sources of microbes and their characteristics. Morphological & physiological characteristics of different groups of bacteria, fungi and yeast. Elementary knowledge of genetics of bacteria and virus. Microbial growth. Control of microorganism by physical, chemical or other agents (sterilization).
Unit 2	Fermentation and fermentable microbes: History and design of fermentors; types of fermentor; application in fermentation; batch, fed batch, continuous cultures of microbes. Production of alcoholic beverages. Fermentation. with reference to Lactose metabolism; Citrate fermentation Growth and growth curve of bacteria; properties, reproduction, physiological characteristics of fungi, mold, yeast, lactic acid bacteria
Unit 3	General characteristics , economic importance, and classification of different bacteria. Genus: <i>Lactococcus</i> , <i>Streptococcus</i> , <i>Leuconostoc</i> , <i>Lactobacillus</i> Family: <i>Bacillus</i> Family: <i>Enterobacteriaceae coliform- E.coli and Enterobacter</i> Family: <i>Acetobacteriaceae</i> , industrial production of acetic acid. Family: <i>Pseudomonaceae-Pseudomonas</i>
Unit 4	Factors affecting growth of microorganism in food, intrinsic and extrinsic factors Preservation of food. Spoilage of food and food products.
Unit 5	Poultry products, fruits & vegetables, wines, beer production.
Unit 6	Fermented foods (fermented milk products and fermented foods)
Unit 7	Food poisoning (<i>Staphylococcus</i> , <i>Bacillus</i> , <i>Listeria</i> , <i>Salmonella</i>) and food infection.

Learning Outcomes -

1. The student will be able to apply microbiological aspects involved in different settings of food industry
2. The student will gain an understanding of safety standards to be followed in a food industry

Reference Books:

1. Food Microbiology M.R. Adams
2. Basic Food Microbiology J. Banwart. C.B.S., Publication, Delhi.
3. Modern Food Microbiology James M. Jay
4. Microbial Food Poisoning R. Eley
5. Practical Food Microbiology & Technology Mouny & Gould
6. Fermentation Technology Singh & Pandit

Course Objectives –

1. To explain students with the collection, presentation and analysis of data, quantitative and qualitative analysis of data, and its interpretation.
2. To familiarize students with the experimental design in laboratory as well as field level, hypothesis testing and interpretation.
3. To understand the basics about computer and different software used in data analysis.

L+T+P : 4+1+0

IAE : 50

Credits: : 5

ETE : 50

Contact hours : 50

Unit 1	Statistics: Definition and scope. Presentation of data: Frequency distribution, graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves.
Unit 2	Central tendency and measures of dispersion: Mean, mode, median, their properties (with-out and with derivation), standard deviation and coefficient of variation. Simple correlation coefficient and regression
Unit 3	Tests of significance: T-test, Z-test, χ^2 -test for goodness of heterogeneity and independence of attributes, F-test
Unit 4	Principles of experimental designs, Complete Randomized block design (CRD): randomized block (RBD) and Latin square designs (LSD) and analysis of variance (ANOVA).
Unit 5	Introduction to computers: General idea of classification and characteristics of computers, input/output units, representation of data (bits & bytes, binary, octal and hexagonal systems). Disc operating systems (DOS), UNIX and its versions (Linux), WINDOWS and its upgraded versions. Introduction to networking: LAN (local area network), WAN (wide area network), MAN (metropolitan area network) including www (world wide web).
Unit 6	Microsoft (MS) office and its applications: Introduction to MS Excel and its applications for statistical analyses with particular reference to agricultural data (tabular and graphical representation of data, analyses of variance, regression and correlation); introduction to MS Word and its application for document preparation; power Point and its application for preparing presentations.

Learning Outcomes -

1. The student will be able to learn about data collection, presentation, hypothesis testing, comparison and analysis of laboratory as well as field data.
2. The student will gain to understand about computer hardware and software and different software to analyze the data.

Reference Books:

1. Goulden, C.H. (1952). Methods of Statistical Analysis. John Wiley, New York.
2. Hoshmand, A. Reza. (1988). Statistical Methods for Agriculture Sciences. Timber Press, USA.
3. Gomez, A.G. and Gomez, A. A (1994). Statistical Procedures for Agriculture Research, New York.
4. Panse, V.C. and Sushatme, PM. (1967). Statistical Methods for Agriculture Workers. I.C.A.R. Delhi.
5. Raja Raman, V. Fundamentals of Computers. Printed Hall of India Pvt. Ltd. New Delhi.
6. S. R. S. Chandel (2007). Hand Book of Agriculture Statistics. Impact printing Press, Kanpur.

Semester II

Course Objectives –

1. To acquaint students with extraction procedures of nutrients and functional components from foods
2. To acquaint students with nutraceutical product development, clinical testing and toxicity aspects

L+T+P : **4+1+0**IAE : **50**Credits : **5**ETE : **50**Contact hours : **50**

Unit 1	Preparation and standardization of solutions, buffers. Determinations of proximate.
Unit 2	composition: Moisture, fat, protein, fiber, carbohydrate, ash
Unit 3	Analysis of starch, reducing and non-reducing sugars in foods.
Unit 4	Determination of minerals: Iron, calcium, phosphorus, magnesium. Water soluble and fat soluble vitamins. Plant pigments (carotene, lycopene, chlorophyll, anthocyanins)
Unit 5	Analysis of fats and oil (FFA, PV, RM value)
Unit 6	Sensory evaluation of foods, methods of sensory evaluation, selection and training of panelists, establishment of sensory evaluation laboratory

Learning Outcomes -

1. The student will gain an understanding of nutrient components of foods that have health benefits
2. The student will be able to appreciate the role of biomolecules as nutraceuticals

ReferenceBooks :

1. Y. Pomeranz. Food Analysis Theory and Practice. C.B.S., Publication, Delhi.
2. Morris B. Jacobs. The Chemical Analysis of Foods and Food Products.
3. W. Graenwedel. Food Analysis: Separation Techniques. Wood Head Published Limited, England.
4. S. Ranganna. Handbook of Analysis and Quality Control for Fruits and Vegetables. Daya, Publication, Delhi.

Course Objectives –

1. To acquaint students with major agricultural crops of India and their processing techniques
2. To familiarize students with nutritional value differences as a result of crop processing

L+T+P : 4+1+0

IAE : 50

Credits : 5

ETE : 50

Contact hours : 50

Unit 1	Wheat: Introduction, structure, composition, nutritive value, conditioning and milling of wheat. Wheat flour, quality characteristics and its uses in bakery products: bread, biscuits & cakes.
Unit 2	Rice: Grain structure, composition, cooking characteristics, nutritive value, parboiling and milling of rice. Utilization of byproducts: rice bran, rice bran oil.
Unit 3	Corn: Grain structure, composition, and nutritive value, dry and wet milling, corn flakes, starch, corn syrup.
Unit 4	Barley: Structure, composition, nutritive value, malting of barley.
Unit 5	Oat: Grain structure, nutritive value, preparation of oat flakes, oatmeal.
Unit 6	Oilseeds and legume: Composition, nutritive value and antinutritional, factors in legumes and oilseeds. Milling of different pulses and their utilization, cooking characteristics of different pulses.
Unit 7	Oil seeds and their processing: Processing of oilseeds, extraction and refining of oil, by-product utilization. Technology of protein isolates, concentrates. Food grain storage and concerned agencies. Functional and multigrain food products

Learning Outcomes -

1. The student will gain an understanding of processing techniques used for agricultural produce
2. The student will comprehend the effect of processing on nutritional value of agricultural produce

Reference Books:

1. Houston. Rice chemistry and technology.
2. Chakraverty. Post harvest technology of cereals and pulses.
3. Matz S. A. Chemistry and technology of cereals as food and feed.
4. N.L. Kent (2006). Technology of cereals, Wood Head Published Limited, England.

Course Objectives –

1. To provide students with the basic practical skills required to prepare foods, and evaluate raw and processed foods
2. To enable students evaluate food establishments for their consumer acceptability and sanitation attributes

L+T+P : 4+1+0

IAE : 50

Credits : 5

ETE : 50

Contact hours : 50

Unit 1	Food science as a discipline, definition and scope; Food quality factors in food industry: Appearance, textural, flavor factors, additional quality factors and quality standards.
Unit 2	Unit operations in food processing- Common unit operations, raw material and grading preparation like size reduction, mixing, homogenization, separation, cleaning and sorting.
Unit 3	Heat preservation and processing: Principles of thermal processing, blanching, pasteurization, UHT processing, thermal sterilization, basic steps in thermal processing, TDT curve and TDR curve, margin of safety, 12 D value, low temperature; aseptic processing; thermal inactivation and sterilization of micro-organisms and enzymes.
Unit 4	Cold preservation and freezing: Refrigeration and freezing, refrigeration cycle, cold storage, freezing and frozen storage, rate of freezing, methods of freezing, effect of cold storage and freezing on quality of food products.
Unit 5	Food dehydration and concentration: Concept and mechanism of drying, methods of drying, effect of drying on quality of food products.
Unit 6	Principle of food concentration- Food concentration methods and their application. Intermediate moisture foods: definition and methods of preparation and their utility.
Unit 7	Irradiation, microwave and ohmic processing: Ionizing radiations, methods of irradiation and effects; principle and application of ohmic heating; and microwave heating in processing and preservation.

Learning Outcomes -

1. The student will be able to prepare basic foods while relating the same to the principles of food chemistry and processing
2. The student will be able to apply the principles of quality analysis to foods and industry

Reference Books:

1. N. Potter. (2002). Food science Norman, C.B.S., Publication, Delhi.
2. P. Fellows. (2004). Food processing technology. Wood Head Published Limited, England.
3. Desosier & Desosier. (2006) Technology of Food Preservation. Gene Tech. Book, Delhi.
4. R. K. Singh & Sahai. (1998). Unit operations in Food Processing. C.B.S., Publication, Delhi.
5. Khetrapaul & Pania. (2004) Food Packaging Daya, Publication, Delhi.

Semester III

Course - 7**Food Beverages****Course Objectives –**

1. To acquaint students with the particulars of manufacturing industrial beverages
2. To familiarize students with the quality requirements of bottled beverages, quality control tests and their importance in the beverage industry

L+T+P : **4+1+0**Credits : **5**Contact hours : **50**IAE : **50**ETE : **50**

Unit 1	Fruit juices, squashes and cordials: Equipment for fruit juices, double operations processes; Pulping equipment, dearator and flash pasteurization, fruit beverage-preparation & preservation. Straining, filtration and clarification. Preservation of fruit juices, preservation by addition of sugar, freezing, by carbonation and by filtration.
Unit 2	Fruit beverages: Squashes and cordials, juices, syrups, carbonated beverages. Fruit juice concentrate. Fruit juice powder
Unit 3	Fermented beverages: Beer –brewing, raw material and manufacture, storage, finishing and packaging. Grapevine- composition of grapes, wine type and their composition, mold and yeast of grapes and wine. Chemistry of fermentation. Composition of wine, production of red and white table wine, production of sherry sparkling wine, desert wine, vermouth wine, flavoured wine, fruit wine, etc. Spoilage of wine–non bacterial and bacterial.
Unit 4	Brandy and whisky production: Definition, compounds and methods of manufacture.
Unit 5	Winery byproducts.
Unit 6	Coffee: Production practice, processing of coffee beans into powder, instant coffee, decaffeination.
Unit 7	Tea: Leaf processing, various classes of tea, changes during processing of tea leaves, instant tea.

Learning Outcomes -

1. The student will gain an understanding of processing techniques used in the beverage industry and able to analyze the quality of commercial beverages
2. The student will comprehend the role of ingredients on beverage manufacture

References Books:

1. Preservation of fruits & vegetable. Girdharilal & Siddappa
2. Commercial fruits & Vegetable Product. W.V. Cruées
3. Technology of wine making food science. W.V. Cruées.
4. Technology, chemistry and microbiology of food beverages: Varman & Sakesland

Course - 8**Technology of Fruits and Vegetables**

Course Objectives –

1. To facilitate understanding of students about the commercial processing of fruits and advances storage techniques of fruits/ vegetables.
2. To acquaint students with the principles and methods of preserving fruits and vegetables
3. To familiarize students with processing techniques of horticultural produce

L+T+P : **4+1+0**Credits: : **5**Contact hours : **50**IAE : **50**ETE : **50**

Unit 1	Fruits and vegetables as living commodity, chemical composition, pre and post harvest changes, maturity standards for storage. Desirable characteristics of fruits and vegetables for processing.
Unit 2	Post harvest handling of fresh fruits and vegetables for processing: Role of plant growth regulators in relation to storage; physical and chemical treatment to increase the shelf life conditions for transportation and storage. Post harvest diseases and defects; cold, controlled and modified storage of fruits and vegetables. Freezing of fruits and vegetables.
Unit 3	Canning and bottling: Quality of raw materials; preparation of materials. Preparation of syrups and brines, canning and bottling, flow sheets of typical fruits and vegetables, effect of canning and bottling on nutritive value, spoilage of canned products- detection and control .
Unit 4	Preserve candies and crystallize fruits: Preliminary processing, methods, storage life, changes during frozen storage. Candied, glazed, crystallized fruits; improved equipment for manufacture of preserves. Some common preserves and other preserves and candied fruits.
Unit 5	Jams, jellies and marmalades: Jam-definition and standards, method of jam manufacture, jelly-extraction of pectin, mechanism of gel formation, processing of jelly, processing of some typical jams jellies & marmalades.
Unit 6	Dehydration of fruits and vegetables; Methods, packaging, storage, quality control during and after dehydration.
Unit 7	Pickles and chutneys: Preparation of various types of pickles- theory and practice; preparation of sauces and chutneys; problem related to the shelf life of pickles and chutneys, quality control.
Unit 8	Tomato products: Preparation of sauce and ketchup, puree and paste; food standards and quality control.

Learning Outcomes -

1. The student will gain an understanding of processing techniques used for horticulture produce
2. The student will comprehend the quality characteristics of importance in fresh and processed horticulture produce

Reference Books:

1. Preservation of Fruits and Vegetables Girdharilal
2. Commercial fruits & vegetable products W. V. Cruess
3. Fruit – processing Ramaswamy
4. Fruit & Vegetales Thompson
5. Hand book of fruit science & Technology Salunkhe & Radam. Marcel, Dekker. Inc.

Course Objectives –

1. To enhance the understanding of students about the physical properties of foods, process optimization and machine/ plant design.
2. To acquaint students with the principles and processes of food engineering
3. To familiarize students with basic operations and calculations of importance in the food industry

L+T+P : **4+1+0**IAE : **50**Credits : **5**ETE : **50**Contact hours : **50**

Unit 1	Fluid flow: Properties of fluids density, specific weight, specific volume, specific gravity viscosity – kinematics viscosity, newton’s law of viscosity – variation of viscosity with temperature, type of fluid flow, steady – unsteady, uniform – non uniform, laminar – turbulent, compressible fluid etc, rate of flow and discharge, continuity equation, equation of motion, bernoulli’s equation, and euler’s equations flow of viscous fluid through circular pipe – Hagen poiseille formula.
Unit 2	Heat transfer: Introduction, mode of heat transfer conduction – Fourier equation, thermal conductivity, general one dimension conduction equation, Heat condition through a plane wall, composite wall, cylindrical wall and multilayer cylindrical wall. Heat exchangers – parallel flow exchanger counter flow exchanger overall heat transfer coefficient, convection heat transfer, radiation.
Unit 3	Energy balance: General principles, energy terms, heat, properties of saturated and superheated steam, heat balance.
Unit 4	Refrigeration: Law of thermodynamics, principle of operation, refrigeration cycle, reverse carnot air refrigeration cycle, working, calculations of condenser, evaporator, compressor, refrigeration load , coleman cycle, vapor compression cycle.
Unit 5	Evaporation: Single effect evaporators, condenser, vapor recompression, multiple-effect evaporators, psychrometry process, psychrometric chart.

Learning Outcomes -

The student will gain an understanding of the influence of food characteristics on unit operations used in the food industry and the processing techniques

Reference Books:

1. Fundamentals of Food Process Engineering T. Toledo. C.B.S., Publication, Delhi
2. Hand book of food Engineering R.P. Singh. Academic Press, Delhi.
3. Hand book of food Engineering Aeldmam & Lunde. Marcel, Dekker. Inc.

Course Objectives –

1. To acquaint students with the types of dairy products
2. To familiarize students with processing techniques specific to the dairy industry

L+T+P : **4+1+0**Credits : **5**Contact hours : **50**IAE : **50**ETE : **50**

Unit 1	Technology of fluid milk: Collection, chilling, transportation, cream separation, standardization, pasteurization, sterilization, homogenization, packaging, storage and distribution of fluid milk, flavoured milk, enriched milk.
Unit 2	Technology of fermented milk: Principles and practices of manufacture, packaging, storage and marketing of curd (dahi), butter milk, acidophilus milk, yoghurt, shrikhand.
Unit 3	Technology of cheese: Standards of manufacture of hard, semi-hard, soft and processed cheeses. Storage and marketing of cheese. Cheese defects and their control.
Unit 4	Technology of fat rich dairy products: Manufacture, packaging, storage and marketing of butter & cream, butter defects and their control.
Unit 5	Technology of frozen milk products: Classification, standards, manufacture, packaging, storage and marketing. Defects of frozen products and their control.
Unit 6	Technology of concentrated, evaporated and dried milk: Standards, manufacture, packaging, storage, defects and their control.
Unit 7	Technology of indigenous dairy products: Khoa (manufacture, classification and use), paneer, ghee. Technological aspects of casein manufacture- by-products utilization

Learning Outcomes -

1. The student will gain an understanding of processing techniques used in the dairy industry
2. The student will be able to develop products from processing of milk

Reference Books :

1. Milk and Milk Processing B.L. Herrington
2. Milk and Dairy Technology Edgar Spreer. Marcel, Dekker. Inc.
3. W.E. Peterser. Dairy Science. Asiatic Publication House, Delhi.
4. D. Miller. Handbook of Dairy Foods and Nutrition Gregory.
5. Su Kumar De. Outlines of dairy technology. Oxford University Press.
6. Walstra, G. Normen. Dairy Technology. Marcel, Dekker. Inc

Course Objectives –

1. To facilitate understanding of students about the current techniques used in food analysis and estimation of component as well as genetically modified food crops.
2. To acquaint students with the principles and methods of genetic engineering.
3. To familiarize students with ethical and IPR issues.

L+T+P : **4+1+0**IAE : **50**Credits: : **5**ETE : **50**Contact hours : **50**

Unit 1	Introduction to Food biotechnology: Importance and scope. Isolation, cultivation and preservation of microorganisms of food biotechnological importance. Basic principles of genetic engineering; improvement of the food crops by genetic engineering; genetically modified plants and animals for enhanced food production; safety of GM food crops.
Unit 2	Fermentation technology: definition, types- aerobic and anaerobic fermentation. Design of typical bioreactors and their parts, function and operations. Microbial starter culture, their uses in dairy, meat, fruits and vegetables products. Production of pickle and olives, alcoholic beverages and pre and pro-biotic foods, acetone, butanol, glutamic acid, lactic acid, citric acid, vitamin B ₁₂ and baker's yeast.
Unit 3	Biotechnological Techniques: Genetic Engineering technique and their application in food technology. Biotechnology applied to fats and oils, production of single cell protein, low calorie sweeteners, food coloring agents and nutraceuticals.
Unit 4	Enzyme Immobilization: Definition and different method. Application of immobilized enzymes in food processing technology. Processing of food wastes: Whey, molasses, starch substrates and other food waste for bioconversion to useful products
Unit 5	Biotechnology for food security: Prospects and problems, ethical issues concerning GM foods; trade related aspects of biotech foods; intellectual property rights (IPR) issues and biopiracy problems. Effect of biotech foods on the food business of developing and developed countries. Use of genetically modification food and various legal and ethical aspects involved.
Unit 6	Food Law and Regulations: Food Laws, safety and standards Act, 2006. Labelling issues. Development of food standards, objectives and requirements of consumers protection Act. (1986), Vanaspati Control Order (1978), Export quality control and inspection Act. (1963), Meat Products order (1974) Codex Alimentarous Act, ISO 9000 series. TQM, GMP, use of HACCP in food processing, food adulteration & food safety. International food standards.

Learning Outcomes -

1. The student will gain an understanding of processing techniques used for food biotechnology
2. The student will comprehend the quality characteristics and importance of genetic modified food.

Reference Books:

1. Knorr D. Food Biotechnology. Marcel Dekker.
2. Lee BH. Fundamentals of Food Biotechnology. VCH.
3. Prescott SC & Dunn CG. Industrial Microbiology. McGraw Hill.
4. Hand book of fruit science & Technology Salunkhe & Radam. Marcel, Dekker. Inc.
5. Joshi VK & Pandey A. Biotechnology: Food Fermentation. vols. I, II. Education Publ.

Course - 12**Food Additives and Packaging****Course Objectives –**

1. To acquaint students with the types of
2. To familiarize students with processing techniques specific

L+T+P : **4+1+0**
 Credits: : **5**
 Contact hours : **50**

IAE : **50**
 ETE : **50**

Unit 1	Food additives- definition, classification and functions. Acidulants, buffering agents, salts and chelating/sequestering agents as food additives. Low calorie and non nutritive sweeteners, Polyols.
Unit 2	Antioxidants, colours and flavours (synthetic and natural), sequestrants, humectants, hydrocolloids, Emulsifying and stabilizing agents, thickeners, firming agents. Flour bleaching agents and bread improvers.
Unit 3	Anti-caking agents-their food uses and functions in formulations. Anti microbial agents / Class I and Class II preservatives as per PFA Act. Functional properties of nutraceuticals. Fibers-their application in food and health benefits.
Unit 4	Colorants, Flavouring agents and related substances, Clarifying agents. Tracers and other additives. Spices and condiments, essential oils and oleoresins. Flavours composites. Analysis and extraction techniques of flavours. Stability of flavours during food processing, Flavor emulsions. Toxicological evaluation of food additives.
Unit 5	Types of packaging materials – paper, glass, metals, plastics and their properties. Packaging requirements and selection of packaging materials. Types of packaging materials – paper, glass,metals, plastics and their properties
Unit 6	Barrier properties of packaging materials : Theory of permeability and its measurement. Methods of testing and evaluations such as WVTR (Water Vapour Transmission Rate), GTR (Gas Transmission Rate), tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength etc.
Unit 7	Biodegradable packaging. Recent advances in packaging. SMART and functional packaging materials. Regulations & quality control standards for labelling & printing.

Learning Outcomes -

1. The student will gain an understanding of processing techniques used in the dairy industry
2. The student will be able to develop products from processing of milk

Reference Books :

1. Kadoya T. (Ed). Food Packaging. Academic Press.
2. Sacharow S & Griffin RC. Principles of Food Packaging. AVI Publ.
3. Branen AL, Davidson PM &Salminen S. Food Additives. 2nd Ed. Marcel Dekker.
4. Morton ID & Macleod AJ. Food Flavours. Part A, BC. Elsevier..