

# FOOD SCIENCE AND TECHNOLOGY

## Course Structure

COURSE NO.	COURSE TITLE	CREDITS	SEM
<b>Deficiency Courses* (Non credit)</b>			
FST 451/ STAT 501	① MATHEMATICAL METHODS FOR APPLIED SCIENCES <sup>1</sup>	2+0	I
FST 452	② INTRODUCTION TO MICROBIOLOGY <sup>2</sup>	2+1	I
FST 453/ CE 512/ EE 505	③ GENERAL ENGINEERING PRINCIPLES <sup>3</sup>	2+1	I
<b>Major Courses</b>			
FST 501	FOOD CHEMISTRY AND NUTRITION	2+1	I
FST 502	FOOD MICROBIOLOGY	2+1	II
FST 503	FOOD ENGINEERING	2+1	II
FST 504	PRINCIPLES OF FOOD PROCESSING	2+1	I
FST 505/ PFE 510	④ FOOD PACKAGING	2+1	I
FST 506	FOOD QUALITY SYSTEMS AND MANAGEMENT	1+1	II
FST 507	TECHNIQUES IN FOOD ANALYSIS	1+2	II
<b>Minor Courses**</b>			
<b>Group I (Food Products Technology)</b>			
FST 511	POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLES	2+1	I
FST 512	TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING	2+1	I
FST 513	TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS	2+1	I
FST 514	BAKERY AND CONFECTIONARY TECHNOLOGY	2+1	I
FST 515	TECHNOLOGY OF MILK AND MILK PRODUCTS	2+1	I
FST 516	TECHNOLOGY OF MEAT, POULTRY AND FISH PROCESSING	2+1	I
FST 517	SNACK FOODS TECHNOLOGY	1+1	I
FST 518	BEVERAGES TECHNOLOGY	1+1	I
<b>Group II (Food Processes)</b>			
FST 519/ MBB 514	⑤ FOOD BIOTECHNOLOGY	2+1	I
FST 520	FOOD ADDITIVES AND INGREDIENTS	2+1	II
FST 521	INDUSTRIAL MICROBIOLOGY	2+1	II
FST 522	NUTRACEUTICALS AND HEALTH FOODS	2+1	II
FST 523	ENZYMES IN FOOD PROCESSING	2+1	II
FST 524	FOOD PHYSICS	2+1	II
FST 525	FOOD TOXICANTS AND ALLERGENS	2+1	II
FST 526/ CE 511	⑥ WASTE RECYCLING AND RESOURCE RECOVERY SYSTEM	2+1	II
FST 527/ PFE 505	⑦ ENERGY MANAGEMENT IN FOOD PROCESSING INDUSTRIES	2+1	II
FST 528	SENSORY EVALUATION	1+1	II
<b>Supporting Courses</b>			
FST 531/ STAT 534/ MBB 553 SOC 512	① BIOSTATISTICS AND COMPUTERS	2+1	I
FST 532/ COMP 502	⑧ COMPUTER FUNDAMENTALS	1+2	I
FST 533/ ABM 535	⑨ BUSINESS MANAGEMENT AND INTERNATIONAL TRADE	3+0	I

FST 534	APPLIED NUTRITION	2+0	I
FST 591	MASTER'S SEMINAR	1+0	I, II
FST 599	MASTER'S RESEARCH	20	I, II
FST 601	ADVANCES IN FOOD CHEMISTRY	3+0	I
FST 602	MODERN FOOD MICROBIOLOGY	2+1	I
FST 603	FOOD PROCESSING	2+0	I
FST 604	PRODUCT DESIGN & DEVELOPMENT	2+1	II
FST 605	FLAVOUR CHEMISTRY & TECHNOLOGY	2+0	II
FST 606	CARBOHYDRATE CHEMISTRY AND TECHNOLOGY	2+1	II
FST 607	PROTEIN CHEMISTRY AND TECHNOLOGY	2+1	II
FST 608	LIPID CHEMISTRY AND TECHNOLOGY	2+1	II
FST 609	CURRENT TOPICS IN FOOD SCIENCE AND TECHNOLOGY	2+0	II
FST 691	DOCTORAL SEMINAR I	1+0	I, II
FST 692	DOCTORAL SEMINAR II	1+0	I, II
FST 699	DOCTORAL RESEARCH	45	I, II
<b>SERVICE COURSE</b>			
ABM 518	FOOD TECHNOLOGY AND PROCESSING MANAGEMENT	2+0	

**For M. Sc.**

\*Deficiency Courses:

<sup>1</sup> Compulsory for graduates not having Maths at 10+2/graduate level.

<sup>2</sup> Compulsory for graduates not having Microbiology at graduate level.

<sup>3</sup> Compulsory for all.

\*\*Students should take at least one course from each group of minor courses.

**In Plant Training:** The students are required to undertake compulsory four weeks training during semester break in a reputed food industry/organization after completion of major courses. On completion of the training, the students are required to submit a report. The departmental committee on the basis of certificate from host industry/organization, training report, and viva voce will assess the student's performance. They will be awarded Satisfactory/Unsatisfactory grade.

**For Ph. D.**

**Compulsory courses:** FST 601, FST 602 and FST 603; other courses to be selected from rest of 600 series and remaining courses from FST 511 to FST 528 if not taken at Master's level.

**Minor Subjects:** Processing & Food Engineering, Livestock Product Technology, Biochemistry, Molecular Biology & Biotechnology, Foods & Nutrition, and Microbiology

**Supporting Courses:** FST 531-533, if not taken during M.Sc. or any other course relevant to the research topic of the student and offered by any other department in the university can be opted by the student on recommendation of the advisory committee

**Note:** Students should take Deficiency courses FST 453 (Non Credit), if not done during Master's programme except for B.Tech., B.E. degree students.

**Courses open for Post graduate students of other departments: FST 501 - 507**

To be taught by: ❶ Statistics; ❷ Basic Engineering (CE and EE); ❸ Processing & Food Engineering and Food Science & Technology; ❹ Molecular Biology & Biotechnology; ❺ Civil Engineering and Food Science & Technology; ❻ Processing & Food Engineering; ❼ Computer Section; ❽ Business Management

# FOOD SCIENCE AND TECHNOLOGY

## Course Contents

**FST 451/  
STAT 501**                      **MATHEMATICAL METHODS  
FOR APPLIED SCIENCES**                      **2+0**                      **SEM - I**

(To be taught by Statistics)

### **Objective**

This course is meant for students who do not have sufficient background of Mathematics. The students would be exposed to elementary mathematics that would prepare them to study their main courses that involve knowledge of Mathematics. The students would get an exposure to differentiation, integration and differential equation.

### **Theory**

UNIT-I: Variables and functions; limit and continuity. Specific functions. Differentiation: theorems of differentiation, differentiation of logarithmic, trigonometric, exponential and inverse functions, function of a function, derivative of higher order, partial derivatives. Application of derivatives in agricultural research; determination of points of inflexion, maxima and minima in optimization, etc.

UNIT-II: Integration as a reverse process of differentiation, methods of integration, reduction formulae, definite integral; Applications of integration in agricultural research with special reference to economics and genetics, engineering, etc.

UNIT-III: Vectors and vector spaces, Matrices, notations and operations, laws of matrix algebra; transpose and inverse of matrix; Eigen values and Eigen vectors. Determinants ó evaluation and properties of determinants, application of determinants and matrices in solution of equation for economic analysis.

UNIT-IV: Set theory-set operations, finite and infinite sets, operations of set, function defined in terms of sets.

### **Suggested Readings**

Harville DA. 1997. *Matrix Algebra from a Statistician's Perspective*. Springer Verlag.

Hohn FE. 1973. *Elementary Matrix Algebra*. Macmillan.

Searle SR. 1982. *Matrix Algebra Useful for Statistics*. John Wiley.

Stewart J. 2007. *Calculus*. Thompson.

Thomas GB. Jr. & Finney RL. 1996. *Calculus*. 9<sup>th</sup> Ed. Pearson Edu.

**FST452**                      **INTRODUCTION TO MICROBIOLOGY**                      **2+1**                      **SEM - I**

### **Objective**

To acquaint the students with history, classification and role of Microbiology in agriculture, food and environment.

### **Theory**

UNIT-I: Microbiology and its importance; Role of microorganisms as producers, consumers and degraders. Historical developments in microbiology and allied disciplines. Prokaryotes ó morphology, structure and function of microbial cell and their components.

UNIT-II: Classification of prokaryotes. Important groups of bacteria. Eukaryotic cell - structure and function.

UNIT-III: Major groups of Fungi, Algae and Protozoa. Viruses ó general characteristics, morphology and classification of plant, animal and bacterial viruses. Physical and chemical methods of control of microorganisms. Role of microorganisms in agriculture, food and biotechnology.

UNIT-IV: Role of microorganisms and food spoilage. Food fermentations and principles of food preservation.

### **Practical**

Microscopic examination of microorganisms. Stains and staining techniques-simple, Gram, spore, capsule, flagella and negative staining. Preparation of media and methods of sterilization, Isolation, purification and maintenance of microorganisms. Microbiological examination of water and milk.

### **Suggested Readings**

Brock, T.D. 1961. *Milestones in Microbiology*. Infinity Books.

- Pelczar MJ, Chan ECS & Kreig NR. 1997. *Microbiology : Concepts and Application*. Tata Mc Graw Hill.
- Stainier RY, Ingraham JL, Wheelis ML & Painter, PR. 2003. *General Microbiology*. Macmillan.
- Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

**FST 453/  
CE 513/  
EE 505**                      **GENERAL ENGINEERING PRINCIPLES**                      **2+1**                      **SEM - I**  
(To be taught by Basic Engineering)

**Objective**

To acquaint with basic principle of General Engineering required for food processing. To familiarise with techniques for process heat and their availability.

**Theory**

UNIT-I: Alternating current fundamentals - Electromagnetic induction magnitude of induced E.M.F, Alternating current, R.M.S. value and average value of an alternating current. Phase relations and vector representation. A.C. series and parallel circuits, Concept of resonance, polyphase alternating current circuits, three-phase concept, Star and delta connections, star delta transformation.

UNIT-II: Energy measurement- Transformers: Fundamental of transformer, Theory, vector diagram without load and with load, Losses, voltage regulation and efficiency of transformer, auto-transformer.

UNIT-III: Alternators - Elementary principles and different types of alternators; E.M.F. in alternators, circuit breakers; Induction motors ó Fundamental principles, production of rotating fields, construction; Rotor winding squirrel cage and phase wound rotors; Analysis of current and torque; starting of induction motors, motor housing, selection of motor and its controls.

UNIT-IV: D.C. Machines - Construction and operation of D.C. generator, Types of generators, various characteristics of generator, D.C. motors, torque-speed characteristics of D.C. motors, Starting and speed control of D.C. motors.

UNIT-V: Industrial sheds: Materials for the construction , various types of trusses, ventilation and lighting in industrial building. Various types of floors, roofs and foundations. Rough cost estimation.

**Practical**

Study of voltage resonance in L.C.R. circuits at constant frequency; (a) Star connection-study of voltage and current relation (b) Delta connection-study of voltage and current relation; Measurement of power in 3-phase circuit; (a) For balanced loads (b) For unbalanced loads, by wattmeter and energy meters; Polarity test, no-load test, efficiency and regulation test of single phase; Voltage and current relation in a 3-phase transformer of various kinds of primary and secondary connection systems; Test on 3-phase induction motor. Tests on various construction materials, study of drawings and various symbols.

**Suggested Readings**

- Farral AW. 1979. *Food Engineering Systems*. Vols. I, II. AVI Publ.
- Sharma & Kaul. *Building construction*.
- Thareja BL. *Electrical Machines*.

**FST 501**                      **FOOD CHEMISTRY AND NUTRITION**                      **2+1**                      **SEM - I**

**Objective**

To acquaint with properties, role of various constituents in foods, interaction and changes during processing and importance of various foods and nutrients in human nutrition.

**Theory**

UNIT-I: Definition and importance; major food constituents, water in food.

UNIT-II: Carbohydrates, proteins and lipids: classification, physical, chemical and functional properties and their structural correlations.

UNIT-III: Properties of minerals, vitamins, pigments, flavor components, Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.

UNIT-IV: Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances;

digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation. allergens, toxins and anti-nutritional factors in foods.

**Practical**

Proximate analysis of foods; calorific value of foods; TSS; pH; acidity; determination of vitamin C, sugars; estimation of calcium, phosphorus and iron; anti-nutritional factors.

**Suggested Readings**

Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.  
Belitz HD.1999. *Food Chemistry*. Springer Verlag.  
DeMan JM. 1976. *Principles of Food Chemistry*. AVI.  
Fennema OR.1996. *Food Chemistry*. Marcel Dekker.  
Meyer LH. 1987. *Food Chemistry*. CBS.  
Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

**FST 502                      FOOD MICROBIOLOGY                      2+1                      SEM - II**

**Objective**

To acquaint with different groups of micro-organisms associated with food, their activities, destruction and detection in food.

**Theory**

UNIT-I: Growth and survival of microorganisms in foods; spoilage organisms of milk, fruits and vegetables, grains, meat; Physical and chemical methods to control microorganisms.

UNIT-II: Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms.

UNIT-III: Food poisoning and food borne infections; Microbial toxins; Food hygiene and sanitation; Contamination during handling and processing and its control; Indicator organisms; Rapid methods for detection of microorganisms.

UNIT-IV: Food Fermentations; Traditional fermented foods of India and other Asian countries; Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables; Fermented beverages.

**Practical**

Microscopic examination of bacteria, and yeast and molds; Standard plate count; Yeast and mould count; Spore count; Detection of faecal coliform MPN of coli forms; Enumeration of physiological groups - psychrophile, thermodurics, osmophiles and halophiles.

**Suggested Readings**

Banawart GJ. 1989. *Basic Food Microbiology*. 2<sup>nd</sup> Ed. AVI Publ.  
Frazier J & Westhoff DC. 1988. *Food Microbiology*. 4<sup>th</sup> Ed. McGraw Hill.  
Garbutt J. 1997. *Essentials of Food Microbiology*. Arnold Heinemann.  
Jay JM, Loessner MJ & Golden DA. 2005. *Modern Food Microbiology*. 7<sup>th</sup> Ed. Springer.  
Ray B. 2004. *Fundamentals of Food Microbiology*. 3<sup>rd</sup> Ed. CRC.  
Robinson RK. (Ed.). 1983. *Dairy Microbiology*. Applied Science.  
Steinkraus KS. 1996. *Handbook of Indigenous Fermented Foods*. Marcel Dekker.

**FST 503                      FOOD ENGINEERING                      2+1                      SEM - II**

**Objective**

To acquaint with basic principle of Food Engineering and its Processes, with importance of various foods process and their evaluation.

**Theory**

UNIT-I: Introduction to food engineering and processes; size reduction, mixing and homogenization; principles of thermodynamics, fundamentals of heat and heat transfer and analogy to mass transfer

UNIT-II: Kinetics of reactions occurring in processed foods, reaction velocity constant, order of reaction; application of Arrhenius equation.

UNIT-III: Method for thermal processing; pasteurization and sterilization based on slowest heating region; general introduction to canning process, hydrostatic sterilizer.

UNIT-IV: Food chilling and freezing ó properties of frozen foods; freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for predicting rates of product freezing; cryogenic freezing and IQF; design of food freezing equipment such as air blast freezers, plate freezers and immersion freezers.

**UNIT-V:** Heat exchanger, process heat transfer - modes of heat transfer and overall heat transfer; thermal properties of foods such as specific heat and thermal conductivity; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes; natural convection.

**Practical**

Determination of viscosity of Newtonian fluid, Non Newtonian fluids; Particle size analysis; Design of pumping systems; Determination of thermal properties of foods such as thermal conductivity, thermal diffusivity, calorific value and specific heat; Calculation of freezing time for some typical foods; Study of different types of freezers; Calculation of thermal process time in canning of some foods; Determination of  $U_0$  for PHE; Determination of  $U_0$  for SSHE; Study of blast freezer; Visit to Food Processing Plants.

**Suggested Readings**

Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. *Food Engineering Operations*. Elsevier.  
 Charm SE, McCabe WL, Smith JC & Harriott P.1993. *Unit Operations of Chemical Engineering*. McGraw Hill.  
 Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.  
 Fellows P. 1988. *Food Processing Technology*. VCH Ellis Horwood.  
 Heldman DR & Singh RP.1995. *Food Process Engineering*. AVI Publ.  
 McCabe WL & Smith JC. 1971. *Fundamental of Food Engineering*. AVI Publ.  
 Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.  
 Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.

**FST 504                      PRINCIPLES OF FOOD PROCESSING                      2+1                      SEM - I**

**Objective**

To acquaint with principles of different techniques used in processing and preservation of foods.

**Theory**

**UNIT-I:** Scope of food processing; historical developments; principles of food processing and preservation.  
**UNIT-II:** Processing and preservation by heat ó blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc.  
**UNIT-III:** Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.  
**UNIT-IV:** Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products; ultra- filtration, reverse osmosis.  
**UNIT-V:** Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.  
**UNIT-VI:** Use and application of enzymes and microorganisms in processing and smoking etc; Food additives: definition, types and functions, permissible limits and safety aspects.

**Practical**

Seaming and testing of cans; Determination of thermal inactivation time of enzymes; Thermal processing of foods; Dehydration of foods; Refrigeration and freezing of foods; Concentration of foods; Use of chemicals in preservation of foods; Visit to food processing plants.

**Suggested Readings**

Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2<sup>nd</sup> Ed. Vols. I, II. AVI Publ.  
 Desrosier NW & James N.1977. *Technology of Food Preservation*. 4<sup>th</sup> Ed. AVI. Publ.  
 Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2<sup>nd</sup> Ed. CRC.  
 Jelen P. 1985. *Introduction to Food Processing*. Prentice Hall.  
 Potter NN & Hotchkiss 1997. *Food Science*. 5<sup>th</sup> Ed. CBS.  
 Potty VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.

Ramaswamy H & Marcotte M. 2006. *Food Processing: Principles and Applications*. Taylor & Francis.

**FST 505/  
PFE 510**                      **FOOD PACKAGING**                      **2+1**                      **SEM - I**  
(To be taught jointly by Food Science & Technology and Processing & Food Engineering)

**Objective**

To acquaint and equip the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

**Theory**

UNIT-I: Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

UNIT-II: Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate); Flexible packaging materials and their properties; Aluminium as packaging material; Evaluation of packaging material and package performance.

UNIT-III: Packaging equipments: Food packages, bags, types of pouches, wrappers, carton and other traditional package; Retortable pouches; Shelf life of packaged foodstuff.

UNIT-IV: Methods to extend shelf life; Packaging of perishables and processed foods; Special problems in packaging of food stuff. Different packaging system for (a) dehydrated foods, (b) frozen foods, (c) dairy products, (d) fresh fruits and vegetables, (e) meat, poultry and sea foods.

UNIT-V: Package standards and regulation; Shrink packaging; Aseptic packaging, CA and MAP, Active packaging; Biodegradable packaging.

**Practical**

Identification and testing of packaging materials; Determination of wax from wax paper; Testing of lacquered tin plate sheets; Measurement of tin coating weight by Clarke's method; To perform sulphide stain test; To conduct ferricyanide paper test for porosity; Determination of equilibrium moisture content; Grading of glass bottles for alkalinity; Determination of water vapour transmission rate of packaging material; To perform vacuum packaging of food sample and carry out its storage study; Testing the compression strength of the boxes; 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.

**Suggested Readings**

Crosby NT. 1981. *Food Packaging: Aspects of Analysis and Migration Contaminants*. App. Sci. Publ.

Kadoya T. (Ed). 1990. *Food Packaging*. Academic Press.

Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill.

Palling SJ. (Ed). 1980. *Developments in Food Packaging*. App. Sci. Publ.

Painy FA. 1992. *A Handbook of Food Packaging*. Blackie Academic.

Sacharow S & Griffin RC. 1980. *Principles of Food Packaging*. AVI Publ.

Stanley S & Roger CG. 1970. *Food Packaging*. AVI Publ.

**FST 506**                      **FOOD QUALITY SYSTEMS AND**                      **1+1**                      **SEM - II**  
**MANAGEMENT**

**Objective**

To acquaint with food quality parameters and control systems, food standards, regulations, specifications.

**Theory**

UNIT-I: Concept of quality; Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-à-vis* instrumental methods for testing quality.

UNIT-II: Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling techniques and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards.

UNIT-III: Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex; Export import policy, export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.

**Practical**

Testing and evaluation of quality attributes of raw and processed foods; Detection and estimation of food additives and adulterants; Quality assurance procedure, GMP, GAP documentation; Preparation of quality policy & documentation, Application of HACCP to products, Preparation of HACCP chart; Preparation of documentation & records, Visit to Units with ISO systems; Visit to Units with HACCP certification; Visit to Units implementing GMP, GAP; Mini-project on preparation of a model laboratory manual.

**Suggested Readings**

- Amerine MA, Pangborn RM & Rosslos EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
- Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
- Furia TE. 1980. *Regulatory status of Direct Food Additives*. CRC Press.
- Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood.
- Krammer A & Twigg BA. 1973. *Quality Control in Food Industry*. Vols. I, II. AVI Publ.
- Macrae R, Roloson R & Sadlu MJ. 1994. *Encyclopedia of Food Science & Technology & Nutrition*. Vol. XVI. Academic Press.
- Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science.
- Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2<sup>nd</sup> Ed. Tata McGraw-Hill.
- Export/Import policy by Govt. of India.

**FST 507                      TECHNIQUES IN FOOD ANALYSIS                      1+2                      SEM - II**

**Objective**

To familiarize with the conventional analysis of raw and processed food products of all commodity technologies used for routine quality control in food industry and their role on nutritional labeling.

**Theory**

- UNIT-I: Significance of food analysis; Water activity, its measurements.
- UNIT-II: Color analysis; Spectroscopic techniques using UV/Vis, fluorescence, IR, NMR, atomic absorption and emission, flame photometry, polarimetry, refractometry, nephelometry; Electrochemical methods, conductivity and polarographic techniques.
- UNIT-III: Chromatographic techniques: adsorption, partition, affinity, ion exchange, size exclusion, TLC and paper chromatography, GLC, HPLC, GCMS.
- UNIT-IV: Separation techniques: Gel filtration, electrophoresis, isoelectric focusing; Manometric techniques and gas analysis
- UNIT-V: Rheology and texture analysis; Surface tension; Thermal analytical methods; Latest techniques in food analysis.

**Practical**

Sorption isotherms of food material, Karl Fischer titration; Spectrometric method, analysis by NIR spectroscopy; color analysis; Separation and identification of carotenoids by column chromatography; fatty acid analysis using GC; Analysis of organic acids by HPLC; Metal analysis using flame photometer, atomic absorption/emission spectrometry; and other methods based on polarimeter, nephelometer, rheology and texture analysis, conductimetry and polarography, etc.

**Suggested Readings**

- AOAC International. 2003. *Official Methods of Analysis of AOAC International*. 17<sup>th</sup> Ed. Gaithersburg, MD, USA.
- Kirk RS & Sawyer R. 1991. *Pearson's Chemical Analysis of Foods*. 9<sup>th</sup> Ed. Longman Scientific & Technical.
- Leo ML. 2004. *Handbook of Food Analysis*. 2<sup>nd</sup> Ed. Vols. I-III.
- Linden G. 1996. *Analytical Techniques for Foods and Agricultural Products*. VCH.
- Macleod AJ. 1973. *Instrumental Methods of Food Analysis*. Elek Sci. Marcel Dekker.
- Nielsen S. (Eds.). 1994. *Introduction to Chemical Analysis of Foods*. Jones & Bartlett.



Pomrenz Y & Meloan CE. 1996. *Food Analysis - Theory and Practice*. 3<sup>rd</sup> Ed. CBS.  
 Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2<sup>nd</sup> Ed. Tata McGraw-Hill.  
 Robinson JW. 1970. *Undergraduate Instrumental Analysis*. Marcel Dekker.

**FST 511                      POST HARVEST MANAGEMENT OF                      2+1                      SEM - I**  
**FRUITS AND VEGETABLES**

**Objective**

To acquaint with the proper handling technologies of fruits and vegetables to reduce post harvest losses and value addition.

**Theory**

UNIT-I: Importance and scope of post harvest management of fruits and vegetables in Indian economy.

UNIT-II: Classes and morphology, structure and composition of fruits and vegetables; maturity indices and standards for selected fruits and vegetables; methods of maturity determinations.

UNIT-III: Harvesting and handling of important fruits and vegetables, Harvesting tools and their design aspects; Field heat of fruits and vegetables and primary processing for sorting and grading at farm and cluster level; factors affecting post harvest losses; Standards and specifications for fresh fruits and vegetable.

UNIT-IV: Post-harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; regulations, methods; Storage practices: CA and MA, hypobaric storage, pre-cooling and cold storage, Zero energy cool chamber; Commodity pretreatments - chemicals, wax coating, prepackaging, VHT and irradiation.

UNIT-V: Physiological post harvest disorders - chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; Post Harvest handling system for fruits and vegetables of regional importance- tomato, grape, guava, leafy vegetables. cauliflower, onions, packaging house operations; principles of transport and commercial transport operations.

**Practical**

Studies on morphological features of some selected fruits and vegetables; Studies of maturing indices; Studies of harvesting of fruits and vegetables; Studies of export of pre cooling and storage of fruits and vegetables; Studies on pre treatments on selected fruits; Studies on use of chemicals for ripening and enhancing shelf life of fruits and vegetables; Studies of regulations of ripening of banana, mango, papaya; Studies on various storage systems and structures; Studies on pre packaging of fruits; Studies on pre packaging of vegetables; Studies on physiological disorders - chilling injury of banana; Visit to commercial storage structures- fruits, vegetables, onion, garlic and potato.

**Suggested Readings**

Kadar AA.1992. *Post-harvest Technology of Horticultural Crops*. 2<sup>nd</sup> Ed. University of California.

Lal G, Siddapa GS & Tandon GL.1986. *Preservation of Fruits and Vegetables*. ICAR.

Pantastico B. 1975. *Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables*. AVI Publ.

Salunkhe DK, Bolia HR & Reddy NR. 1991. *Storage, Processing and Nutritional Quality of Fruits and Vegetables*. Vol. I. *Fruits and Vegetables*. CRC.

Thompson AK. 1995. *Post Harvest Technology of Fruits and Vegetables*. Blackwell Sci.

Verma LR. & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.

**FST 512                      TECHNOLOGY OF FRUITS AND                      2+1                      SEM - I**  
**VEGETABLE PROCESSING**

**Objective**

To acquaint with principles and methods of preservation and processing of fruits and vegetables into various products.

### Theory

UNIT-I: Indian and global scenario on production and processing of fruits and vegetable; Quality requirements of raw materials for processing; sourcing and receiving at processing plants; primary processing: grading, sorting, cleaning, washing, peeling, slicing and blanching; minimal processing.

UNIT-II: Processing for pulp and juices, puree and concentrates, especially from mango, tomato, guava, papaya, cauliflower, grapes etc.; RTS fruit beverages, IQF and frozen fruits and vegetables.

UNIT-III: Technology for processed products like pickles, chutneys, sauces particularly from tomato, lime and other regional fruits and vegetables of importance.

UNIT-IV: Processing of fruits for candies, bars, toffees, jams and jellies, squashes and syrups using locally available fruits like papaya, mango, aonla, petha and other fruits.

UNIT-V: Dehydration of fruits and vegetables using various drying technologies like sun drying, solar drying (natural and forced convection), osmotic, tunnel drying, fluidized bed drying, freeze drying, convectional and adiabatic drying; applications to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables, fruit powder using spray drying.

### Practical

Evaluation of pectin grade; canning of mango/guava/papaya; preparation and quality evaluation of fruit jam: apple/ mango/ guava /papaya /aonla / strawberry and fruits of regional importance; fruit jelly, sweet orange/mandarin/guava; fruit marmalade; fruit preserve and candy; fruit RTS, squash, syrup and candy; preparation of grape raisin, dried fig and dried banana; Processing of tomato products; preparation of papaya /guava cheese; Preparation of pickles, dried onion and garlic, preparation of banana and potato wafers, dehydrated vegetables.

### Suggested Readings

- Barret DM, Somogyi LP & Ramaswamy H. 2005. *Processing of Fruits*. CRC Press.
- FAO. 2007. *Handling and Preservation of Fruits and Vegetables by Combined Methods for Rural Areas- Technical Manual*. FAO Agr. Ser. Bull., 149.
- Fellows P. 2007. *Guidelines for Small-Scale Fruit and Vegetables Processors*. FAO Agr. Ser. Bull., 127.
- Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits and Vegetables*. ICAR.
- Salunkhe DK & Kadam SS. 1995. *Handbook of Fruit Science & Technology: Production, Composition and Processing*. Marcel Dekker.
- Salunkhe DK & Kadam SS. 1995. *Handbook of Vegetables Science & Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
- Somogyi LP. et al. 1996. *Processing Fruits - Science and Technology*. Vols. I, II. Technomic Publ.
- Srivastava RP & Kumar S. 2003. *Fruit and Vegetable Preservation - Principles and Practices*. International Book Distributors.
- Verma LR & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.

## FST 513                      TECHNOLOGY OF CEREALS, PULSES                      2+1                      SEM - I AND OILSEEDS

### Objective

To acquaint with processing technologies for product development and value addition of various cereals, pulses and oilseeds.

### Theory

UNIT-I: Production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

UNIT-II: Wheat: Types, physicochemical characteristics and quality parameters; wheat milling - products and by-products and processed products.

UNIT-III: Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; by-products of rice milling and their utilization; parboiling of rice and aging of rice - quality changes; processed products based on rice.

UNIT-IV: Corn: dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets, ready-to-cook, instantized products, breakfast cereals.

UNIT-V: Legumes: composition, anti-nutritional factors, processing and storage, flour, extrusion cooking technology, protein concentrates and isolates, snack foods.

UNIT-VI: Oilseeds: composition, storage, processing for production of edible oil, oilseed cake and meal and development of low cost protein foods, fat and oil processing, fat and oil products.

#### **Practical**

Physical-tests on wheat and rice; Physicochemical and rheological properties; Determination of gluten content in wheat flour; Conditioning of wheat; Milling of wheat and rice by laboratory mill; Parboiling of rice; Quality tests of rice; Amylose content determination in rice; Malting of barley; puffing and popping of grains; experimental parboiling and assessment of degree of polishing; Preparation of protein concentrates and isolates and their evaluation for protein content and solubility; Extraction of oil using expeller and solvent extraction methods; chemical analysis of fats and oils; Visit to related processing industries.

#### **Suggested Readings**

- Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats*. Prentice Hall.  
Dendy DAV & Dobraszczyk BJ. 2001. *Cereal and Cereal Products*. Aspen.  
Hamilton RJ & Bhati A. 1980. *Fats and Oils - Chemistry and Technology*. App. Sci. Publ.  
Hoseney RS. 1994. *Principles of Cereal Science and Technology*. 2<sup>nd</sup> Ed. AACC.  
Kay DE. 1979. *Food Legumes*. Tropical Products Institute.  
Kent NL. 1983. *Technology of Cereals*. 4<sup>th</sup> Ed. Pergamon Press.  
Kulp K & Ponte GJ. 2000. *Handbook of Cereal Science and Technology*. 2<sup>nd</sup> Ed. Marcel Dekker.  
Lorenz KL. 1991. *Handbook of Cereal Science and Technology*. Marcel Dekker.  
Marshall WE & Wadsworth JL. 1994. *Rice Science and Technology*. Marcel Dekker.  
Mathews RH. 1989. *Legumes Chemistry, Technology and Human Nutrition*. Marcel Dekker.  
Matz SA. 1969. *Cereal Science*. AVI Publ.  
Paquot C. 1979. *Standard Methods of Analysis of Oils, Fats and Derivatives*. Pergamon Press.  
Pomeranz Y. 1987. *Modern Cereal Science & Technology*. VCH Publ.  
Salunkhe DK. 1992. *World Oilseeds: Chemistry, Technology and Utilization*. VNR.  
Swern D. 1964. *Bailey's Industrial Oil and Fat Products*. Inter Sci. Publ.  
Watson SA & Ramstad PE. 1987. *Corn; Chemistry and Technology*. AACC.

<b>FST 514</b>	<b>BAKERY AND CONFECTIONARY TECHNOLOGY</b>	<b>2+1</b>	<b>SEM - I</b>
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#### **Objective**

To acquaint with basic and applied technology of baking and confectionary and acquaint with the manufacturing technology of bakery and confectionary products.

#### **Theory**

UNIT-I: Bakery and confectionary industry; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough- Farinograph, Mixograph, Extensograph, Amylograph / Rapid Visco Analyzer, Falling number, and interpretation of the data.

UNIT-II: Technology for the manufacture of bakery products-bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking; equipment used in bakery industry.

UNIT-III: Quality characteristics of confectionery ingredients; technology for manufacture of flour, fruit, milk, sugar, chocolate, and special confectionary products; standards and regulations; equipment used in confectionery industry.

#### **Practical**

Determination of dough relaxation constants and their interpretation; Effect of mixing method on the quality of baked product; Effect of mixing time on the rheological characteristics of dough; Effect of mixing time on the crispness and firmness of biscuits; Effect of additives on the quality and textural characteristics of bakery products; Development and quality evaluation of baked products based on composite flour; Preparation and quality evaluation of cakes, biscuits, croissant, doughnuts, and pizza base; Effect of syrup consistency and temperature on the quality characteristics of hardboiled

sweets; Preparation and quality evaluation of chocolate; Visit to bakery and confectionery industries.

**Suggested Readings**

Dubey SC. 2002. *Basic Baking*. The Society of Indian Bakers, New Delhi.  
Francis FJ. 2000. *Wiley Encyclopedia of Food Science & Technology*. John Wiley & Sons.  
Manley D. 2000. *Technology of Biscuits, Crackers & Cookies*. 2<sup>nd</sup> Ed. CRC Press.  
Pylar EJ. *Bakery Science & Technology*. 3<sup>rd</sup> Ed. Vols. I, II. Sosland Publ.  
Qarooni J. 1996. *Flat Bread Technology*. Chapman & Hall.

**FST 515                      TECHNOLOGY OF MILK AND                      2+1                      SEM - I**  
**MILK PRODUCTS**

**Objective**

To acquaint with techniques and technologies of testing and processing of milk into various products.

**Theory**

UNIT-I: Present status of milk & milk products in India and abroad; Market milk- Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning and sanitization of dairy equipments.

UNIT-II: Condensed and evaporated milk- Definition, methods of manufacture, evaluation of quality of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantization, physiochemical properties, evaluation, defects in dried milk powder.

UNIT-III: Cream- Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter.

UNIT-IV: Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.

UNIT-V: Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese.

UNIT-VI: Indigenous milk products - Present status, method of manufacture of *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi* etc; probiotic milk products.

**Practical**

Study on basics of reception of milk at the plant; platform tests in milk; estimation and fat and SNF in milk; Operation of LTLT & HTST Pasteurization; Preparation of special milks; Cream separation & standardization of milk; Preparation and evaluation of table butter, icecream, cheese and indigenous milk product such as *khoa, chhana, paneer, ghee, rosogolla, gulab jamun, shrikhand, lassi, burfi* etc.; Visit to dairy plants.

**Suggested Readings**

Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Milk Products*. Dairy India Publ.  
De S.1980. *Outlines of Dairy Technology*. Oxford Univ. Press.  
Henderson JL. 1971. *Fluid Milk Industry*. AVI Publ.  
Rathore NS *et al.* 2008. *Fundamentals of Dairy Technology - Theory & Practices*. Himanshu Publ.  
Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.  
Walstra P. 1999. *Dairy Technology*. Marcel Dekker.  
Walstra P. (Ed.). 2006. *Dairy Science and Technology*. 2<sup>nd</sup> Ed. Taylor & Francis.  
Web BH, Johnson AH & Lford JA. 1987. *Fundamental of Dairy Chemistry*. 3<sup>rd</sup> Ed. AVI Publ.

**FST 516                      TECHNOLOGY OF MEAT, POULTRY                      2+1                      SEM - I**  
**AND FISH PROCESSING**

**Objective**

To provide an understanding of the technology for handling, processing, preservation and bi-product utilization of meat, poultry and fish products processing.

**Theory**

UNIT-I: Meat composition from different sources; muscle structure and compositions; post-mortem muscle chemistry; meat colour and flavours; meat microbiology and safety.

UNIT-II: Modern abattoirs, typical layout and features, Ante-mortem handling and design of handling facilities; Hoisting rail and traveling pulley system; stunning methods; steps in slaughtering and dressing; offal handling and inspection; inedible by-products; operational factors affecting meat quality; effects of processing on meat tenderization; abattoir equipment and utilities.

UNIT-III: Chilling and freezing of carcass and meat; canning, cooking, drying, pickling, curing and smoking; prepared meat products like salami, kebabs, sausages, sliced, minced, corned; intermediate moisture and dried meat products; meat plant hygiene ó GMP and HACCP; Packaging of meat products.

UNIT-IV: Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Lay-out and design of poultry processing plants, Plant sanitation; Poultry meat processing operations, equipment used ó Defeathering, bleeding, scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, by products ó eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

UNIT-V: Commercially important marine products from India; product export and its sustenance; basic biochemistry and microbiology; preservation of postharvest fish freshness; transportation in refrigerated vehicles; deodorization of transport systems; design of refrigerated and insulated trucks; grading and preservation of shell fish; pickling and preparation of fish protein concentrate, fish oil and other by products.

#### **Practical**

Slaughtering and dressing of meat animals; study of post-mortem changes; meat cutting and handling; evaluation of meat quality; Preservation by dehydration, freezing, canning, curing, smoking and pickling of fish and meat; shelf-life studies on processed meat products; evaluation of quality of eggs; preservation of shell eggs; estimation of meat: bone ratios; preparation of meat products- barbecued sausages, loaves, burger, fish finger; visit to meat processing plants.

#### **Suggested Readings**

Forrest JC. 1975. *Principles of Meat Science*. Freeman.

Govindan TK. 1985. *Fish Processing Technology*. Oxford & IBH.

Hui YH. 2001. *Meat Science and Applications*. Marcel Dekker.

Kerry J. et al. 2002. *Meat Processing*. Woodhead Publ. CRC Press.

Levie A. 1984. *Meat Hand Book*. 4<sup>th</sup> Ed. AVI Publ.

Mead M. 2004. *Poultry Meat Processing and Quality*. Woodhead Publ.

Mead GC. 1989. *Processing of Poultry*. Elsevier.

Pearson AM & Gillett TA. 1996. *Processed Meat*. 3<sup>rd</sup> Ed. Chapman & Hall.

Stadelman WJ & Cotterill OJ. 2002. *Egg Science and Technology*. 4<sup>th</sup> Ed. CBS.

### **FST 517                      SNACK FOODS TECHNOLOGY                      1+1                      SEM - I**

#### **Objective**

To provide knowledge of principles and characteristics of extruders and support systems for effective selection and operation, to review current practices for preparation of fried chips and other extruded snacks and also to demonstrate equipment in operation and familiarize students with practical aspects of snack foods processing technology.

#### **Theory**

UNIT-I: Technology for grain-based snacks: whole grains ó roasted, toasted, puffed, popped and flakes, coated grains-salted, spiced and sweetened; flour based ó batter and dough based products; *savoury* and *farsans*; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

UNIT-II: Technology for fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts ó salted, spiced and sweetened; *chikkis* .

UNIT-III: Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging.

UNIT-IV: Equipments for frying, toasting, roasting and flaking, popping, blending, Coating, chipping.

**Practical**

Preparation of various snack foods based on cereals, legumes, nuts, fruits, vegetables and extrusion cooking their quality evaluation; development of instant food premixes; determination of shelf-life and packaging requirements; Visits to industries manufacturing snack foods.

**Suggested Readings**

Edmund WL. *Snack Foods Processing*. AVI Publ.  
 Frame ND .1994. *The Technology of Extrusion Cooking*. Blackie Academic.  
 Gordon BR.1997 *Snack Food*. AVI Publ.  
 Samuel AM.1976. *Snack Food Technology*. AVI Publ.

<b>FST 518</b>	<b>BEVERAGES TECHNOLOGY</b>	<b>1+1</b>	<b>SEM - I</b>
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**Objective**

To provide a technical view of beverages and a full discussion of manufacturing processes in the context of technology and its related chemistry as well as a more fundamental appraisal of the underlying science.

**Theory**

UNIT-I: Types of beverages and their importance; status of beverage industry in India; synthetic beverages; technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks; role of various ingredients of soft drinks, carbonation of soft drinks.

UNIT-II: Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, beverages.

UNIT-III: Alcoholic beverages- types, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, technology of brewing process, equipments used for brewing and distillation, wine and related beverages, distilled spirits.

UNIT-IV: Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

**Practical**

Chemical and microbiological analysis of raw water quality; Preparation of regional fruit juices; Preparation of whey-based beverages; preparation of iced and flavoured tea beverage; Preparation of carbonated and noncarbonated soft drinks; Preparation of wine and beer; Preparation of soy milk, fruit milkshakes, herbal beverages; visit to relevant processing units.

**Suggested Readings**

Hardwick WA. 1995. *Handbook of Brewing*. Marcel Dekker.  
 Hui YH. *et al* 2004. *Handbook of Food and Beverage Fermentation Technology*. Marcel Dekker.  
 Priest FG & Stewart GG. 2006. *Handbook of Brewing*. 2<sup>nd</sup> Ed. CRC.  
 Richard P Vine. 1981. *Commercial Wine Making - Processing and Controls*. AVI Publ.  
 Varnam AH & Sutherland JP. 1994. *Beverages: Technology, Chemistry and Microbiology*. Chapman & Hall.  
 Woodroof JG & Phillips GF.1974. *Beverages: Carbonated and Non Carbonated*. AVI Publ.

<b>FST 519/ MBB 514</b>	<b>FOOD BIOTECHNOLOGY</b>	<b>2+1</b>	<b>SEM - I</b>
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(To be taught by Molecular Biology & Biotechnology)

**Objective**

This is a special course designed for students of FST to acquaint with the fundamentals and application of biotechnology in relation to raw materials for food processing, nutrition, food fermentations, waste utilization and better use of genetic resources.

**Theory**

UNIT-I: Prospects of biotechnology- definition, history, scope and applications, Application of biotechnology in food (food industries), pharmaceuticals and agriculture,

food/plant waste utilization, biogas plants; organisms and their utilization for the production of fermented foods and beverages.

UNIT-II: Structure and function of nucleic acids; Recombinant DNA technology: restriction and other DNA modifying enzymes, vectors, DNA libraries, gene cloning, PCR, gene expression, etc.

UNIT-III: Applications of genetical control mechanism in industrial fermentation process, (induction, manipulation and recombination); Biomass production by using various microorganisms; Cell and tissue culture, Secondary metabolites synthesis; Transgenic organisms (GMOs): methods, applications, safety aspects, etc.

UNIT-IV: Biotechnology for enhancing quality attributes of food; Enzyme biotechnology; Enzyme immobilization techniques and their applications in food industry; Microbial transformations; Potential impact and future aspects of biotechnology in food industry.

#### **Practical**

Study of auxotroph, Micropropagation through tissue culture, Strain improvement through U.V. mutation, Mutagenesis using chemical mutagens (ethidium bromide), Isolation and analysis of genomic DNA from *E.coli* and *Bacillus cereus*, Isolation of protoplasts, Introduction to the techniques of ELISA / Southern blot /DNA fingerprinting/ Agarose gel electrophoresis, etc.

#### **Suggested Readings**

Bains W. 1993. *Biotechnology from A to Z*. Oxford Univ. Press.

Joshi VK & Pandey A. 1999. *Biotechnology: Food Fermentation*. Vols. I, II. Education Publ.

Knorr D.1982. *Food Biotechnology*. Marcel Dekker.

Lee BH. 1996. *Fundamentals of Food Biotechnology*. VCH.

Perlman D. 1977-1979. *Annual Reports of Fermentation Processes*.

Prescott SC & Dunn CG. 1959. *Industrial Microbiology*. McGraw Hill.

Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall.

### **FST 520                      FOOD ADDITIVES AND INGREDIENTS                      2+1                      SEM - II**

#### **Objective**

To get an insight into the additives that are relevant to processed food industry for shelf life extension, processing aids and sensory appeal. To develop an understanding of isolation of various biopolymers from food resources and their relevant applications.

#### **Theory**

UNIT-I: Food additives- definitions, classification and functions, Preservatives, antioxidants, colours and flavours (synthetic and natural), emulsifiers, sequestrants, humectants, hydrocolloids, sweeteners, acidulants, buffering salts, anticaking agents, etc. - chemistry, food uses and functions in formulations; indirect food additives; toxicological evaluation of food additives.

UNIT-II: Flavour technology: Types of flavours, flavours generated during processing ó reaction flavours, flavour composites, stability of flavours during food processing, analysis of flavours, extraction techniques of flavours, flavour emulsions; essential oils and oleoresins; authentication of flavours etc.

UNIT-III: Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods and as nutraceuticals.

UNIT-IV: Manufacturing and applications of dietary fibres, fructooligosaccharides.

#### **Practical**

Estimation of preservatives, sweeteners, fibres, colours, antioxidants, flavour enhancers; Isolation, modification, and functional properties of native and modified proteins, starches and lipids; extraction of essential oil and oleoresins; applications of additives and ingredients in foods.

#### **Suggested Readings**

Branen AL, Davidson PM & Salminen S. 2001. *Food Additives*. 2<sup>nd</sup> Ed. Marcel Dekker.

George AB. 1996. *Encyclopedia of Food and Color Additives*. Vol. III. CRC Press.

George AB. 2004. *Fenaroli's Handbook of Flavor Ingredients*. 5<sup>th</sup> Ed. CRC Press.

Madhavi DL, Deshpande SS & Salunkhe DK. 1996. *Food Antioxidants: Technological, Toxicological and Health Perspective*. Marcel Dekker.

Morton ID & Macleod AJ .1990. *Food Flavours*. Part A, BC. Elsevier.

Nakai S & Modler HW. 2000. *Food Proteins. Processing Applications*. Wiley VCH.

Stephen AM. (Ed.). 2006. *Food Polysaccharides and their Applications*. Marcel Dekker.





**FST 521                      INDUSTRIAL MICROBIOLOGY                      2+1                      SEM - II**

**Objective**

To acquaint with application of micro-organisms for the production of Industrial products with particular reference to foods and food ingredients.

**Theory**

UNIT-I: Introduction, scope and historical developments; Isolation screening and genetic improvement of industrially important organisms.

UNIT-II: Fermenter design and various types of fermentation systems (submerged, surface and solid state); Fermentation substrates, Principles and production of amino acids, enzymes, nucleotides, organic acids, food colours, Baker's yeast, alcoholic beverages, vinegar.

UNIT-III: Principles and production of microbial proteins, lipids, polysaccharides and vitamins ó properties and applications; mushroom cultivation.

UNIT-IV: Utilization and disposal of industrial wastes through microorganisms; use of genetically modified microorganisms in food processing.

**Practical**

Isolation of industrially important microorganisms from natural environments and foods; study and operation of laboratory fermenter; Laboratory scale production of microbial metabolites such as organic acids, lipids, exopolysaccharides, etc.; BOD and COD measurements in industrial effluents; visit to related industries.

**Suggested Readings**

Perman D. 1977-79. *Annual Reports of Fermentation Processes*. Vols. I-III.

Prescott SC & Dunn CG. 1959. *Industrial Microbiology*. Mc Graw Hill.

Waits MJ. 2001. *Industrial Microbiology*. Blackwell Science.

Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall.

**FST 522                      NUTRACEUTICALS AND HEALTH FOODS                      2+1                      SEM - II**

**Objective**

To cater to the newly emerging area of nutraceuticals with respect to the types, mechanisms of action, manufacture of selected nutraceuticals, product development, clinical testing and toxicity aspects.

**Theory**

UNIT-I: Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX.

UNIT-II: Concept of angiogenesis and the role of nutraceuticals/functional foods; Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related muscular degeneration, endurance performance and mood disorders ó compounds and their mechanisms of action, dosage levels, contradictions, if any etc.

UNIT-III: Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals ó stability and analytical issues, labelling issues.

UNIT-IV: Clinical testing of nutraceuticals and health foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity of nutraceuticals; nutrigenomics ó an introduction and its relation to nutraceuticals.

**Practical**

Market survey of existing health foods; identification and estimation of selected nutraceuticals; production and quality evaluation of foods containing nutraceuticals; development of labels for health foods; Visit to relevant processing Units.

**Suggested Readings**

Brigelius-Flohé, J & Joost HG. 2006. *Nutritional Genomics: Impact on Health and Disease*. Wiley VCH.

Campbell JE & Summers JL. 2004. *Dietary Supplement Labeling Compliance*.

Cupp J & Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.

Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*.

Goldberg I. 1994. *Functional Foods: Designer Foods, Pharma Foods*.

- Losso JN. 2007. *Anti-angiogenic Functional and Medicinal Foods*. CRC Press.
- Manson P. 2001. *Dietary Supplements*. 2<sup>nd</sup> Ed. Pharmaceutical Press.
- Neeser JR & German BJ. 2004. *Bioprocesses and Biotechnology for Nutraceuticals*. Chapman & Hall.
- Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2<sup>nd</sup> Ed. Wildman.
- Shi J. (Ed.). 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC Press.
- Webb GP. 2006. *Dietary Supplements and Functional Foods*. Blackwell Publ.

**FST 523                      ENZYMES IN FOOD PROCESSING                      2+1                      SEM - II**

**Objective**

To develop an understanding of enzymes useful in food product technology and food processing with respect to production and purification protocols, applications in commodity technologies, and their impact on sensory and nutritional quality.

**Theory**

UNIT-I: Enzymesó classification, properties, characterization, kinetics and immobilization; Production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing.

UNIT-II: Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides.

UNIT-III: Enzymes as processing aids: Role of enzymes in Cheese making and whey processing; Fruit juices - cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices; Baking (fungal - amylase for bread making; maltogenic -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases for dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); Meat tenderization; Egg processing.

UNIT-IV: Enzyme processing for flavours (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides; flavours from hydrolyzed vegetable/animal protein); enzymatic approach to tailor- made fats.

**Practical**

Assay of enzymes for activity, specific activity, kinetics, stability (temperature, pH and storage); Extraction and clarification of juices using enzymes; Applications of enzymes in baking, starch and protein hydrolysis, meat tenderization, cheese making.

**Suggested Readings**

- Flickinger MC & Drew SW. 1999. *Encyclopedia of Bioprocess Technology*. A Wiley-Inter Science Publ.
- Kruger JE. *et al.* 1987. *Enzymes and their Role in Cereal Technology*. American Association of Cereal Chemists.
- Nagodawithana T & Reed G. 1993. *Enzymes in Food Processing*. Academic Press.
- Tucker GA & Woods LFJ. 1991. *Enzymes in Food Processing*.
- Whitehurst R & Law B. 2002. *Enzymes in Food Technology*. Blackwell Publ.

**FST 524                      FOOD PHYSICS                      2+1                      SEM - II**

**Objective**

To introduce and relate the physical characteristics of food constituents at molecular and functional level to that of the product characteristics.

**Theory**

UNIT-I: Molecular changes of conformation and charge distribution; structure and microstructure of food, its relation to texture and mouth feel, factors that affect the structure, principles of electron microscopy for structural analysis (TEM and SEM); particle size distribution, separation and its relation to food functionality.

UNIT-II: Viscoelastic response of materials (2-3 dimensional), situations at rest, under flow and confining geometry; sol-gel transitions, emulsions, foams, dispersions, gels and solids; interface formation, control and design of gelation, stability and texture, the design of new mesostructure using food components like protein, polysaccharides, fats and oils.

UNIT-III: Use of radiation in food processing and testing including X-rays, -rays, and MRI techniques.

UNIT-IV: Nano particles and applications of nanotechnology in foods, food processing, and food packaging.

**Practical**

Study of structures of some food samples using microscopes and electron microscope; Evaluation of powder foods for particle size index using standard sieves and correlation with food components; Evaluation of structure texture correlations in food samples; Preparation and evaluation of emulsions and foams in food systems and their stability under various environments; Study of gel formation and gel stability; Evaluation of liquid foods for viscosity and consistency using various instruments and the factors that affect the fluidity; Structural analysis using X-ray system. Visit to food irradiation plant; Application of nanotechnology in any one of the aspects in food.

**Suggested Readings**

Belton PS. 2005. *Chemical Physics of Food*. Blackwell Publ.  
 Figura LO & Teixeira AA. 2007. *Food Physics*. Springer Publ.  
 Physicsworld.com- features by Jamieson V.

**FST 525                      FOOD TOXICANTS AND ALLERGENS                      2+1                      SEM - II**

**Objective**

To gain an understanding of microbial, chemical and natural toxicants and allergens those are indigenously present and developed during food processing with an aim of producing safe food; to assess risk and develop detoxification strategies for the same.

**Theory**

UNIT-I: Definition, scope and general principles of food toxicology; manifestation of toxic effects; classification of food toxicants; factors affecting toxicity of compounds; methods used in safety evaluation and-risk assessments.

UNIT-II: Toxicants and allergens in foods derived from plants, animals, marine, algae and mushroom; Microbial toxins; Food Poisoning; Food borne infections and disease.

UNIT-III: Derived Food toxicants- Processing & Packaging; Toxicants generated during food processing such as nitrosamines, acrylamide, benzene, dioxins and furans; persistent organic pollutants.

UNIT-IV: Toxicology and food additives; Toxicological aspects of nutrient supplements; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods, agrochemicals; heavy metals; intentional and unintentional additives.

**Practical**

Protocol for detection & quantification of toxins in food, Detection of pesticide residues, antibiotic residues, hormones and veterinary drugs, and heavy metals; Analysis of microbial and plant toxins; Immunoassays.

**Suggested Readings**

Branen AL, Davidson PM & Salminon S. 1990. *Food Additives*. Marcel Dekker.  
 Concon JM. 1988. *Food Toxicology - Principles & Concepts*. Marcel Dekker.  
 Hathcock JN. (Ed.). 1982. *Nutritional Toxicology*. Vol. I. Academic Press.  
 Rechcigl M Jr. 1983. (Ed.). *Handbook of Naturally Occurring Food Toxicants*. CRC Press.  
 Shabbir S. 2007. *Food Borne Diseases*. Humana Press.  
 Steven T. 1989. *Food Toxicology: A Perspective on Relative Risks*.  
 Tweedy BG. 1991. *Pesticide Residues and Food Safety*. Royal Society of Chemistry.

**FST 526/                      WASTE RECYCLING AND RESOURCE                      2+1                      SEM - II**  
**CE 511                      RECOVERY SYSTEM**

(To be taught jointly by Basic Engineering and Food Science & Technology)

**Objectives**

To acquaint with importance of food wastes for resource generation. To familiar with various technologies for recycling of waste.

**Theory**

UNIT-I: Waste and its consequences in pollution and global warming, Types of food processing wastes & their present disposal methods.

UNIT-II: Treatment of plant waste by physical, chemical and biological methods, Effluent treatment plants, Use of waste and waste water.

UNIT-III: Types, availability and utilization of by-products of cereals, legumes and oilseeds, Utilization of by-products from fruits and vegetables processing industries, sugar and agro based industries, and brewery and distillery waste.

UNIT-IV: Status and utilization of dairy by-products i.e. whey, buttermilk and ghee residues, Availability and utilization of by-products of meat industry, poultry industry and fish processing units.

UNIT-V: Biomethanation and biocomposting technology for organic waste utilization, incineration and efficient combustion technology, Integration of new and renewable energy sources for waste utilization.

#### **Practical**

Study of waste utilisation processes; Various treatments in use for waste disposal; Study on operational precautions; Extraction of volatile oils from organic waste; Use of crop residue for the production of cellulose; Use of mango kernels for manufacturing of starch; Production of pectin from organic waste. Preparation of design of sewage treatment plants.

#### **Suggested Readings**

Beggs C. *Energy Management and Conservation*. Elsevier Publ.

Chaturvedi P. 2000. *Energy Management: Challenges for the Next Millennium. Energy Conservation through Waste Utilization*. American Society of Mechanical Engineers, New York.

Kreit F & Goswami DY. 2008. *Energy Management and Conservation Handbook*. CRC Press.

Murphy WR & Mckay G. 1982. *Energy Management*. BS Publ.

Patrick DR. 1982.. *Energy Management and Conservation*. Elsevier Publ.

Patrick DR., Fardo SW, Richardson RE & Steven Patrick DR. 2006. *Energy Conservation Guidebook*. The Fairmont Press.

Wulfinghoff DR. *Energy Efficiency Manual*. Energy Institute Press.

**FST 527/  
PFE 505**

### **ENERGY MANAGEMENT IN FOOD PROCESSING INDUSTRIES**

**2+1**

**SEM - I**

(To be taught by Processing & Food Engineering)

#### **Objective**

To acquaint and equip the students with different energy management techniques including energy auditing of food industries.

#### **Theory**

UNIT-I: Energy forms and units, norms and scenario, basic principles & fundamentals of energy conservation, status of energy utilization for food processing in India & abroad and opportunities of energy conservation in food processing industries.

UNIT-II: Sources of energy, energy auditing, data collection, analysis and management in various operational units of the food processing industries, passive heating, passive cooling, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in food processing industries.

UNIT-III: Cogeneration and waste heat recovery, reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Energy accounting methods, measurement of energy, design of computer-based energy management systems, economics of energy use.

#### **Practical**

Study of energy use pattern in various processing units i.e., rice mills, sugar mills, dal mills, oil mills, milk plants, food industries etc. Energy audit study and management strategies in food processing plants. Identification of energy efficient processing machines. Assessment of energy consumption, production and its cost in food processing plants, visit to related food processing industry.

#### **Suggested Readings**

Kreit F & Goswami DY. 2008. *Energy Management and Conservation Hand Book*. CRC Press.

Murphy WR & Mckay G. 1982. *Energy Management*, BS Publ.

Patrick DR. 1982. *Energy Management and Conservation*, Elsevier Publ.

Patrick DR, Fardo SW, Richardson RE & Steven, 2006. *Energy Conservation Guidebook*. The Fairmont Press.

Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*, CRC Press.

Rai GD. 1998. *Non-conventional Sources of Energy*. Khanna Publ.  
 Twindal JW & Anthony D Wier. 1986, *Renewable Energy Sources*. E & F.N. Spon Ltd.  
 Verma SR, Mittal JP & Surendra Singh. 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publ. & Distr., Ludhiana.

**FST 528                      SENSORY EVALUATION                      1+1                      SEM - II**

**Objective**

To acquaint with sensory quality parameters, and methods of sensory evaluation of foods.

**Theory**

UNIT-I: Introduction to sensory analysis; general testing conditions, Requirements of sensory laboratory; organizing sensory evaluation programme.

UNIT-II: Selection of sensory panelists; Factors influencing sensory measurements; Sensory quality parameters -Size and shape, texture, aroma, taste, color and gloss; Detection, threshold and dilution tests.

UNIT-III: Different tests for sensory evaluation of discrimination, descriptive, affective; Flavour profile and tests; Ranking tests; Methods of sensory evaluation of different food products.

UNIT-IV: Computer-aided sensory evaluation of food & beverage, statistical analysis of sensory data.

**Practical**

Selection and training of sensory panel; Detection and threshold tests; Ranking tests for taste, aroma colour and texture; Sensory evaluation of various food products using different scales, score cards and tests; Estimation of color and texture; Relationship between objective and subjective methods.

**Suggested Readings**

Amerine MA, Pangborn RM & Rossles EB. 1965. *Principles of Sensory Evaluation of Food*. Academic Press.

Early R. 1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.

Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood.

Lawless HT & Klein BP. 1991. *Sensory Science Theory and Applications in Foods*. Marcel Dekker.

Macrae R, Rolonson Roles & Sadlu MJ.1994. *Encyclopedia of Food Science & Technology & Nutrition*. Vol. XI. Academic Press.

Maslowitz H. 2000. *Applied Sensory Analysis of Foods*. Vols. I, II. CRC Press.

Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science Publ.

Potter NN & Hotchleiss JH. 1997. *Food Science*. 5<sup>th</sup> Ed. CBS.

Rai SC & Bhatia VK. 1988. *Sensory Evaluation of Agricultural Products*. Indian Agricultural Statistics Research Institute (ICAR).

Stone H & Sidel JL. 1985. *Sensory Evaluation Practices*. Academic Press.

Watts CM, Ylimaki CL, Jaffery LE & Elias LG. 1989. *Basic Sensory Methods for Food Evaluation*. Int. Dev. Res. Centre, Canada.

**FST 531/                      BIostatistics AND COMPUTERS                      2+1                      SEM - I**

**STAT 534/                      (To be taught by Statistics)**

**MBB 553/**

**SOC 512**

**Objective**

This is a course of Applied Statistics to be taken by M.Sc. students of Biotechnology, FST and Sociology departments of C.O.B.Sc. & H. They are exposed to various statistical methods to analyze their experimental data.

**Theory**

UNIT-I: Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis.

UNIT-II: Concept of probability and probability laws, mathematical expectation, moments, moments generating function; Standard probability distributions-Binomial, Poisson and Normal distributions.

UNIT-III: Tests of significance based on Z,  $\chi^2$ , t and F statistics; Correlation and regression, curve fitting by least squares methods.

UNIT-IV: Basic principles, organization and operational aspects of computers, operating systems. Introduction to MS-Office, MS-Word, MS-Excel, Statistical Data analysis based on above topics through MS-Excel.

**Practical**

Data analysis using probability, test of significance; Correlation and regression analysis; Usage of MS-Windows; Exercises on test processing, spreadsheet and DBMS; SPSS

**Suggested Readings.**

Agarwal BL. 2003. *Basic Statistics*. New Age.  
Dutta NK. 2002. *Fundamentals of Bio-Statistics*. Kanishka Publ.  
Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.

**FST 532/**                      **COMPUTER FUNDAMENTALS**                      **1+2**                      **SEM - I**  
**COMP 502**                      (To be taught by Computer Section)

**Objective**

To acquaint and equip the students about the basic concepts of Computers and Solving their day-to-day information processing problems using the computer application softwares.

**Theory**

UNIT-I: Introduction to computer organization, computer generations, input-output units; computer memory system; system and application softwares; Fundamental concepts of operating systems, Booting process, file and directory concepts through DOS and Windows .

UNIT-II: Introduction to Word Processors ; Creating and editing files in MS-Word, designing and formatting Word-documents.

UNIT-III: Introduction to spreadsheets , menus and capabilities of MS-Excel, using inbuilt mathematical and statistical functions in Excel, modification and editing of Excel work sheets, creating and editing graphs, introduction to macros -programming, data import and export.

UNIT-IV: Introduction to DBMS, creating, retrieving and updating files, sorting, indexing and using multiple files, creating and printing reports under the Data base package.

**Practical**

Operating system commands and exercises pertaining to the above mentioned packages.

**Suggested Readings**

Balagurusamy E. *Office Automation and Word Processing*.  
Courter, Microsoft Office 2000.  
Jaggi VP & Jain Sushma. *Introductory Computer Science*.  
Suresh K. Basandra, *Computers Today*.

**FST 533/**                      **BUSINESS MANAGEMENT AND**                      **3+0**                      **SEM - I**  
**ABM 535**                      **INTERNATIONAL TRADE**  
(To be taught by Business Management)

**Objective**

To acquaint the students with concepts, areas, functions and techniques of Business Management and International Trade in the context of food sector.

**Theory**

UNIT-I: The concept of business, trade, industry, firm and management; functions of management; areas of management; concept and functions of marketing; scope of marketing management; marketing mix; marketing organizational structure; micro and macro environments; consumer behaviour; consumerism; marketing research and marketing information systems.

UNIT-II: Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning; Allocation of marketing resources; Marketing Planning Process; Product policy and planning; Product-mix; product line; product life cycle; New product development process; Branding, packaging, services decisions; Marketing channel decisions: Retailing, wholesaling and distribution; Pricing Decisions: Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry.

UNIT-III: Promotion mix decisions, Advertising: functions, objectives, and types; advertising budget and advertising message; Media Planning; Personal Selling; Publicity; Sales Promotion; Food and Dairy Products Marketing.

UNIT-IV: International Marketing and International Trade; Salient features of International Marketing; Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports-Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process; Deciding marketing Programme; Product, Promotion, Price, Distribution Channels; Deciding the Market Organization; World Trade Organization (WTO).

**Suggested Readings**

Cateora Philip R & Graham John L. 2001. *International Marketing*. 10<sup>th</sup> Ed. Tata McGraw Hill.

Keegan WJ. 1996. *Global Marketing Management*. 5<sup>th</sup> Ed. Prentice Hall of India.

Kotler Philip. *Marketing Management – Analysis, Planning, Implementation and Control*. Pearson Edu.

Stanton William J, Etzel Michael J & Walker Bruce J. 1996. *Fundamentals of Marketing*, McGraw-Hill.

Terpstra V & Sarathy R. 1997. *International Marketing*. 7<sup>th</sup> Ed. The Dryden Press.

**FST 534                      APPLIED NUTRITION                      2+0                      SEM - I**

**Objective**

To acquaint the students about importance of nutrition, balanced diets, therapeutic diets for health and role of food and nutraceuticals in health.

**Theory**

UNIT-I: Importance of nutrition to health and growth; Relation of food and diseases; Nutritional requirement of human body and RDA.

UNIT-II: Preparation of balanced diets; Deficiencies of essential nutrients; Assessment of nutritional status of population; Effect of cooking and processing on nutrients; Nutritional value of processed foods; Therapeutic nutrition.

UNIT-III: Nutritional requirements of special group of people such as infants, pregnant and lactating mothers, patients, aged, etc.; Formulation of special dietary foods.

UNIT-IV: Functional foods and nutraceuticals with attributes to control cardiovascular diseases, cancer, obesity, ageing etc.; Food components and nutrients affecting immune systems, behaviour and performance.

UNIT-V: Functional aspects of dietary fibre, amino acids & peptides, antioxidants, vitamins, fatty acids etc. Assessment of nutritional quality of food, Formulation of nutrient rich foods.

**Suggested Readings**

Bamji MS, Rao NP & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.

Joshi SA. 1999. *Nutrition and Dietetics*. Tata McGraw Hill.

Khanna K, Gupta S, Passi SJ, Seth R & Mahna R. 1997. *Nutrition and Dietetics*. Phoenix Publ.

Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

**FST 601                      ADVANCES IN FOOD CHEMISTRY                      3+0                      SEM - I**

**Objective**

To understand the concepts and advances in food chemistry with the aim of gaining knowledge for development of shelf-stable, safe, convenient, healthy and nutritious foods.

**Theory**

UNIT-I: Functional properties of food ingredients, Glass transitions and molecular mobility in foods, their relevance to quality and stability of food products, Interactions among food components and their effect on sensory, nutritional and processing quality.

UNIT-II: Carbohydrates sources, properties, modification and applications in food products, low energy sweeteners, Protein sources, structure and functional properties and interactions, Protein technology and food application isolation, concentration, modification, hydrolysis and functional peptides, texturization.

UNIT-III: Nutritional and functional aspects of food lipids, genesis and sources of -3, -6 and trans-fatty acids, Chemical, physical and enzymatic approach to tailor made fats,



Formulation of fat products and shortenings, fat replacers, Lipid degradation during deep-fat frying and storage.

UNIT-IV: Flavouring compounds: essential oils, terpenoids-oleoresins, Interactions among food flavours and packaging materials, Interactions among food additives and their significance in food processing.

UNIT-V: Alkaloids, toxins, allergens, contaminants, agrochemical residues, fumigants & veterinary drugs in foods ó health risks, detection and methods for removal/management, Concept of organic farming and certification systems.

#### **Suggested Readings**

*Advances in Food and Nutrition Research*. Elsevier Book Series.

Aurand LW, Woods A & Wells MR. 1987. *Food Composition and Analysis*. AVI Publ.

Baynes JW, Monnier VM, Ames JM & Suzanne R. 2005. *The Maillard Reaction: Chemistry at the Interface of Nutrition, Aging, and Disease Thorpe*. Annals of the New York Academy of Science.

Birch GG & Lindley MG. 1986. *Interactions of Food Components*. Elsevier.

Fennema OR. 1996. *Food Chemistry*. Marcel Dekker.

Kumar A & Gaonkar G. 1995. *Ingredient Interaction: Effect on Food Quality*. Marcel Dekker.

### **FST 602                      MODERN FOOD MICROBIOLOGY                      2+1                      SEM - I**

#### **Objective**

To expose the students to recent advances and applications in the area of food microbiology.

#### **Theory**

UNIT-I: Foods as ecological niches, Relevant microbial groups, Harmful microbes in raw materials and foods, Factors that influence the growth of microbes in food, newer and rapid methods for qualitative and quantitative assay demonstrating the presence and characterization of microbes, stress, damage, adaptation, repairation, death.

UNIT-II: Microbial growth in food: intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Effects of enzymes and other proteins, Combination systems, Effect of injury on growth or survival, Commercial available databases.

UNIT-III: Microbial behaviour against the newer methods of food processing, Adaption and resistance development, Microbes as test organisms, as sensors and as tools for future applications in energy production and food and non food industrial products.

UNIT-IV: Modern methods of cell culture: synchronous and co- cell culture, continuous cell culture in liquid and solid media, Cell immobilization and applications, Pre and probiotics cultures.

#### **Practical**

Evaluation of microorganism in raw and processed products by using various techniques, Study of factors influencing growth of microorganisms, determination of effects of various preservatives including antibiotics on the suppression of microbial growth, Development of cell cultures using various techniques, production of newer microbial metabolites of industrial importance, development of probiotics in lab.

#### **Suggested Readings**

Adams M. 2006. *Emerging Food-borne Pathogens*. Woodhead Publ.

Adams MR & Moss MO. 2000. *Food Microbiology*. Panima.

Easter MC. 2003. *Rapid Microbiological Methods in the Pharmaceutical Industry*.

Harrigan W. 2003. *Laboratory Methods in Food Microbiology*. University of Reading, UK, Elsevier.

James MJ, Loessner MJ & David A. 2005. *Modern Food Microbiology*. 7<sup>th</sup> Ed. Golden Food Science Text Series.

Pederson CS. 1979. *Microbiology of Food Fermentations*. AVI Publ.

Roberts R. 2002. *Practical Food Microbiology*. Blackwell Publ.

Rossmore HW. 1995. *Handbook of Biocide and Preservative*. Blackie.

Wood JBB. 1999. *Microbiology of Fermented Foods*. Vols. I, II. Blackwell Academic.

Yousef AE. 2002. *Food Microbiology: A Laboratory Manual*. AVI.

**FST 603                      FOOD PROCESSING                      2+0                      SEM - I**

**Objective**

To develop an insight among the students about the existing modern techniques so as to make them aware about their methodology and applications in food processing.

**Theory**

UNIT-I: Membrane technology: Introduction to pressure activated membrane processes: micro- filtration, UF, NF and RO and their industrial application. Supercritical fluid extraction: Concept, property of near critical fluids, NCF and extraction methods, Advances in extrusion process.

UNIT-II: Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.

UNIT-III: High Pressure processing: Concept, equipments for HPP treatment, mechanism of microbial inactivation and its application in food processing. Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques.

UNIT-IV: Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation. Nanotechnology: Principles and applications in foods.

**Suggested Readings**

Barbosa-Canovas. 2002. *Novel Food Processing Technologies*. CRC.

Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*.

Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie.

Gould GW. 2000. *New Methods of Food Preservation*. CRC.

Shi J. (Ed.). 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC.

**FST 604                      PRODUCT DESIGN AND DEVELOPMENT                      2+1                      SEM - II**

**Objective**

To enable the student to plan and prepare a project report for food processing unit and to provide capability to execute and evaluate the same.

**Theory**

UNIT-I: Concept of product development - product success and failure, factors for success, process of product development, managing for product success. Innovation strategy - possibilities for innovation, building up strategy, product development programme.

UNIT-II: The product development process - product strategy, product design and process development, product commercialization, product launch and evaluation.

UNIT-III: The knowledge base for product development technology - knowledge and the food system, knowledge management, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing).

UNIT-IV: Role of consumers in product development - consumer behaviour, food preferences, avoiding acceptance, integration of consumer needs in product development and sensory needs.

UNIT-V: Managing the product development process, - principles of product development management, people in product development management, designing the product development process, key decision points, establishing outcomes, budgets and constraints, managing and organizing product development process.

UNIT-VI: Improving the product development process - key message, evaluating product development, innovative matrices, striving for continuous improvement, Improving success potential of new products, market exploration and acquisition, Legal aspects of new product launch.

**Practical**

Locating new product opportunities, Assessment of raw materials availability, Input output analysis, Cost analysis for new products, Testing the product for consumer

acceptability, Planning of requirements for manufacture of new products in industry, Positioning of product in market, Launching and market evaluation.

**Suggested Readings**

Clarke & Wright W. 1999. *Managing New Product and Process Development*. Free Press.  
Earle & Earle. 2001. *Creating New Foods*. Chadwick House Group.  
Earle R, Earle R & Anderson A. 2001. *Food Product Development*. Woodhead Publ.  
Fuller 2004. *New Food Product Development - from Concept to Market Place*. CRC.

<b>FST 605</b>	<b>FLAVOUR CHEMISTRY AND TECHNOLOGY</b>	<b>2+0</b>	<b>SEM - II</b>
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**Objective**

To make students to understand the science behind the art of flavouring foods, their analysis, the problem of off-flavours and the reasons thereof, development of flavours for specific applications, and legal aspects on use of flavours in food products.

**Theory**

UNIT-I: Sources of flavours (natural, processed and added), Flavour composites (natural, semi-synthetic and synthetic).

UNIT-II: Genesis of flavours in food ó natural and processed foods (Maillard's Reaction and Lipid Oxidation).

UNIT-III: Analysis of flavours (subjective and objective); Formulations of flavours, adulteration, Flavour emulsions, Flavours production in fermented foods, Off-flavours in foods.

UNIT-IV: Spices and spice-based products ó essential oils and oleoresins, Plantation crops as flavours, tea, coffee, cocoa and vanilla.

UNIT-V: Sensory evaluation of flavours, selection of flavourist, flavours and legal issues.

**Suggested Readings**

Ashurst PR. 1994. *Food Flavorings*. 2<sup>nd</sup> Ed. Blackie.  
Burdock GA. 2004. *Fenaroli's Handbook of Flavor Ingredients*. 5<sup>th</sup> Ed. CRC Press.  
Deibler D & Delwiche J. 2004. *Handbook of Flavor, Characterization: Sensory Analysis, Chemistry and Physiology*. Marcel Dekker.  
Heath HB & Reineccius G. 1986. *Flavor Chemistry and Technology*. AVI Publ.  
Taylor A. 2002. *Food Flavour Technology*. Sheffield Academic Press.

<b>FST 606</b>	<b>CARBOHYDRATE CHEMISTRY AND TECHNOLOGY</b>	<b>2+1</b>	<b>SEM - II</b>
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**Objective**

To cater to the emerging areas of industrial manufacturing, properties and applications of carbohydrates and their products in food product development and food packaging.

**Theory**

UNIT-I: Different carbohydrates in food products such as starch, cellulose, sugars, pectin, fibres (significance in diet, isolation from natural sources, chemistry and changes therein during processing).

UNIT-II: Chemical and enzymatic modification of carbohydrates especially starches and celluloses, manufacture of maltodextrins and corn syrups, Cyclodextrins ó chemistry, technology and food applications.

UNIT-III: Interactions with other food constituents and their implications; Newer carbohydrates for food applications such as xanthan, dextran, pullulan, gellan, curdlan and -glucans (nutraceutical and functional properties)

UNIT-IV: Stabilization of food systems, simulated and low-fat foods, Fat-substitutes based on carbohydrates, Carbohydrate-based biodegradable packaging.

**Practical**

Isolation and assay of food carbohydrates; synthesis and analysis of modified carbohydrates such as starches and celluloses; evaluating gelling abilities of different polysaccharides, their blends and the effect of food ingredients such as salts, sugars and acids; development of food products with newer carbohydrates in relevant food systems.

**Suggested Readings**

Eliasson AC. 1999. *Carbohydrates in Foods*. Marcel Dekker.  
Eliasson AC. 2004. *Starch in Food: Structure, Function and Applications*. Woodhead Publ.  
Kritchevsky D & Bonfield C. 1994. *Dietary Fiber in Health and Disease*. AACC.

- Roberfroid M. 2004. *Inulin-Type Fructans: Functional Food Ingredients*. Woodhead.
- Roy L, Whistler JN & Miller B.1981. *Carbohydrate Chemistry for Food Scientists*. AACC.
- Stephens AM. 2000. *Food Polysaccharides and their Applications*. Marcel Dekker.
- Steve W Cui. 2000. *Polysaccharide Gums from Agricultural Products: Processing, Structures and Functionality*. CRC.
- Tomasik P. 2003. *Chemical and Functional Properties of Food Saccharides*. CRC.

**FST 607                      PROTEIN CHEMISTRY AND                      2+1                      SEM - II**  
**TECHNOLOGY**

**Objective**

To cater to the emerging areas of industrial manufacturing, properties and applications of proteins, and their products in food product development and food packaging.

**Theory**

UNIT-I: Protein structure and chemistry; protein-protein interactions, methods of evaluation of protein quality and amount, Conventional and novel sources of protein.

UNIT-II: Production of proteins, protein concentrates/isolates from legumes, oilseeds, fish, seafood, leaf, microbes.

UNIT-III: Functional properties of proteins and their applications; Structure-function relationships of different food proteins, textured vegetable proteins and different methods of texturization.

UNIT-IV: High protein food formulations, Modification of proteins by enzymic (manufacture of protein hydrolysates, their characterization and applications), chemical and physical methods.

UNIT-V: Interactions of proteins with flavours, polysaccharides, lipids and their technological effects, Protein-based fat substitutes, Protein engineering.

**Practical**

Isolation of proteins from different raw materials such as soybeans, oilseed meals, fish, leaves, milk; preparation of protein isolates, concentrates and hydrolysates and evaluation of their nutritional and functional properties; development of high-protein food formulations; visits to industrial units manufacturing protein-based products.

**Suggested Readings**

- Damodaran S & Paraf A. 1997. *Food Proteins and their Applications*. Marcel Dekker.
- Gennadios A. 2002. *Protein-Based Films and Coatings*. CRC.
- Sikorski ZE. 2001. *Chemical and Functional Properties of Food Proteins*.CRC.
- Yada R. 2004. *Proteins in Food Processing*. Woodhead.

**FST 608                      LIPID CHEMISTRY AND TECHNOLOGY                      2+1                      SEM - II**

**Objective**

To cater to the emerging areas of industrial manufacturing, properties and applications of lipids and the products derived there from in food product development with the aim of improved nutritional and technological benefits.

**Theory**

UNIT-I: Nutritional aspects of food lipids and their sources; omega-3 and omega-6 fatty acids and their significance, Phytosterols and their nutraceutical significance.

UNIT-II: Measurement of lipid degradation parameters during deep-fat frying and storage of foods. Flavour emulsions and their stability.

UNIT-III: Fat powders like cream, butter, cod-liver oil etc. and techniques involved such as micro encapsulation, Fat substitutes based on carbohydrates and proteins.

UNIT-IV: Formulation and characterization of low-fat spreads, whipped creams, margarines, mayonnaise, salad dressings etc. Bakery shortenings chemistry, formulation and technology.

UNIT-V: *Trans*-fatty acids- formation during processing and nutritional aspects, Enzymatic approach to tailor made fats.

**Practical**

Assay of lipid degradation and polymerization products in fried foods and fried oils; analysis of phytosterols, *trans*-fatty acids and omega fatty acids; preparation of fat and cream powders; formulation and stabilization of low fat spreads, margarines and mayonnaise based on locally available fats; applications of emulsifiers in industrially produced foods.

**Suggested Readings**

- Akoh CC. 2005. *Handbook of Functional Lipids*. Taylor & Francis.  
Dutta PC. 2004. *Phytosterols as Functional Food Components and Nutraceuticals*. Marcel Dekker.  
Garti N & Kiyotaka S.2001. *Crystallization Processes in Fats and Lipid Systems*. Marcel Dekker.  
Gunstone F. 2006. *Modifying Lipids for Use in Food*. Woodhead.  
O'Brien RD.1998. *Fats and Oils - Formulating and Processing for Applications*. Woodhead.  
Sikorski ZE & Kolakowska A. 2002. *Chemical and Functional Properties of Food Lipids*. CRC.

**FST 609**                      **CURRENT TOPICS IN FOOD SCIENCE**                      **2+0**                      **SEM - II**  
**AND TECHNOLOGY**

**Objective**

Discourses and discussions on the selected important and relevant latest topics pertaining to food science and technology.

**Theory**

UNIT-I: Functional properties of food components, new food ingredients, new food product development.

UNIT-II: Nano-technology in food processing and packaging, innovation in bio-preservation.

UNIT-III: Organic foods, functional foods, GM foods, authentication of food sources.

UNIT-IV: Advances in food quality, risk assessment, food safety concerns, emerging food pathogens.

UNIT-V: Current issues in food science.

**Suggested Readings**

Selected articles from books and journals.

# FOOD SCIENCE AND TECHNOLOGY

## List of Journals

- Advances in Food Sciences
- Agri.-Food Perspectives
- Asia Pacific Food Industry
- Cereal Foods World
- Dairy Foods
- Dairy Packaging Newsletter
- Dairy Technology Paper
- Developments in Food Analysis Techniques
- Developments in Food Colours
- Developments in Food Science
- Food and Agricultural Chemistry
- Food & Fermentation Industries
- Food Additives and Contaminants
- Food Pack.com
- Food Technology
- Haryana Journal of Horticultural Sciences
- Horticultural Science
- Indian Dairyman
- Indian Food Industry
- Indian Food Packer
- Indian Horticulture
- International Food Hygiene
- International Journal of Food Microbiology
- International Journal of Food Science & Technology
- International Journal of Food Sciences & Nutrition
- Indian Food & Beverage Technology
- Italian Journal of Food Science
- Journal of Food and Agricultural Chemistry
- Journal of Dairy Research
- Journal of Dairy Science
- Journal of Food Science
- Journal of Food Engineering
- Journal of Food Industry
- Journal of Food Process Engineering
- Journal of Food Processing & Preservation
- Journal of Food Products Marketing
- Journal of Food Protection
- Journal of Food Quality
- Journal of Food Safety
- Journal of Food Science and Nutrition
- Journal of Food Science and Technology
- Journal of Food and Drug Analysis
- Journal of the Science of Food and Agriculture
- Plant Foods for Human Nutrition
- Post harvest Biology and Technology
- Trends in Food Science and Technology

## e-Resources

- [www.cftri.com/department/fostis.htm](http://www.cftri.com/department/fostis.htm)

- [www.ifst.org](http://www.ifst.org)
- [www.hau.ernet.in/cfst.htm](http://www.hau.ernet.in/cfst.htm)
- [www-fst.ag.ohio-state.edu](http://www-fst.ag.ohio-state.edu)
- [www.gbpuat.ac.in/acads/cag/fsct.htm](http://www.gbpuat.ac.in/acads/cag/fsct.htm)
- [www.fst.nus.edu.sg/](http://www.fst.nus.edu.sg/)
- [www.foodsciencecentral.com](http://www.foodsciencecentral.com)
- [www.ift.org/](http://www.ift.org/)
- [www.vasatwiki.icrisat.org](http://www.vasatwiki.icrisat.org)
- [www.nysaes.cornell.edu/fst](http://www.nysaes.cornell.edu/fst)
- [www.cifst.ca](http://www.cifst.ca)
- [www.iufost.org](http://www.iufost.org)
- [www.foodscience.unsw.edu.au/](http://www.foodscience.unsw.edu.au/)
- [www.usda.gov](http://www.usda.gov)
- [www.fnic.nal.usda.gov/](http://www.fnic.nal.usda.gov/)
- [mohfw.nic.in/pfa.htm](http://mohfw.nic.in/pfa.htm)
- [www.fda.gov](http://www.fda.gov)
- [www.iflr.msu.edu](http://www.iflr.msu.edu)
- [www.ift.org/divisions/food\\_law/ -](http://www.ift.org/divisions/food_law/)
- [www.food.gov.uk/foodindustry/regulation/](http://www.food.gov.uk/foodindustry/regulation/)
- [www.foodsafety.gov](http://www.foodsafety.gov)
- [www.mofpi.nic.in/](http://www.mofpi.nic.in/)
- [www.ficci.com](http://www.ficci.com)
- [www.indianfoodindustry.net/](http://www.indianfoodindustry.net/)
- [www.pfonline.com/](http://www.pfonline.com/)
- [www.beverageandfoodworld.com](http://www.beverageandfoodworld.com)
- [www.worldoffoodindia.com](http://www.worldoffoodindia.com)
- [www.jadavpur.edu](http://www.jadavpur.edu)
- [www.udct.org](http://www.udct.org)
- [www.foodregulatorysummit.org](http://www.foodregulatorysummit.org)
- [www.icmr.nic.in](http://www.icmr.nic.in)
- [www.apeda.com](http://www.apeda.com)
- [www.foodtecindia.com](http://www.foodtecindia.com)
- [www.etfoodprocessing.com](http://www.etfoodprocessing.com)
- [www.modernfoodprocessing.in](http://www.modernfoodprocessing.in)
- [www.indianspices.com](http://www.indianspices.com)
- [www.absfoodingredients.com](http://www.absfoodingredients.com)
- [www.iip-in.com](http://www.iip-in.com)
- [www.foodqualitynews.com](http://www.foodqualitynews.com)
- [www.foodstradeholding.com](http://www.foodstradeholding.com)
- [www-fst.ag.ohio-state.edu](http://www-fst.ag.ohio-state.edu)
- [www.foodscience.unsw.edu.au](http://www.foodscience.unsw.edu.au)
- [www.ourfood.com](http://www.ourfood.com)
- [www.bis.org.in](http://www.bis.org.in)
- [www.haccpindia.org](http://www.haccpindia.org)
- [www.cfsan.fda.gov](http://www.cfsan.fda.gov)
- [www.agmark.com](http://www.agmark.com)
- [www.fao.org](http://www.fao.org)
- [www.ifc.org](http://www.ifc.org)
- [www.foodnetbase.com](http://www.foodnetbase.com)
- [www.fruitandvegetable.ucdavis.edu](http://www.fruitandvegetable.ucdavis.edu)
- [www.ifis.org](http://www.ifis.org)
- [www.worldfoodscience.org](http://www.worldfoodscience.org)
- [www.astaindia.com](http://www.astaindia.com)

### **Suggested Broad Topics for Master's and Doctoral Research**

- Development of low cost processing technologies
- Development of health/functional foods
- Development of instant foods
- Food safety and quality control
- Enhanced shelf life of perishables
- Reduction of post harvest losses
- Utilization of non-conventional fruits and vegetables
- Minimum processing of fruits and vegetables
- Development, optimization and evaluation of processing machinery
- Development of shelf stable ready to eat foods as home meal replacement
- Development of instant and convenience foods
- Development of probiotic foods
- Development of fermented foods and beverages
- Development of organic foods
- Assessment of different varieties for use in specific products
- Evaluation of different varieties for specific processing technologies
- Evaluation and optimization of traditional processing technologies
- Development of technologies for traditional products
- Utilization of byproducts of processing
- Development of processes for extraction and concentration of food ingredients
- Development of intermediate moisture foods
- Development of fruit drinks and shelf stable concentrates and powders
- Development of extruded products, low fat and high fibre foods
- Formulation and development of new products and food ingredients
- Use of medical, aromatic and under-utilized crops in food products