

M. Sc in Food Science and Technology (SYLLABUS)

Duration : 2 Yrs (Four Semesters)

Level : Post Graduate

Type: Degree

Admission Requirements: BSc in Food and Nutrition /B.Sc.in Food Science/ Bachelor's degree in any other branch of Science and Technology .

M. Sc or Master of Food Science and Technology is a post graduate course. Food Science & Technology is the application of science and technology to the sorting, grading, processing, storage or preserving, refining , mixing, blending, heating, drying, manufacturing, handling, packaging, quality control, and distribution food materials , and also use of good quality, safe, nutritious, healthy, and wholesome food.

Increasing technology for value addition of plant , animal, and agricultural resources has made food production extremely complex thus causing a need for a very specialised knowledge based and trained Food Science & Technology professional who can grasp and apply such expertise effectively.

In addition the course also includes a significant quantum of industrial learning giving students the opportunities to boost their specialist professional skills facilitate independent learning and implement a reflective and practical approach to practice.

Under this program students gain a close perspective of real-world problems to food science and technology. Students interested in more detailed learning of the subject can apply for higher education in national or international forum.

The Master degree course in Food Science & Technology is an important and careers oriented nature that opens a lot of job opportunities for the candidate in the position of Food technologist, Nutritional therapist, Product or Process development scientist, Quality control manager, Regulatory affairs officers or Food safety officers, Scientific laboratory technician, Production manager, Technical brewer, etc.

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SL No.	Category	Subject Code	Subject Name	Contact hours/ week			Credit
				L	T	P	
SEMESTER-I							
Theory							
	Major		Nutritional Biochemistry	3	0	0	3
	Major		Microbiology	3	0	0	3
	Major		Analytical Techniques and Research Methodology	3	0	0	3
	Major		Principles of Food Processing Technology	3	0	0	3
	Major		Introductory Mathematics & Biostatistics	3	0	0	3
	Major		Journal Club and Seminar Presentation	2	0	0	2
	Non credit		English Communication	0	0	0	0

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	compulsory		Skills (non credit compulsory course)				
Total theory				17			
Practical							
	Laboratory -I		Microbiology Lab	0	0	6	3
	Laboratory -II		Biochemistry and Analytical techniques Lab	0	0	6	3
Total Practical				12			
Total of semester I							
Semester II							
Theory							
	Major		Food Chemistry	3	0	0	3
	Major		Technology of Fruit and Vegetables	3	0	0	3
	Major		Technology of Cereals, Pulses and Oilseeds	3	0	0	
	Major		Technology of Milk and Milk Products	3	0	0	
	Major		Industrial Visit and	0	0	3	

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			Reporting				
Theory Total						15	
Practical							
	Laboratory - III		Food Chemistry Lab	0	0	6	3
	Laboratory - IV		Food Process Technology Lab	0	0	6	3
Total Practical						12	
Semester III							
	Major		Technology of Meat, Poultry and Fish :	3	0	0	
	Major		Process Control and Instrumentation	3	0	0	
	Major		Food Safety and Quality Control	3	0	0	
	Minor (Elective)		Elective –I (Group A)	3	0	0	
	Minor (Elective)		Elective II(Group B)	3	0	0	

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	Major Project -I		Dissertation –I (progress)	3	0	0	
			Total Theory	18			
			Practical				
	Laboratory V		Milk and Milk product processing Lab	0	0	4	2
	Laboratory VI		Meat and Fish Processing Lab	0	0	4	2
						8	4
			Semester IV				
	Major		Project			16	8
	Major		Dissertation-II			18	9
	Major		Grand Viva			4	

Course Contents

MAJOR COURSES

Semester I

Nutritional Biochemistry

Unit I. Definition, Introduction to biomolecules, Introduction to biochemical and metabolic pathways.

Unit II. Carbohydrate metabolism, Pathway of glycolysis & its regulation, Energetics & Role of hormone, Pathway of TCA cycle & its regulation, Energetics & Role of hormone, Glycogen metabolism & its regulation, Energetics & Role of hormones, HMP Shunt pathway & its regulation, Protein sparing action of carbohydrate, Inborn error of carbohydrate metabolism (galactosemia), Glycoprotein & Proteoglycan

Unit III. Lipid Metabolism Fatty acid synthesis, Lipoprotein synthesis, β -oxidation & ω -oxidation Forward cholesterol, transportation (LDL & VLDL), Reverse cholesterol transportation (HDL), Disorders of lipid metabolism, Dyslipidemia & Lipid storage disease, Ketosis & Ketone body metabolism.

Unit IV. Protein Metabolism, Deamination, Transamination & Transmethylation Urea cycle, Protein structure, Inborn error of amino acid metabolism, Nucleic acid Metabolism, Metabolism of Purine and Pyrimidine, Diseases due to abnormal nitrogen base metabolism, DNA replication, mutation, repair & recombination, Gene Expression, Gene expression in eukaryotes & its regulation (Normal), Translation & post translational modification, Inhibitors of protein biology, Gene expression in mitochondria

Unit V. Enzymes, Enzyme kinetics including inhibition in enzyme kinetics, Co-enzyme & Co-factors, Enzyme in clinical diagnosis, Vitamins, Free radical, ROS & Oxidation, Xenobiotics & its Metabolism

Microbiology

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, vegetables, grains and oilseeds, meat and poultry; 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; Food poisoning and food borne infections; Microbial toxins in food.

UNIT III : Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms; Rapid methods in 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, yeast and molds; Standard plate count; Yeast and mould count; Spore count; Detection and enumeration of pathogenic and indicator organisms in food; MPN of coli forms; Enumeration of physiological groups- psychrophile, thermotolerants, osmophiles and halophiles. Evaluation of microbiological quality of commonly consumed street foods.

Suggested Readings : Banawart GJ. 1989. Basic Food Microbiology. 2nd Ed. AVI Publ. Frazier J & Westhoff DC. 1988. Food Microbiology. 4th Ed. McGraw Hill. Garbutt J. 1997. Essentials of Food Microbiology. Arnold Heinemann. Jay JM,

Loessner MJ & Golden DA. 2005. Modern Food Microbiology. 7th Ed. Springer.
Ray B. 2004. Fundamentals of Food Microbiology. 3rd Ed. CRC.
Robinson RK. (Ed.). 1983. Dairy Microbiology. Applied Science.
Steinkraus KS. 1996. Handbook of Indigenous Fermented Foods. Marcel Dekker. FST

Analytical techniques and Research methodology

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 labelling.

Theory

UNIT I : Sampling techniques; Water activity, its measurements and significance in food quality; Calibration and standardization of different instruments.

UNIT II : Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry, microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.).

UNIT III : Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS.

UNIT IV : Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation, solid phase extraction, supercritical fluid extraction, isoelectric focusing, isotopic techniques, manometric techniques.

UNIT V : Special techniques: Immunoassay techniques; Isotopic, non-isotopic and enzyme immunoassays; surface tension; enzymatic methods of food analysis; thermal methods in food analysis (Differential scanning calorimetry and others).

Practical

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Sorption isotherms by measuring water activity in any hygroscopic food material (for instance - biscuits/potato chips/coffee powder); Estimation of tannin/phytic acid by spectrometric method; moisture and fat analysis by NIR spectroscopy; Separation of amino acids and organic dyes by two dimensional paper chromatography; Separation and identification of sugars in fruit juices; Separation of proteins by ion-exchange chromatography; Separation and identification of carotenoids by column chromatography; Free fatty acid content detection by solvent extraction; Identification and determination of organic acids by HPLC.

Suggested Readings

AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities. Kirk RS & Sawyer R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Longman Scientific & Technical. Leo ML. 2004. Handbook of Food Analysis. 2nd 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. 24 Nielsen S. (Eds.). 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett. Pomrenz Y & Meloan CE. 1996. Food Analysis - Theory and Practice. 3rd Ed. CBS. Ranganna S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill. Robinson JW. 1970. Undergraduate Instrumental Analysis. Marcel Dekker.

Principles of Food Processing Technology

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.

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UNIT II : Processing and preservation by heat – 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 preservation of foods; food fermentations, pickling, smoking etc; Food additives: definition, types and functions, permissible limits and safety aspects.

Suggested Readings Arsdel WB, Copley MJ & Morgan AI. 1973. Food Dehydration. 2nd Ed. Vols. I, II. AVI Publ. Desrosier NW & James N.1977. Technology of Food Preservation. 4th Ed. AVI. Publ. Fellows PJ. 2005. Food Processing Technology: Principle and Practice. 2nd Ed. CRC. Jelen P. 1985. Introduction to Food Processing. Prentice Hall. Potter NN & Hotchkiss 1997. Food Science. 5th Ed. CBS. Potty VH & Mulky MJ. 1993. Food Processing. Oxford & IBH. Ramaswamy H & Marcotte M. 2006. Food Processing: Principles and Applications. Taylor & Francis.

Introductory Mathematics & Biostatistics

Credits

Unit I Calculus review Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima; Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient and Directional derivatives; Chain rule; Maxima and Minima.

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Unit II Ordinary Differential Equations First order differential equations: Exact equations, Integrating factors and Bernoulli equations. Second and higher order differential equations Linear ODE's with constant coefficients: the characteristic equations; Cauchy-Euler equations; Linear dependence and Wronskians; Method of undetermined coefficients; Method of variation of parameters; Laplace transforms: Inverse theorem, shifting theorems, partial fraction

Unit III Linear Algebra Basics: Vectors, matrices, determinants; Matrix addition and multiplication; Systems of equations: Gauss elimination, Matrix rank, Linear independence, Cramer's rule; Inverse of a matrix: Gauss-Jordan elimination; Eigenvalues and Eigenvectors: characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skew-symmetric, normal). Numerical methods Solution of equations by iteration; Interpolation by polynomials; Piecewise linear and cubic splines; Numeric integration and differentiation; Linear systems: Gauss elimination, Gauss-Seidel, matrix inversion; LU factorization; Matrix eigenvalues; Numerical solution of ODEs: Euler and Runge-Kutta methods, Predictor Biostatistics

Unit IV Probability and Statistics - Definition of Probability, Relative frequency, Probability distribution (Binomial, Poisson & normal), simple examples. Statistics - Measure of central tendency – Mean (for grouped & ungrouped data); Measure of dispersion- Standard Deviation (for grouped & Ungrouped data); Sampling theory –Statistical population, Sample from population, Random sample; Statistical Hypothesis - Test of significance, Test for proportion, means & standard deviations, Chi-square test of goodness of fit, t-test, F-test. Correlation & Regression (linear) - Associated test of significance, simple problems.

Unit V Fundamental concepts in applied probability - Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformation Corrector methods; Exposure to software packages like Matlab or Scilab.

Texts/References 1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998. 2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999. 3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, John Wiley,

SEMESTER II

Food Chemistry

Objective

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

To acquaint with importance of various foods and nutrients in human nutrition.

Theory

UNIT I : Definition and importance; major food constituents and their physicochemical properties; role of water in food.

UNIT II : Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.

UNIT III Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, allergens, toxins and anti-nutritional factors in foods; 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.

Practical

Proximate analysis of content of protein and fat in foods; Nitrogen value determination and calculation of calorific value of foods; TSS; pH; acidity; estimation of browning intensity; determination of vitamin C and

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betacarotene, sugars; estimation of calcium, phosphorus and iron; antinutritional factors in foods.

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.

Technology of fruit and vegetables

Objective

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

Theory

UNIT I : Importance & scope of post harvest management of fruits and vegetables in Indian economy. 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 II : 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 pre-treatments - chemicals, wax coating, pre-packaging, VHT and irradiation.

UNIT III : 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. Processing for pulp, puree and concentrates, especially from mango, tomato, guava, papaya, apple, pineapple, pomegranate, grapes etc. using aseptic packaging, canning, RTS fruit beverages, IQF and frozen fruits and vegetables; for peas, mango pulps etc.

UNIT IV : Technology for processed products like pickles, chutneys, sauces particularly from raw mango, lime and other regional fruits and vegetables of importance.

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 powders using spray drying. Processing of fruits for candies, bars, toffees, jams and jellies, squashes and syrups using locally available fruits like papaya, mango, aonla and other under-utilized fruits.

Practical

Evaluation of pectin grade; canning of mango/guava/papaya; preparation and quality evaluation of fruit jam: apple/ mango/ guava /papaya / strawberry and fruits of regional importance; fruit jelly, wood apple, sweet orange/mandarin/guava,/tamarind; fruit marmalade: ginner 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 anardana; preparation of papain /guava jam, jelly and marmalade ; preparation of pickle, mixed pickle; preparation of dried ginger; preparation of amchur; preparation of dried onion and garlic; preparation of banana and potato wafers; preparation of 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.

Technology of cereals, pulses and oilseeds

Objective

To acquaint with production and consumption trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of various cereals, pulses and oilseeds.

Theory UNIT I : General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

UNIT II : Wheat: Types and physicochemical characteristics; wheat milling - products and by-products; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat atta, blended flour and fortified flour.

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

UNIT IV : Corn: Types and nutritive value; dry and wet milling, manufacture of value-added products; processing of barley, oats, sorghum and millets.

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UNIT V : Legumes and oilseeds: composition, anti-nutritional factors, processing and storage; processing for production of edible oil, meal, flour, protein concentrates and isolates; extrusion cooking technology; snack foods; development of low cost protein foods.

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, 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; machineries used in bakery industry.

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; visit to related processing industries. 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. Practical

Determination of thermal inactivation time of enzymes; Thermal processing of foods; Dehydration of foods; Refrigeration Freezing of foods; Concentration of foods; Use of chemicals in preservation of foods; Fermented food products; For Extrusion cooking of foods: Visit to a food processing plant.

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. Hosney RS. 1994. Principles of Cereal Science and Technology. 2nd Ed. AACC. Kay DE. 1979. Food Legumes. Tropical Products Institute. Kent NL. 1983. Technology of Cereals. 4th Ed. Pergamon Press. Kulp K & Ponte GJ. 2000. Handbook of Cereal Science and Technology. 2nd Ed. Marcel Dekker. Lorenz KL. 1991. Handbook of Cereal Science and Technology. Marcel Dekker. Marshall WE & Wadsworth JI. 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. Intersci. Publ. 28 Watson SA & Ramstad PE. 1987. Corn; Chemistry and Technology. AACC.

Technology of milk and milk products

Objective

To acquaint with techniques and technologies of testing and processing of milk into various products and by 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 & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.

UNIT II : Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture

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of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder. UNIT III (Lectures 6) 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. 2nd Ed. Taylor & Francis. Web BH, Johnson AH & Lford JA. 1987. Fundamental of Dairy Chemistry. 3rd Ed. AVI Publ. 31

Semester III

TECHNOLOGY OF MEAT, POULTRY AND FISH :

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, Effect of processing on meat tenderisation, fish harvest, freezing and processing techniques.

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

UNIT III: Poultry industry in India, microbiology of poultry meat, spoilage factors; Lay-out and design of poultry processing plants, Plant sanitation; Poultry meat processing operations, equipment used. Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg

products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

UNIT IV: Commercially important marine products from India; product export and its sustenance; basic biochemistry and microbiology; preservation of postharvest fish freshness; cold chain transportation in refrigerated vehicles; preservation of shell fish; pickling and preparation of fish protein concentrate, fish oil and other by products. Handling of fish and meat waste by-products

Practical

Slaughtering and dressing of meat animals; study of post-mortem changes; meat cutting and handling; pickled meat and fish products, pre-valuation 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. 32 Kerry J. et al. 2002. Meat Processing. Woodhead Publ. CRC Press. Levie A. 1984. Meat Hand Book. 4th 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. 3rd Ed. Chapman & Hall. Stadelman WJ & Cotterill OJ. 2002. Egg Science and Technology. 4th Ed. CBS.

Process Control and Instrumentation

Objective:

Unit I: Process variables : Need for their measurement and control pressure measurement by mechanical and electrical transducers. Low pressure measurement by Mcleod Gage and Pirani gage. Temperature measurement by bi-metal thermometers, resistance thermometer thermistors, thermocouples. Radiation and optial pyrometers.

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Unit II : Flow measurement by Hot – Wire anemometer and magnetic flow meters. Visualization by shadow-graph and interferometer. Liquid level measurement in open vessels and in pressure vessels.

Unit III : Thermal conductivity measurement of solids, liquids and gases. Measurement of diffusivity in gases. Block diagrams. Transfer function closed-loop and open-loop control systems. Response of first order systems and first order systems. Response of time constant.

Unit IV : Different types of controllers. Final control elements. Closed loop transfer functions. Stability Root locus method. Frequency response. Level control. Flow control. Dynamics and control of heat exchangers and distillation columns.

Unit V: case study

Suggested Readings

Food Safety and Quality control

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 procedures 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

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(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;

Unit IV : 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.

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. Vol. I, II. AVI Publ. Macrae R, Roloson R & Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XVI. Academic Press. Piggot J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science. Ranganna S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Ed. Tata-McGraw-Hill. Export/Import policy by Govt. of India.

Technology of milk and milk products

Objective

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

Theory

(Effective for 2019-2020 Admission session)

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 & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.

UNIT II : Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder. UNIT III (Lectures 6) 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, shrihand, 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, shrihand, 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. 2nd Ed. Taylor & Francis. Web BH, Johnson AH & Lford JA. 1987. Fundamental of Dairy Chemistry. 3rd Ed. AVI Publ. 31

Food Biotechnology - Elective

Objective

To provide knowledge of current practices in the sector of food technology which can acquaint the students more about the latest developments and waste utilisation

Theory

UNIT I Biotechnology- definition, scope and applications, Application of Biotechnology in food (Food industries), pharmaceuticals and agriculture, Application of biotechnology for food plant waste utilization, biogas plants.

UNIT II : Introduction to nutraceuticals and functional foods, definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX. Nutraceuticals for different human metabolic disorders, dosage levels, contraindications if any etc.

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

UNIT III : Prebiotics, Probiotics, preparation and their mechanism of action . Enzymes– classification, properties, characterization, kinetics and immobilization; fermentative production of enzymes (amylases, proteases,

cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing.

UNIT IV : GMO, genetic recombination mechanisms and technique used for improvement in microbial strains, Recombinant-DNA technology (plasmids and cloning), Expression of foreign genes, Promoters (Enzyme), Biomass production by using various microorganisms.

UNIT V : 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. 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 such as anthocyanases); baking (fungal α -amylase for bread making; maltogenic α -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); meat and meat processing (meat tenderization); egg processing.

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 Inc. 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; Brigelius-Flohé, J & Joost HG. 2006. Nutritional Genomics: Impact on Health and Disease. Wiley VCH. 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. Angi-angiogenic Functional and Medicinal Foods. CRC Press. Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press. Campbell JE & Summers JL. 2004.

Dietary Supplement Labeling Compliance. Neeser JR & German BJ. 2004. Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall. Robert EC. 2006. Handbook of Nutraceuticals and Functional Foods. 2nd 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. Enzymes in Food Technology. Blackwell Publ. FST

Food packaging technology - Elective

Objective

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

Theory

UNIT I : Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selection of packaging materials; Types of packaging materials: Paper: pulping, fibrillation and beating, types of papers and their testing methods; Glass: composition, properties, types of closures, methods of bottle making; Metals: Tinplate containers, tinning process, components of tinplate, tin free steel (TFS), types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, co-extrusion, edible films, biodegradable plastics.

UNIT II : Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods, selection and design of packaging material for different foods.

(Effective for 2019-2020 Admission session)

UNIT III : Food packaging systems: Different forms of packaging such as rigid, semirigid, flexible forms and 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 IV : Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.

UNIT V 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

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. 22 FST 506

Artificial Intelligence in Food Plant Automation - Elective

Objective

Introduce the role of computerization in processing, particularly for communication, process and quality optimization, automation, simulation, designing and manufacture.

Theory

UNIT I Importance of Computerization and IT in Food Industries Computers, operating environments and information systems for various types of food industries; Principles of Communication.

UNIT II Role of Computer in Optimization: Introduction to operation Research; A Computer Oriented Algorithmic approach; Queuing systems and waiting models; PERT, CPS and CPM.

UNIT III Food Process Modeling and Simulation; CAD and CAM in Food Industry: instrumentation, process Control, inventory Control, Automation, Robotics, Expert system and artificial intelligence. Practical Applications of MS Excel to solve the problems of food technology: Statistical quality control,

Unit IV Sensory evaluation of food, and Chemical kinetics in food processing; Use of word processing software for creating reports and presentation; Familiarization with the application of computer in food industries -Milk plant, Bakery Units, Fruit & Vegetable processing Unit; Familiarization with software related to food industry; Ergonomics application in the same; Visit to Industry and case study problems on computer.

Suggested Readings Gillett BE. Introduction to Operation Research (A Computer Oriented Algorithmic Approach). Groover MP & Zimmers EW. 1987. CAD/CAM: Computer Aided Design and Manufacturing. Prentice Hall. Singh RP. 1996. Computer Applications in Food Technology. Academic Press.

Entrepreneurship and Business management- Elective

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

Syllabus of M. Sc. In Food Science & Technology

(Effective for 2019-2020 Admission session)

Objective To acquaint with techniques of Business Management & International Trade for food sector.

Theory

UNIT I : Concept and functions of marketing; concepts and scope of marketing management; concepts and elements of marketing mix.

UNIT II : Concept of market structure, micro and macro environments; Consumer behaviour; consumerism; Marketing opportunities- Analysis, marketing research and marketing information systems.

UNIT III (Lectures 10) Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning, Allocation and marketing resources, Marketing Planning Process, Product policy and planning: Product-mix; product line; product life cycle, New product development process. Product brand, 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, Promotion-mix decisions.

UNIT IV (Lectures 10) Advertising; how advertising works? Deciding advertising objectives, advertising budget and advertising message, Media Planning, Personal Selling, Publicity; Sales Promotion, Food and Dairy Products Marketing.

UNIT V (Lectures 10) 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

Chhabra TN & Suria RK. 2001. Management Process and Perspectives. Kitab Mahal. Jhingan ML. 2005. International Economics. 5th Ed. Virnda Publ. Kotler

P. 2000. Marketing Management. Prentice Hall. Reddy SS, Ram PR, Sastry TVN & Bhavani ID. 2004. Agricultural Economics. Oxford & IBH.

Speciality Food and Beverage - Elective

Objective

To impart basic and applied technology of baking and confectionary, beverages and acquaint with the manufacturing technology of different food products.

UNIT I : Technology for grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes, coated grains-salted, spiced and sweetened; flour based – 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 – salted, spiced and sweetened; chikkis . Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; 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 III : Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging. Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy-based beverages.

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

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. Handbook of Brewing. Marcel Dekker. Hui YH. et al 2004. Handbook of Food and Beverage Fermentation

Applied Nutrition-Elective

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 & 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, lactic acid bacteria, antioxidants, vitamins, fatty acids etc. Assessment of nutritional quality of food.

Suggested Reads

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

Syllabus of M. Sc. In Food Science & Technology

(Effective for 2019-2020 Admission session)

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.

47 PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT

Objective

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

Theory

Unit I: Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Unit II: Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection;

Unit III: Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity;

Unit IV: International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WB

Syllabus of M. Sc. In Food Science & Technology

(Effective for 2019-2020 Admission session)

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford. Ganguli, Prabudha. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill, New Delhi. India, Ministry of Agriculture. 2004. State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues. Academic Foundation, New Delhi. Intellectual Property Rights: Key to New Wealth Generation.2001. NRDC and Aesthetic Technologies, New Delhi. Rothschild, Max & Newman, Scott (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI, Wallingford. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya, Delhi. The Indian Acts - Patents Act, 1970 & amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 & amendments; Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

Industrial visit and extension / outreach programme II sem