

Department of Food Engineering & Technology
Tezpur University

Detail syllabus and course structure for

“Ph.D. Programme in Food Engineering & Technology”

(As per 21st Meeting of the Academic Council Item No: AC.21/2013/2/3.2)

COURSE STRUCTURE

(Prior to submission of plan of Research minimum 16 credits to be completed)

Code	Course name	L	T	P	CH	CR
FT 701	Doctoral Research Methodology	4	0	0	4	4
FT 700	Seminar	0	0	1	2	1
Core Course	One course from FP 701 or FT 702				5	4
FP 70*	Elective	3	0	0	3	3
CBCT	To choose from list of PhD CBCT courses offered by other departments	4	0	0	4	4
	Mandatory Credit					16
FP 715	Ph. D. Research work and Thesis					

Core courses (At least one from the following)

Code	Course name	L	T	P	CH	CR
FP 701	Advanced Food Technology	3	0	1	5	4
FT 702	Advanced Techniques of Food Analysis	2	1	1	5	4

Elective Courses

Code	Course name	L	T	P	CH	CR
FP 705	Advances in Plant Products Technology	3	0	0	3	3
FP 706	Advances in Animal Products Technology	2	0	1	4	3
FP 707	Food Enzyme Technology	2	0	1	4	3
FP708	Statistical Methods and computer applications in Food and Consumer Research	3	0	0	3	3
FP 711	Nutrition and functional foods	3	0	0	3	3
FP 712	Global Food Regulation and Trade	3	0	0	3	3
FP 715	Ph. D. Research					

L= lecture, T= Tutorial, P= Practical, CH= Contact Hour, CR= Credit

1 practical credit is of 2 hours duration

FT 701 Doctoral Research Methodology 4-0-0

Introduction and overview of research: Definition, philosophy and objective of research; history and types of research; impact of research on society and development

Safety issues in research laboratory: physical, chemical and biological perspectives.

Literature Review and Research Formulation: Primary and secondary sources; use of online literature search tools; evaluating internet and web resources; identifying gap areas from literature review; how to develop a research idea; statement of hypothesis and specific aims

Experimental design, data collection and analysis: Writing background and significance; design of experiments; primary data and secondary data, methods of primary data collection, classification and summarization of data; presentation of data – diagrams and graphs; and statistical analysis; validation; upgradation.

Scientific/technical writing and research presentation: Types, Structure and components of Scientific Reports; Technical Reports and Thesis; Steps in the preparation of reports and thesis-layout, structure and language of typical reports, illustrations and tables, bibliography, referencing and foot notes; components of a good oral research presentation; use of visual aids; importance of effective communication; citation, impact factor, h-index and acknowledgement

Ethics in research: Responsible conduct; the regulations and ethics of animal use in research; Research ethics for human subjects; intellectual property rights; patenting of process and products; reproduction of published material; plagiarism

Components of a good oral research presentation: content, slide preparation, presentation, interaction, acknowledgement

Application of computer in research: Basic principles of Statistical Computation using various softwares; design of experiments and analysis of results using various softwares (MATLAB, ORIGIN, SIGMAPLOT, Design Expert, etc)

Books:

1. Montgomery, D. C., (2001). Design and Analysis of experiments, Fifth Edition, John Wiley & Sons.
2. Kothari, C.R.(2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi
3. Vining, G. G., Kowalski, S. (2010). Statistical Methods For Engineers.2nd Edn. Cengage Learning (RS), Boston, USA.

Fundamentals of food structure: Polymer solutions of food, phase transitions of importance in foods, Food colloids, mechanical and rheological properties of foods.

Examination of food microstructure: Light microscopy, transmission electron microscopy, scanning electron microscopy, spectroscopy and other techniques; Image analysis: Image acquisition, processing and analysis.

Microstructural components and functional properties of food carbohydrates, proteins and lipids: their analysis and application in various food systems.

Food structuring: structuring and texture improvement; freezing, crystallization, milling, crushing, baking and other operations. Microstructural approach to heat and mass transfer operations during processing of foods. Food quality and microstructure: measurement of texture and structural aspects of food texture.

Distillation: Vapour liquid equilibria, flash vaporization, differential distillation, steam distillation, azeotropic distillation and extractive distillation for binary system.

Mechanical and Membrane separation processes: Centrifugal separation, filtration, reverse osmosis, nano-filtration, ultra-filtration, micro-filtration, molecular weight cut-off in each case. Membranes and their characteristics, Pumps and other membrane equipments.

Drying and dehydration: Technological aspects and applications of drying and dehydration of foods, osmotic and freeze drying of foods. Drying equipments.

Solid-liquid and liquid –liquid extraction processes: Principles, choice of solvents, extraction equipments. Leaching.

Super critical fluid extraction: Super critical fluid state, properties of supercritical fluids. Supercritical phase equilibria, SCFE systems and equipment, applications in food.

Crystallization: equipments, crystal growth, crystallization process.

Extrusion: Theory, extrusion cooking, single and twin screw extruders, forming and snack food extruders.

Microwave and Infrared Heating: Theory, Equipment and applications in food industry.

Preservation by Irradiation: Principles and applications.

Emerging food processing techniques: Theory and application of Pulsed Electric Field in food processing, Dielectric and Ohmic heating, High Pressure processing and other new technologies.

Practicals:

Study and design of equipment for distillation, membrane separation and extrusion, Evaluate performance of microwave heating, study of leaching process. Visit to Food Processing Plants.

Books:

1. José Miguel Aguilera and David W. Stanley, *Microstructural Principles of Food Processing and Engineering*, Springer, 1999
2. D.J.McClements and E. Dickinson. *Advances in Food Colloids*, 1st ed. Springer, 1996.
3. E.Dickinson and E. Martin. *Food Colloids*. Springer, 2007.
4. J.Andrew. *Food Texture: Measurement and Perception*. Springer, 1999..
5. Z.E.Sikorski, *Chemical and Functional Properties of Food Components*, 3rd ed. CRC Press. 2006.
6. Christie J. Geankoplis, *Transport Processes and Separation Process Principles*, 4th ed., Prentice Hall of India, 2006
7. Da-Wen Sun, *Emerging technologies for Food Processing*, Elsevier, 1st ed., 2005

8. Warren L. McCabe, Julian C. Smith and Peter Harriot, *Unit Operations of Chemical Engineering*, 5th ed., McGraw Hill, 1993

References:

1. M. Bourne. *Food Texture and Viscosity: Concept and Measurement*, 2nd ed. Academic Press. 2002.
2. Z.E. Sikorski. *Chemical and Functional Properties of Food Proteins*. CRC Press. 2001.
3. B. Dimitrios and A. Kolakowska. *Chemical and Functional Properties of Food Lipids*. CRC Press. 2002.
4. P. Tomasik. *Chemical and Functional Properties of Food Saccharides*. CRC Press, 2003.
5. P. Fellows, *Food Processing Technologies: Principles and Practice*, 2nd ed., CRC Press, 2003
6. R.P. Singh and D.R. Heldman, *Introduction to Food Engineering*, 3rd ed., Academic Press, 2001
7. Gustavo V. Barbosa Canovas, *Novel Food Processing Technologies*, 1st ed., CRC Press, 2005
8. J. E. Lozano, *Trends in Food Engineering*, 1st ed., Technomic, 2000

FT 702 Advanced Techniques of Food Analysis

2-1-1

Gas liquid chromatography: principle; different types of detectors and its applications: discharge ionization detector (DID), electron capture detector (ECD), flame photometric detector (FPD), Hall electrolytic conductivity detector (EICD), helium ionization detector (HID), Nitrogen phosphorous detector (NPD), mass selective detector (MSD), photo-ionization detector (PID), pulsed discharge ionization detector (PDD), thermal energy analyzer (TEA); various applications of GLC.

High performance liquid chromatography (HPLC): different types of HPLC and their principles; Normal phase chromatography, Reverse phase chromatography, Size exclusion chromatography, Ion exchange chromatography, Bioaffinity chromatography, Isocratic flow and gradient elution, various Applications of HPLC.

High performance thin-layer chromatography (HPTLC): principles and applications. Electrophoresis: current tools used to assess the safety of food and feed derived from modern biotechnology.

Amino acid analysis by different techniques like Amino acid analyzer, etc.

Rapid Visco Analyser (RVA): its application as a laboratory scale rheological tool. **Differential scanning calorimetry:** principles and its applications.

Atomic absorption spectroscopy: principles and its applications.

Inductively coupled plasma atomic emission spectroscopy (ICP-AES): principles and its applications.

Gas chromatography-mass spectrometry (GC-MS): principles and applications in foods, flavors and fragrances, residue analysis of veterinary hormonal substances and endocrine disruptors, identification of terpenes.

Liquid chromatography-mass spectrometry (LC-MS): principles and applications, plant phenols, proteins, proteomics, LC-MS for identification of post-translational modifications, oligosaccharides, lipids and phospholipids, nucleic acids.

Scanning Electron Microscopy principles and applications, study of the structure of a variety of food gels.

Non Destructive Techniques in Food Analysis: optical methods like visible, NIR, and FTIR spectroscopy; computer vision, delayed light emission and fluorescence; X-ray imaging for

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classifying food products based on internal defects; nuclear magnetic resonance techniques ; ultrasonics; firmness-measurement methods; linear viscoelastic methods; biosensors in food quality evaluation, new techniques for food quality data analysis and control

Microbial techniques in food analysis: Infectious and toxigenic agents of food borne diseases: detection, identification and control methods. Antibiotic resistant strains; methods of detection-conventional, modern, rapid methods, genetic approaches.

Molecular based techniques in food analysis: Gel Electrophoresis of Plasmid DNA, Polymerase Chain Reaction (PCR) & Sequencing; Setting up a Gene-Specific Polymerase Chain Reaction, Gel Electrophoresis of Gene-Specific PCR Products, Determining DNA Concentration Using Fluorometer, Amplification of cDNA Using PCR, Sequencing of Gene-Specific Products. Real-time PCR assay for detection of microbial spoilage of foods.

Practicals: Practical will be performed on most of the above referred methods will depend on equipment available. .

Books:

1. Francis Rouessac and Annick Rouessac. *Chemical Analysis: Modern Instrumentation Methods and Techniques*, John Wiley & Sons Ltd. 2007
2. C. Moir. *Spoilage of Processed Foods: Causes and Diagnosis..* AIFST Inc. (NSW Branch) Food Microbiology Group, Sydney. 2001
3. C. Blackburn. *Food Spoilage Microorganisms*. CRC Press, 2006
4. D. Tagu and C. Moussard, *Techniques of Molecular Biology*, Science Publishers, 2006
5. Lawrence Jack Bradshaw, *Introduction to Molecular Biological Techniques*, Prentice-Hall, 1966
6. Julian Burke, *PCR: Essential Techniques*, John Wiley & Sons, 1996

References:

1. B. Welz, *Atomic Absorption Spectrometry*, Third Edition, Wiley-VCH, Weinheim, Germany 1998
2. Eugene F. Barry; Grob, Robert Lee. *Modern practice of gas chromatography*. New York: Wiley-Interscience. 2004
3. Wilfried M.A. Niessen, Wilfried M. Niessen. *Liquid Chromatography-Mass Spectrometry*, Third Edition (Chromatographic Science). Boca Raton: CRC. 2006
4. M.P. Doyle and M. Doyle, *Food Microbiology: Fundamentals and Frontiers*, 3rd ed. ASM Press. 2007.
5. Querol and G.H. Fleet. *Yeasts in Food and Beverage*. Springer Publishing, 2006
7. Kary B. Mullis, François Ferré and Richard A. Gibbs, *The Polymerase Chain Reaction: A Textbook*, Birkhäuser, 1994

FP 705 Advances in Plant Products Technology

3-0-0

Introduction to foods of plant origin: Fruits and nuts; cereal grains; legumes; Foods from leaves, stem and roots; spices and herbs; Beverages: both alcoholic and non alcoholic; vegetable oils and fats; gums, gels and resins. Their processing and preservation.

Nutritional and sensory quality of plant foods: Nutritional value of plant foods; effect of processing on nutritional quality, sensory attributes and level of antioxidants and other functional

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ingredients of plant foods. Quality evaluation of plant foods by chromatography, spectrometry, Scanning electron microscopy and various non-destructive techniques.

Improvement of quality of crops and plant foods: Organic farming; fortification of foods of plant origin, their nutritional value and economic aspects.

Plant substances as substitutes for animal products in foods: Animal protein substitutes; milk fat substitutes, etc.

Application of novel techniques of food processing to plant foods: Application of pulsed electric field assisted extraction of juice from food plants, application of PEF to orange juice products; Use of high pressure to processing and preservation of plant foods; use of ultra-violet light, ultra sound, microwave an ohmic-heating technology for processing of plant foods; extraction of essential oils by super-critical fluid extraction; application of non-thermal techniques for plant food processing.

Application of biotechnology to foods of plant origin: Transgenic plants; biotechnology for the improvement of nutritional quality of foods from plants; genetic modification of plant seed storage protein for food production; chemistry, biosynthesis and engineering of starches and other carbohydrates for food application; chemistry and engineering of vegetable oils and fats; plant cell and tissue culture for production of food ingredients; Plant pigments, their characteristics, biosynthesis and gene regulation and application as food additives; Regulation and risk of genetically modified foods and transgenic plants.

Books:

1. D. K. Salunkhe and S. S. Deshpande, *Foods of Plant Origin: Production, Technology, and Human Nutrition*, Van Nostrand Reinhold, 1991
2. Anthony Uyekpen Osagie, Offiong Udo Eka and Victor Ogieva Igodan, *Nutritional Quality of Plant Foods*, Post Harvest Research Unit, Dept. of Biochemistry, University of Benin, 1998
3. Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, *Novel Food Processing Technologies*, CRC Press, 2005
4. Octavio Paredes-Lopez, *Molecular Biotechnology for Plant Food Production*, CRC Press, 1999

References:

1. K.W. Fuller and J.R. Gallon, *Plant Products and the New Technology*, Clarendon press, 1985
2. Donald Kiteley Tressler and Maynard Alexander Joslyn, *Fruit and Vegetable Juice Processing Technology*, Avi Pub. Co., 1961
3. Tong-Jen Fu, Gurmeet Singh and Wayne R. Curtis, *Plant Cell and Tissue Culture for the Production of Food Ingredients*, Springer, 1999
4. Martin Teitel, PH. D. Teitel and Kimberly Ann Wilson, *Genetically Engineered Food: Changing the Nature of Nature*, Inner Traditions / Bear & Company, 2001
5. Tibor Cserhádi and Esther Forgács, *Chromatography in Food Science and Technology*, CRC Press, 1999
6. Sundaram Gunasekaran, *Nondestructive Food Evaluation: Techniques to Analyze Properties and Quality*, CRC Press, 2000
7. M. Shafiur Rahman, *Handbook of Food Preservation*, CRC Press, 2007
8. Pieter A. Luning, F. Devlieghere and Roland Verhé, *Safety in the Agri-food Chain*, Wageningen Academic Publishers, 2006

9. Monika J. A. Schröder, *Food Quality and Consumer Value: Delivering Food that Satisfies*, Springer, 2003

FP 706 Advances in Animal Products Technology

2-0-1

Meat: Genetic engineering of farm animals for better meat quality, automation for the modern slaughterhouse, hot-boning of meat, new spectroscopic techniques for online monitoring of meat quality, real-time PCR for the detection of pathogens in meat, new developments in decontaminating raw meat, automated meat processing, developments in chilling and freezing of meat, high pressure processing of meat, approaches for the development of functional meat products, new techniques for analyzing raw meat, modified atmosphere packaging, perspectives for the active packaging of meat products

Poultry: Breeding and quality of poultry, stunning and slaughter of poultry, processing and packaging of poultry, new techniques of preservation of poultry, production of turkeys, geese, ducks and game birds, microbial hazards in poultry production and processing, latest trends in measuring quality of poultry and poultry products, treatment and disposal of poultry processing waste.

Fish and seafood: Fresh fish handling and chill storage, modified atmospheric packaging of seafoods, fish odours and flavours, assessment of freshness of fish and seafoods, traditional dried and salted fish products, proteolysed fish products, minced fish technology, retort pouch processing technology, irradiation and microwave in fish handling and processing, advanced freezing technology for fish storage, high pressure processing of seafoods, value addition of freshwater and aquacultured fish products, application of enzymes in fish processing and quality control, toxins, pollutants and contaminants in fish and seafoods.

Milk: Physical, chemical and nutritional properties of milk components, improvements in the pasteurization and sterilization of milk. Flavour generation in dairy products, controlling texture of fermented dairy products, functional dairy products, on-line measurement of product quality in dairy processing, high pressure processing of milk products, novel separation technologies to produce dairy ingredients, new technologies to increase shelf-life of dairy products, genetic engineering of milk proteins, production and utilization of functional milk proteins, methods of improving nutritional quality of milk, significance of milk fat in dairy products, chromatographic, spectrometric, ultrasound and other techniques for analysis of milk lipids.

Practical: Analysis of fresh and processed meat, fish, poultry and milk products, Preservation of fresh meat and fish, processing and production of different products from fresh meat, fish and milk, shelflife studies on different meat, fish and milk products. Visit to processing plants.

Books:

1. Advanced Technologies for Meat Processing, By Leo M. L. Nollet, Fidel Toldnl, Published by CRC Press, 2006
2. Meat Processing: Improving Quality, By Joseph Kerry, D.A. Ledward, Published by Woodhead Publishing, 2002
3. Advances in fish processing Technology, By D. P. Sen, Published Allied Publishers
4. Modern dairy technology. Vol. I , Advances in milk processing, By R. K. Robinson, Published by Elsevier
5. Modern dairy technology. Vol. 2, Advances in milk products, By R. K. Robinson, Published by Elsevier
6. Poultry Meat Processing and Quality, By G.C. Mead, NetLibrary, Inc, Published by Woodhead Publishing, 2004
7. Seafood Processing: Adding Value Through Quick Freezing, Retortable Packaging, and Cookchilling, By Vazhiyil Venugopal, Published by CRC Press, 2006

References:

1. Production and Processing of Healthy Meat, Poultry and Fish Products, By A. M. Pearson, Thayne R. Dutson,

Published by Springer, 1997

2. HACCP in Meat, Poultry and Fish Processing: Advances in Meat Research Series, By A. M. Pearson, T. R. Dutson, Published by Springer, 1999
3. Designing Foods: Animal Product Options in the Marketplace, By National Research Council (U.S.). Committee on Technological Options to Improve the Nutritional Attributes of Animal Products, National Research Council (U. S.), Published by National Academies Press, 1988
4. Poultry Products Processing: An Industry Guide, By Shabtai Barbut, Published by CRC Press, 2001
5. Fish Processing Technology, By G. M. Hall, Published by Springer, 1997
6. Advanced Dairy Chemistry: Volume 1: Proteins, By P. F. Fox, P. L. H. McSweeney, Published by Springer, 2003
7. Advanced Dairy Chemistry: Volume 2 Lipids, By P. F. Fox, P. L. H. McSweeney, Published by Springer" 2006
8. Milk and Milk Products: Technology, Chemistry, and Microbiology, By A. H. Varnam, Jane P. Sutherland, Published by Springer, 2001
9. Animal Cell Technology: Principles and Products, By Michael Butler, Published by Taylor & Francis, 1987
10. Safety and Quality Issues in Fish Processing, By H. Allan Bremner, Published by CRC Press, 2002

FP 707 Food Enzyme Technology

2-0-1

Introduction: Brief overview, classification and nomenclature, storage and handling, units of activity, general characteristics; cofactors, coenzymes, prosthetic group and enzyme specificity. Nature of active sites, enzyme-substrate complex. Mechanism of Enzyme Catalysis. Environmental effects on enzyme activity, Assay of enzyme activity.

Principle of industrial enzyme production: Enzyme production, selection of microorganisms and other sources, increasing yield of enzymes, model of enzyme synthesis, cultivation techniques, enzyme recovery, cell disruption, extraction, separation and purification.

Immobilized enzymes: Chemical and physical methods of immobilization. Effect on microenvironment: partition. Effect of diffusional restriction on kinetics. Enzyme reactors. Batch and continuous reactors: CSTR, PBR, FBR. Reactor kinetics. Large-scale use of immobilized enzymes, e.g. glucose isomerase. Applied thermodynamic and kinetic control of enzyme reactions. Aqueous and non-aqueous liquid biphasic systems: effect on equilibria.

Application of enzymes in the food industry: Glycosidic Hydrolases: Specificity. Amylases; Dough Development. Baking. Bread Staling. Cellulases ; Food Processing Uses. β -Fructofuranoside; Invert Sugar. β -Galactosidase: Lactose-Reduced Dairy Products. Pectic Enzymes: Pectinesterase, Polygalacturanases, Pectic Lyases, Fruit & Juice Processing, Wine-Making. Proteolytic Enzymes: Specificity Requirements; Aspartic Proteases; Chymosin, Milk-Clotting, Cheese Ripening. Sulfhydryl Proteases: Papain, Bromelin & Ficin. Serine Proteases. Metallic Proteases. Esterases: Lipase; Cheese-ripening, Bakery Foods. Oxidoreductases: Glucose Oxidase; High Fructose Corn Syrup. Lipoxygenase; Baked Foods

Practicals:

Study of enzyme kinetics, Determination of enzyme activity of different enzymes, Production and purification of enzymes from microbial and other sources, Application of enzymes for clarification and extraction of fruit juices and other food processes.

Books:

1. John R. Whitaker, Alphons G. J. Voragens and Domonic W.S. Wong, *Handbook of food Enzymology*, Marcel Dekker, 2003
2. Daniel L. Purich, *Contemporary Enzyme Kinetics and Mechanism*, Academic Press, 1996

3. R. Eisenthal and M. J. Danson, *Enzyme Assays a Practical Approach*, Oxford University Press, 1992

References:

1. David L. Nelson and Michael M. Cox, *Lehninger Principles of Biochemistry*, 4th ed., W.H. Freeman and Co., 2006
2. John R. Whitaker, *Principles of Enzymology for food science*, Marcel Dekker, 1994

FP 708 Statistical Methods and Computer Applications in Food and Consumer Research **3-0-0**

Experimental design: Simple comparative experiments, completely randomized designs, randomized complete block designs, Latin square designs, change over designs.

Incomplete block experimental designs: balanced incomplete block designs, composite complete-incomplete block designs.

Factorial experiments: 2ⁿ and 3ⁿ factorial experiments, pxq and pxqxk factorial experiments, simple compounding and fractional factorial experiments.

Response surface designs and analysis: fittings of response surfaces, first and second order models, composite designs, rotatable designs.

Regression analysis

Nonparametric statistical methods

Additional nonparametric tests- Wilcoxon test, Mann-Whitney U test, Wilcoxon-Mann-Whitney Rank Sums test, Spearman's ranked correlation, Friedman test, Kruskal-Wallis Test, The Page Test, The Jonckheere Test.

Application of computer in food technology: Use of spread sheets in graphical, statistical and process analysis. Use of different softwares for statistical analysis of quality and process characteristics; Minitab, Design Expert, Statistix, Surfer etc. Computer aided process control; Basics of computer aided process control, process control computer hardware and software. Design of computer aided process control systems; Programmable logic controller, Distributed control system,

Books:

1. M.C. Gacula, Jagbir Singh, B.S. Schweigat, J. Hawthorn, G.F. Stewart (eds). *Statistical Methods in Foods and Consumer Research*, Academic Press, 1989
2. M. O'Mahony, *Sensory evaluation of food: Statistical methods and Procedures*, CRC. 1986
3. R. Paul Singh, *Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical, and Process Analyses*, Academic Press, 1996
4. S.K. Singh, *Computer Aided Process Control*, PHI Learning Pvt. Ltd., 2004

Nutrition

Role of high-energy phosphate in energy storage, electron transport chain and oxidative phosphorylation; Enterocyte contribution to digestion, digestive system disorders and metabolic effects; Alcohol metabolism; Cis-and trans-fatty acids, eicosanoids, steroids, lipoprotein, health implications of lipoprotein-cholesterol levels, integrated metabolism in tissues; functional categories of proteins, protein turnover, protein under- and over- nutrition, protein quality; Distribution of water in the body, sweat water, urinary water, water balance, dehydration and intoxication, role of kidneys, regulation of pH; Role of micronutrients in gene expression, synthesis of purines and pyrimidines, Deficiency, toxicity and assay of vitamins; Mineral bioavailability; Integrated energy metabolism, major metabolic pathways; Methods of assessing body composition, adipocytes, regulation of energy intake, storage and expenditure, energy homeostasis, neuro endocrine influences, assessment of energy expenditure, treatment of obesity; Adaptation to acute and chronic exercise, nutrient metabolism during activity; Cardiovascular disease and nutrition; Cancer and nutrition; Diabetes and nutrition; Osteoporosis and nutrition; Inborn errors of metabolism; Nutrigenomics

Functional foods

Neutraceuticals; Health attributes of functional foods; Health functionality of food components- dietary fiber, newly developed oligosaccharides, sugar alcohols, amino acids, peptides and proteins, vitamins, lactic acid bacteria, minerals, fatty acids, phytochemicals, antioxidants, tocopherols, tocotrienols, isoflavones, flavonoids, lycopene, limonene, organosulfur compounds, docosahexaenoic acid, caffeine; separation technologies of functional food component.

Books:

1. R.E.C. Wildman and D.M. Medeiros *Advanced Human Nutrition*, CRC Press. 1999.
2. S.A.S. Gropper, J.L. Smith, J.L. Groff. *Advanced Nutrition and Human Nutrition 5th ed.* Wadsworth Publication Co. 2008.
3. I. Goldberg *Functional Foods*, Springer. 1994.
4. J. Shi, Mazza and Maguer *Functional Foods: Biochemical and Processing Aspects*, CRC Press. 2002.

References:

1. C.D. Berdanier. *Advanced Nutrition-Macronutrients 2nd ed.* CRC Press. 2000.
2. C.D. Berdanier and T.K. Adkins. *Advanced Nutrition-Micronutrients. Vol II* CRC Press. 1997.
3. R.E.C. Wildman *Handbook of Neutraceuticals and Functional Foods* CRC Press, 2000.

FP 712 Global Food Regulation and Trade

3-0-0

Food regulation in an open economy, globalizations of the food supply;

Trade-related regulations in the global food system, economic rationales for food regulation, classification of regulations, risk analysis and appropriate degree of caution, trade effects of food

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regulation, science and economics in risk-reducing regulations, capture of regulations by producers or consumers, welfare enhancing regulation of food trade;

Global food regulatory framework, multilateral governance of food regulation, the SPS Agreement, the TBT Agreement, the TRIPS Agreement, enforcement of the multilateral disciplines., the Doha development agenda negotiations;

Control of animal and plant pests and diseases, animal and plant pests and diseases and their control, trade issues related to agricultural pests and disease, animal and plant regulations in practice, managing agricultural trade in the presence of risks;

Food safety and control of human health hazards, food safety regulation, trade issues and food safety, controlling natural food-borne pathogens, the health effects of yield enhancing inputs, managing trade related food safety issues;

Regulating quality through labeling and standards, private and public provision of information, food quality regulation in practice, impacts of labeling and standards on trade;

Emerging food regulation issues, scope for trade conflicts, labeling process attributes, international regulation of process attributes, recent regulatory developments :genetically modified foods, organics, and animal welfare, the challenges ahead;

Toward a safe and open global food supply, assessment of the state of food regulation, role of the WTO in the food regulatory frameworks, recommendations for improving regulation, seizing the opportunities from trade.

References:

1. Roberts, Donna and Laurian Unnevehr *International Trade and Food Safety* ed. Sy J. Buzby. Agricultural Economics Report 828. Washington : Economic Research Service. USDA. 2002
2. Tim Josling, Donna Roberts and David Orden *Food Regulation and Trade: Towards a Safe and Open Global System*. Institute for International Economics. 2004