

M.Sc. (Food Science & Technology)

Syllabus

FIRST SEMESTER

BIO 6111: Food and Dairy Microbiology [3 1 0 4]

History of microbiology of food and dairy, Microbial growth pattern, physical and chemical factors, History and development of Microbiology-Importance and significance of microorganisms in food and dairy science. Factors affecting the growth of microorganisms in food-Intrinsic and Extrinsic parameters. Determination of microorganisms and their products in food and dairy: Sampling, sample collection, transport and storage, sample preparation for analysis. Classification of foods and general principles involved in their preservation. Effects on microbes of: Low temperature preservation, lethal effects of chilling, freezing and thawing; high temperature preservation. Heat resistance of microorganism, heat penetration and thermal processing. Pasteurization, sterilization, canning and dehydration; chemical preservation and its toxic effects; irradiation.

References:

1. Doyle, M. P., Diez-Gonzalez, F., & Hill, C. (Eds.). (2020). Food microbiology: fundamentals and frontiers. John Wiley & Sons.
2. Banwart, G. (2012). Basic food microbiology. Springer Science & Business Media.
3. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). Modern food microbiology. Springer Science & Business Media.
4. Pelezar, M. I., & Reid, R. D. (1993). Microbiology. 5th Ed. McGraw Hill Book Company, New York.
5. Prescott, L. M., Willey, J. M., Sherwood, L., & Woolverton, C. J. (2014). Prescott's microbiology. McGraw- Hill Education.
6. Jay, J. M. (2000). Modern Food Microbiology. 2nd Ed. CBS Publisher.
7. Frazier, W.C. (2017). Food Microbiology. 5th Ed. Mc Graw Hill Inc.

BIO 6112: Fermentation Technology [3 1 0 4]

Fermentation: History, definition and types. Study of a Bio-fermenter, aeration and agitation in fermentation, Types of fermentation systems: batch and continuous systems, fed-batch culture, solid substrate fermentation instrumentation. Dairy Fermentations-starter cultures and their types, Microbial enzymes, role in various industrial processes, Bio-transformations, Immobilized enzymes-based bioreactors; Bioconversion of substrates, anti-nutritional factors present in feeds, Food fermentations: Bacterial, yeast and mold cultures; single and mixed cultures, propagation, maintenance and evaluation of cultures; Microbiology of fermentation: Fermented milks. Cereal foods, vinegar, oriental foods, alcoholic beverages. Therapeutic value of fermented foods. Food Biotechnology: Use of biotechnologically improved enzymes in the food processing industry

References:

1. Huffnagle GB & Wernick S. (2007). The Probiotics Revolution: The Definitive Guide to Safe, Natural Health. Bantam Books.
2. Nout RMJ, de Vos WM and Zwietering MH. 2005. Food fermentation. Wageningen Academic Publishers, Netherlands.
3. Stanburry, P.F. & Whitaker. (2005). Principles of Fermentation Technology. Pergamon Press, Butterworth Heinemann-Elsevier.
4. Mudler, M. (2007). Basic Principles of Membrane Technology. Springer.
5. Drioli, E. & Gicorna, L. (2004). Biocatalytic Membrane Reactors. Taylor Francis Group.
6. Prescott and Dunn's Industrial Microbiology. (1999). Reed, G. (Ed.). 4th Ed., CBS Publishers and Distributors, New Delhi.

BIO 6113: Industrial Food Technology [2 1 0 3]

Enzymes in Food Industry Carbohydrase's, proteases, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients. Criteria for selection of industrially important microorganisms. Overview of strain improvement of

Industrially important microorganisms. Preservation of industrially important microorganisms. Principles of upstream and downstream processing. Bacterial starter culture, Methods of inoculum, and medium preparation, slurry processing and product isolation. Technological aspects of industrial production of beer, wine, enzymes amylase, pectinase, proteases, organic acids (vinegar), amino acids (MSG), vitamins (Vit B12), antibiotics (nisin), baker's yeast, single cell protein, immobilized and nanoenzymes.

References:

1. Nduka Okafor. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.
2. Dennis E. Briggs, Chris A. Boulton, Peter A. Brookes and Roger Stevens. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.
3. G. Reed. 2004. Prescott & Dunn's Industrial Microbiology, 4th Ed. AVI Publishers, Connecticut, USA.
4. Peter F. Stanbury, Allan Whitaker and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.
5. L.E. Casida Jr. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.

BIO 6135: Food and Dairy Microbiology Lab [0 0 6 2]

Preparation of common laboratory media and special media. Microbiological analysis of typical processed and unprocessed food. Staining: Gram's staining, endospore, capsule and flagellar staining, staining of yeast and molds. Identification of important molds and yeast. Microbiology of water. Microbiology of hand and effect of sanitation on the hand microbiology in a small food joint. Enumeration and microscopic examination of psychotropic, thermophilic, thermotolerant and spore forming bacteria in milk. Detection of important pathogens using selective media. Detection of adulteration of milk. Determination of efficiency of pasteurization. Preparation of milk products - yoghurt/probiotic, ghee, paneer, khoa, milk beverages.

References:

1. Garg, N., Garg, K. L., & Mukerji, K. G. (2010). Laboratory manual of food microbiology. IK International Pvt Ltd.
2. Yousef, A. E., & Carlstrom, C. (2003). Food microbiology: a laboratory manual. John Wiley & Sons.
3. Roberts, D., & Greenwood, M. (2008). Practical food microbiology. John Wiley & Sons.
4. Penfield, M. P., Campbell, A. M., & Penfield, M. P. (1990). Experimental food science. (pp. 362-421). Academic press, San Diego, CA. L.E. Casida Jr. 1968.
5. Weaver, C. M., & Daniel, J. R. (2003). The food chemistry laboratory: a manual for experimental foods, dietetics, and food scientists. CRC Press.
6. Nielsen, S. S. (Ed.). (2003). Food analysis laboratory manual. (p. 557). Kluwer Academic/Plenum Publishers, New York.
7. Aggarwala, A. C., & Sharma, R. M. (1961). A laboratory manual of milk inspection. 4th Ed.
8. Sokolova, Z. S., Lakomova, L. I., Chekulyaeva, L. V., Tinyakov, V. G., & Rostrova, N. K. (1984). Laboratory manual for milk and milk products technology.

BIO 6136: Fermentation Technology Lab [0 0 6 2]

Handling of a Bio fermenter: batch and continuous systems, fed-batch operation, solid substrate fermentation. Production of alcoholic beverages, organic acids, enzymes and immobilization of enzymes. Probiotics production. Microbial enzymes production. Food fermentations: Bacterial, yeast and mold cultures; single and mixed cultures.

References:

1. Huffnagle GB & Wernick S. (2007). The Probiotics Revolution: The Definitive Guide to Safe, Natural Health. Bantam Books.
2. Nout RMJ, de Vos WM and Zwietering MH. (2005). Food fermentation. Wageningen Academic Publishers, Netherlands.
3. Stanburry, P.F. & Whitaker. (2005). Principles of Fermentation Technology. Pergamon Press, Butterworth Heinemann-Elsevier.
4. Mudler, M. (2007). Basic Principles of Membrane Technology. Springer.

5. Drioli, E. & Gicorna, L. (2004). Biocatalytic Membrane Reactors. Taylor Francis Group.
6. Prescott and Dunn's Industrial Microbiology. (1999). Reed, G. (Ed.). 4th Ed., CBS Publishers and Distributors, New Delhi.

BIO 6211: Food Chemistry and Nutrition [3104]

Introduction to Food Chemistry, Water and its Properties in Foods, Carbohydrates: Structure, Classification, and Functions. Proteins: Amino Acids, Protein Structure, and Nutritional Significance. Lipids: Classification, Structure, and Functions in Food. Enzymes and their Role in Food Processing. Vitamins and Minerals: Functions, Sources, and Deficiency Symptoms. Fundamentals of Human Nutrition. Macronutrients: Carbohydrates, Proteins, and Fats. Micronutrients: Vitamins and Minerals. Digestion and Absorption of Nutrients. Dietary Requirements for humans. Nutritional Deficiency Diseases (Vitamin A Deficiency, Iron Deficiency, etc.)

References:

1. H.D. Belitz, Werner Grosch, and Peter Schieberle, (2009), Food Chemistry, 4th Edition, Springer.
2. B. S. Prakash, R. N. Sharma. (2017), Food Chemistry and Nutritional Biochemistry, 1st Edition, New Age International
3. S. Suzanne Nielsen (2010), Food Analysis, 4th Edition, Springer.
4. Sri Lakshmi, Fundamentals of Foods (2022), Nutrition and Diet Therapy, 7th Edition, New Age International.
5. D.V. Ahirrao, N.H. Desale, (2019) A textbook of Food and Nutrition, Harshwardhan Publication Pvt. Ltd.

BIO 6212: Analytical Techniques of Food Technology [3104]

Introduction, Food Regulations and Standards - Sampling methods and analysis; Determination of total fat and oil in foods, Quality standards, and adulterants; determination of protein and amino acids in foods; determination of total carbohydrates, starch, disaccharides and simple sugars in foods, Basic Principles- Spectrophotometric analysis of food additives, IR Spectroscopy toxic metals analysis; use of fluorimeter in vitamin assay. Chromatographic techniques- Basic principles and types of: thin layer chromatography, column chromatography, Ion exchange chromatography, HPTLC, HPLC, UHPLC, GC, GC-MS, total soluble solids in fruit juice and honey, specific rotation of sugars, Immunoassay techniques and its applications in foods science.

References:

1. Y. H. Hui, (2017), Food Analysis: Principles and Techniques, 2nd Edition, CRC Press.
2. S. Suzanne Nielsen, (2010) Food Analysis, 4th Edition, Springer
3. R. O. Apenten (2002) Introduction to Food Analysis, 2nd Edition, CRC Press.
4. H.-D. Belitz, W Grosch, and P Schieberle, (2009) Food Chemistry, 4th Edition, Springer.
5. Y.H. Hui., (2017) Food Analysis: Principles and Techniques, 2nd Edition, CRC Press
6. Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology (2010), Keith Wilson and John Walker, Cambridge University Press.
7. Skoog, D.A., Holler, F.H. and Nieman (1998): Principles of Instrumental Analysis Saunders College Publishing, Philadelphia.

BIO 6213: Functional Foods and Nutraceuticals [2103]

Functional foods - Definition, development of functional foods. Effect of environmental condition and food matrix; Effects of processing conditions and storage; Development of biomarkers to indicate efficacy of functional ingredients; delivery of immunomodulators /vaccines through functional foods. Nutrigenomics concept of personalized medicine. Usefulness in gastrointestinal health and other health benefits; development of probiotic products; Challenges and regulatory issues related to probiotic products, Symbiotic. Nutraceutical and functional foods -Definition, concept, history and market; Evolution of nutraceuticals and functional foods market. Classification of nutraceuticals and functional foods. Natural occurrence of certain phytochemicals-antioxidants and flavonoids: omega-3 fatty acids, carotenoids, dietary fiber. Dosage for effective control of disease or health benefit with

adequate safety; studies with animals and humans.

References:

1. Wildman, Robert. (2007) Nutraceuticals and Functional Foods, second edition. Taylor and Francis Group.
2. GR Gibson and CM William. (2000) Functional Foods - Concept to Product.
3. I Goldberg (1994) Functional Foods: Designer Foods, Pharma Foods.
4. J Brigelius-Flohé, HG Joost (2006) Nutritional Genomics: Impact on Health and Disease. Wiley, VCH.
5. Cupp J & Tracy TS. (2003) Dietary Supplements: Toxicology and Clinical Pharmacology. Humana Press.

BIO 6205: Research Methodology and Technical Writing [2103]

Foundations of Research: Meaning, objectives, motivation, utility, empiricism, deductive and inductive theory, characteristics of scientific method, understanding the language of research; Research Process, hypothesis, qualities of a good hypothesis, types of hypothesis; Research Design: Concept and importance in research, experimental research design; Types of Data: Classification of data, uses, advantages, disadvantages, sources; Measurement: Concept of measurement, problems in measurement in research, Statistical Techniques and Tools: Introduction of statistics, functions, limitations, graphical representation, measures of central tendency, measure of dispersion, skewness, kurtosis, correlation, regression, tests of significance based on t, F, Chi-square, Z and ANOVA test; Paper Writing: Layout of a research paper, Scopus/Web of Science journals, impact factor of journals, when and where to publish, ethical issues related to publishing, plagiarism and self-plagiarism. Introduction to LATEX and MATLAB.

References:

1. C.R. Kothari (2008). Research Methodology Methods & Techniques, New Age International Publishers, Reprint 2008.
2. Ranjit Singh (2014), Research Methodology, Saga Publication, 4th Edition, 2014.
3. J. Anderson and M. Poole (2011). Thesis and Assignment Writing, Wiley India 4th Edition, 2011.
4. Mukul Gupta and Deepa Gupta (2011), Research Methodology, PHI Learning Private Ltd., New Delhi.
5. S.C. Gupta and V.K. Kapoor (1999), Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.

BIO6235: Food Chemistry and Nutrition Lab [2103]

Effect of pH and acidity in food, Separation of enzymes - SDS Page, Effect of inhibitors on the activity of enzymes, Estimation of lipase activity. Determination of moisture content of food, Estimation of carbohydrate, proteins and lipid/fatty acid, Preparation analysis of functional food (probiotics and Yogurt).

References:

1. Hamilton, R.J., & Bhati, A. (1980). Fats and Oils - Chemistry and Technology. App. Sci. Publ.
2. Chakrabarthy, M.M. (2003). Chemistry and Technology of Oils and Fats. Prentice Hall.
3. S.S. Deshpande Ed (2013), Handbook of Food Toxicology, CRC Press, ISBN 9780824707606
4. Wilson and John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology Keith Wilson and John Walker, Cambridge University Press

BIO 6236: Analytical Techniques of Food Analysis Lab [2002]

Chromatographic analysis of food by GC-MS, HPLC, TLC. Spectroscopic techniques of food analysis by UV-Vis spectrophotometry, FTIR. Microbiological analysis of food by total plate count, Water activity measurements.

References:

1. M. Marcone (2012) Analytical techniques in food biochemistry, Food Biochemistry and Food Processing, 2nd Edition, Wiley.
2. S. Suzanne Nielsen (2010), Food analysis, 4th Edition, Springer publication.

3. Pomeraz, Y. and MeLoari, C.E.(1996) Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.

4. Food and Agricultural Organization (1980): Manuals of Food Quality Control. 2 Additives Contaminants Techniques, Rome.

**** Open elective/MOOC [0021]

BIO6214: Industrial Internship (2 months) [0042]

BIO 7111: Food Processing and Preservation Technology [3 1 0 4]

Hygiene and sanitation requirement in food processing and fermentation industries; Cleaning, sanitizing & pest control in food processing; storage and service areas. Application of enzymes for production in biochemical and food processing industries. Introduction to food preservation, Canning: Preservation principle of canning of food items, spoilage in canned foods. Dehydration and drying of food items; Low temperature preservation: cold storage, cold chain, freezing. Dehydration of fruits and vegetables applications to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables. Fruit powders using spray drying. Preservation by fermentation: curing and pickling; Hurdle technology, non-thermal (e.g. high-pressure processing) and minimal processing technologies. Ionization radiation; Use of preservative in foods: chemical preservatives, bio preservatives, antibiotics, lactic acid bacteria.

References:

1. Smith, J. S., & Hui, Y. H. (2008), Food processing: principles and applications. John Wiley & Sons.
2. Desrosier, N. W., & James, N. (2007), Technology of food preservation. AVI Publishers.
3. Fellows, P. J. (2005), Food processing technology: Principle and Practice. 2nd Ed. CRC Publishers.
4. Jelen, P. (2005), Introduction to Food Processing. Prentice Hall.
5. Mujumdar, A. S. (2014), Handbook of industrial drying, revised and expanded.4th Ed. CRC Press.
6. Fellows, P. J. (2009), Food processing technology: principles and practice. Elsevier.
7. Desrosier, N. W., & Desrosier, J. N. (1977), The technology of food preservation. 4th Ed. AVI Publishing Company. Inc.
8. Gould, G. W. (2012), New methods of food preservation. Springer Science & Business Media.

BIO 7112: Natural Food Additives (Flavors, Enzymes and Colorants) [3 1 0 4]

Food additives- definitions, classification and functions, regulatory issues in India, international legal issues. Food additives- flavor compounds and types of flavors, brominated vegetable oil (BVO). Sweeteners,

Emulsifiers: Types, selection of emulsifiers, emulsion stability, functions and mechanism of action. Nutrient supplements & thickeners, polysaccharides, bulking agents, anti-foaming agents, synergists, antagonists' additives, food uses and functions in formulations; permitted dosages, indirect food additives; harmful effects/side effects associated with various additives and natural alternatives.

Enzymes in Food Industry carbohydrase's, proteases, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients.

References:

1. Early. R. (1995): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and Professional, London.
2. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
3. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.
4. Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organization, Geneva
5. Kirk, R.S and Sawyer, R. (1991): Composition and Analysis of Foods, Longman Scientific and Technical. 9th Edition, England.
6. Food and Agricultural Organization (1980): Manuals of Food Quality Control. 2

BIO 7113: Food Packaging and Supply Chain [3104]

Introduction of Food packaging, Different forms of Food packaging systems and their characteristic features; Paper, Glass, metals as food packaging material. Designing of package materials, Testing of package materials, Transport of package materials, Safety aspect/assessment of food packaging materials, Advance in packaging food technology, Aseptic packaging systems, Package printing machines, Packaging requirements of selected food: cereal and snack food, beverage, milk and dairy products, poultry and egg, red meat, frozen food, horticultural products.

References:

1. G. L. Robertson (2013), Food Packaging: Principles and Practice, Third Edition.
2. G. L. Robertson (2010), Food Packaging and Shelf Life: A Practical Guide, 2010.
3. R. Hernandez, S. E. M. Selke, J. Culter, J. D. Culter (2000), Plastics Packaging: Properties, Processing, Applications, and Regulations.
4. W. Soroka (2010), Fundamentals of Packaging Technology-Fourth Edition.
5. G.L. Robertson (2006), Food Packaging: Principles and Practice (2nd ed.): CRC Press, Boca raton.

BIO7135: Food Processing and Preservation Lab [0062]

Preparation of fruit preserves (jam, jelly), Preparation of vegetable preserves (pickle), Dehydrated products, Tomato processing, Fruit pulping/beverage preparation, Preparation of fermented foods, Bread making, confectionery etc.

References:

1. Desrosier, N. W., & James, N. (2007). Technology of food preservation. AVI Publishers.
2. Fellows, P. J. (2005). Food processing technology: Principle and Practice. 2nd Ed. CRC Publishers.
3. Jelen, P. (2005). Introduction to Food Processing. Prentice Hall.
4. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi
5. Kirk, R.S and Sawyer, R. (1991): Composition and Analysis of Foods, Longman Scientific and Technical. 9th Edition, England.

BIO 7136: Natural Food Additives Lab [0062]

Determination of benzoic acid in the presence of saccharin in the beverages, Estimation of nitrate and nitrite, aspartame, saccharin and caffeine, Identification of natural colors, Estimation of synthetic food colors, oil soluble, antioxidants, Detection of brominated vegetable oils in soft drink, Food applications of emulsifiers, stabilizers, thickeners, flavor enhancers.

References:

1. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.
2. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analysis: Theory and Practice, CBS publishers and Distributor, New Delhi.
3. Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organization, Geneva

BIO 7137: Food Packaging and Supply Chain Lab [0031]

Identification and testing of packaging materials, Determination of wax from wax paper, Determination of moisture content, Testing the compression strength of the boxes, Perform vacuum packaging of food, Testing the strength of filled pouches by drop tester. Estimation of self-life of various packaged food. Scuff Proofness testing.

References:

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

****** DSE-I [3104]**

BIO7146: Intellectual Property Rights [3104]

Introduction of Intellectual Property Right, Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties. Fundamentals of patents, copyrights, geographical indications, designs and layout, trademarks. Protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; International Treaty on Plant Genetic; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Reference Books:

1. Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.
2. Ganguli, Prabudha. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill, New Delhi.

BIO7147: Fundamentals of Nutrition

Introduction to human nutrition. Macronutrients and micronutrients-classification and functions. Digestion, absorption and assimilation of nutrients. Energy metabolism-components of energy expenditure, Basal Metabolic Requirements and Activity, Recommended Dietary Allowances, Food Groups, Concept of a balanced diet, Methods of evaluation of nutritive value of foods. Carbohydrates- Types, functions, sources, requirement, storage, Effect of deficiency and excess. Proteins- Types, functions, sources, requirement, storage, Effect of deficiency and excess. Fat- Types, functions, sources, requirement, storage, Effect of deficiency and excess. Vitamin- Types, functions, sources, requirements, storage, Effect of deficiency and excess. Minerals- Types, functions, sources, requirement, storage, Effect of deficiency and excess. Water and electrolytes-Concept and importance. Nutritional assessment and nutritional policies- Salient features, concept of community nutrition.

Reference books

1. B. Srilakshmi (2023). Nutrition Science, Science and Technology, 8th edition, New Age international publisher, New Delhi.
2. Sumati R. Mudambi (2007). Fundamentals of Foods & Nutrition, New Age international publisher, New Delhi.
3. Ravinder Chadha (2015). Textbook of Nutrition: A Life cycle approach,1st edition, Orient Blackswan Pvt. Ltd.

BIO7148: Species and Flavor Technology

Introduction, classification, composition and functions. Standards specification of spices and flavors, Spice processing, spice reconditioning, spice grinding, post- processing treatments. Processing of Major Spices: Pepper, cardamom, ginger, onion, garlic, vanilla, cinnamon, chilly and turmeric –

method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavor identical. Processing of Minor Spices, herbs and leafy vegetables: Spice volatile oils, spice oleoresins, Use of spice extractives, replacement of spices with oils and oleoresins, alternative products, Ground spices, processed spices, organic spices, curry powders. Packaging of spices and spice products Chemistry and physiology of taste, flavoring compounds in foods, Separation, purification and identification of natural flavoring materials& Synthetic flavoring agents and their stability: Processing quality control of Savory, Thyme, Ajowan, Curry leaves, Asafoetida, Tea, Coffee, Cocoa, Vanilla and annatto. Flavors of soft drinks, Baking and confectionery industry.

Reference Books:

1. J. S. Pruthi (1980). Spice and condiments, Advance in Food Research, 4th edition, Academic Press, USA
2. R Hemphill (1974). Herbs and spices, Paul Hamlyn, Australia.
3. R garten, F. and Livingston Jr (1969). The book of spices, Livingston publishing company, USA
4. Y.S. Lewies (1992). Spices and herbs for the Food Industry, Technomic Publishing Company, USA.

BIO7149: Advance Food Analysis

Concepts of food analysis. Rules and regulations of food analysis. Sample preparation for food analysis. Measurement of color and water activity of raw and processed foods. Determination of browning reaction in foods, food additives, residues and deleterious factors in raw and processed foods. Measurement of enzymatic changes in foods. Sugar profiling foods through Bioscan. Measurement of viscosity/texture in food products. Rheological techniques and instrumentation in food. Microscopic, Fluorometric and polarimetric techniques in food analysis. application and operating parameters of spectrophotometer, AAS (Atomic absorption spectroscopy), Inductively coupled plasma optical emission spectroscopy (ICP-OES), NMR (nuclear magnetic resonance), FTIR (Fourier transform infrared spectroscopy). Application and operating parameters of GC (Gas chromatography), HPLC (high performance liquid chromatography), GC-MS (gas chromatography-mass spectroscopy), LC-MS (liquid chromatography-mass spectroscopy).

Reference Books:

1. S.S. Nielson (2017). Food Analysis. Fifth edition. Springer, New York.
2. M Clifton and Y Pomeranz (1988) Food Analysis - Laboratory Experiments. AVI Publ.
3. AP Leenheer, WE Lambert WE & JF van Bocxlaer (2000) Modern Chromatographic Analysis of Vitamins. 3rd Ed. Marcel Dekker, New York.
4. LML Nollet (2004) Handbook of Food Analysis. Vol. I. Marcel Dekker, Switzerland.

DSE-II

BIO7150: Entrepreneurship in Food Processing

Aggregate Planning:- General design considerations, Financial Analysis, plant location and plant layout, Flowcharts and their design, equipment selection, Design of service facilities, Human resource planning: Planning and design of marketing system, worker's safety and plant hygiene. Introduction to Marketing and economics: Demand, Supply, Sample survey techniques, marketing information, consumer trends, consumer behavior. Introduction to Operations Research: Definition, applications. Inventory control, Linear Programming. Queuing Theory, Transportation and Assignment.

Reference Books

1. P. Chandra (2005). Project Management. Tata McGraw Hill.
2. P Gopal Krishan & K. Nagarajan (2005). Project Management. New Age.
3. RD Hisrich & MP Peters (2002). Entrepreneurship. Tata McGraw Hill.
4. JM Kaplan (2003). Patterns of Entrepreneurship. John Wiley & Sons.
5. H Nandan (2007). Fundamentals of Entrepreneurship Management. Prentice Hall.

BIO7151: Food Product Development

Concept of product development - product success and failure, process of product development, managing for product's success. Innovation strategy - possibilities for innovation, building up strategy, product development program. The product development process - product strategy, product design

and process development, product commercialization, product launch and evaluation. 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. Role of consumers in product development - consumer behavior, food preferences, avoiding acceptance, integration of consumer needs in product development and sensory needs. 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, innovative matrices, Improving success potential of new products, market exploration and acquisition, Legal aspects of new product launch.

Reference Books:

1. Clarke & W. Wright (1999). Managing New Product and Process Development. Free Press.
2. R Earle, R Earle & A. Anderson (2001). Food Product Development. Woodhead Publ.
3. Fuller (2004). New Food Product Development - from Concept to Market Place. CRC.

FOURTH SEMESTER

BIO 7211: Dissertation / Project work [16]

Students will work on specific projects attached to a supervisor and submit a thesis at the end of the semester. The assessment will be based on the research work evaluation, evaluation of final report and viva-voce examination.