NATIONAL EDUCATION POLICY- 2020
common minimum syllabus for all Uttarakhand state university and colleges

PROPOSED SYLLABUS
For

M.Sc. FOOD TECHNOLOGY
Choice Based Credit System

Submitted to Sri Dev Suman Uttarakhand University, Badshahithol, Tehri (garhwal)

M. Sc. FOOD TECHNOLOGY

Course Structure

CODE	COURSE TITLE	CREDITS
Major Courses		**Total 20**
FT 501	FOOD CHEMISTRY	2+1
FT 502	FOOD MICROBIOLOGY	2+1
FT 503	PRINCIPLES OF FOOD ENGINEERING	2+1
FT 504	PRINCIPLES OF FOOD PROCESSING	2+1
FT 505	FOOD PACKAGING TECHNOLOGY	2+1
FT 506	FOOD QUALITY SYSTEMS & MANAGEMENT	1+1
FT 507	TECHNIQUES IN FOOD ANALYSIS	2+1
Minor Courses*		**Total 9**
	Group I	
FT 511	POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLES	2+1
FT 512	TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING	2+1
FT 513	TECHNOLOGY OF CEREAL LEGUME AND OILSEEDS	2+1
FT 514	BAKERY AND CONFECTIONARY TECHNOLOGY	2+1
FT 515	TECHNOLOGY FOR PLANTATION CROPS AND SPICES	2+1
FT 516	TECHNOLOGY OF MILK AND MILK PRODUCTS	2+1
FT 517	TECHNOLOGY OF MEAT AND MEAT PRODUCTS	2+1
FT 518	BEVERAGE TECHNOLOGY	1+1
	Group II	
FT 519	FOOD BIOTECHNOLOGY	2+1
FT 520	FOOD ADDITIVES CONTAMINANTS AND TOXICOLOGY	2+1
FT 521	INDUSTRIAL MICROBIOLOGY	2+1
FT 522	NUTRACEUTICALS AND FUNCTIONAL FOODS	2+1
FT 523	ENZYMES IN FOOD PROCESSING	2+1
FT 524	PRINCIPLES OF FOOD ANALYSIS AND SENSORY EVALUATION	1+1
Supporting Courses		**Total 5**
FT 525	STATISTICAL METHODS FOR FOOD SCIENCE	1+1
FT 526	COMPUTER APPLICATIONS IN FOOD INDUSTRY	1+2
FT 527	BUSINESS MANAGEMENT AND INTERNATIONAL TRADE	3+0
FT 528	APPLIED NUTRITION	2+1
Seminar		**Total 1**
FST 529	MASTER'S SEMINAR	1+0
Research		**Total 20**
FST 530	MASTER'S RESEARCH	20
Compulsory Non-credit Courses**		
Deficiency Courses		
FST 531	MATHEMATICS[1]	3+0
FST 532	GENERAL MICROBIOLOGY[2]	1+1
FST 533	CROP PRODUCTION: CONCEPTS AND PRACTICES[3]	2+1

* Students should take at least two courses from each group; Department/College can offer the courses depending upon local need, facilities and expertise available.

**** See the relevant section for details**

[1] Compulsory for graduates not having Maths at 10+2/graduate level

[2] Compulsory for graduates not having Microbiology at graduate level

[3] Compulsory for non-agricultural graduates

M. Sc. FOOD TECHNOLOGY

Distribution of credits

- Major - 20 credits
- Minor - 9 credits
- Supporting - 5 credits
- Seminar - 1 credit
- Thesis - 20 credits

Total credits: 55 (35 course work + 20 thesis)

M. Sc. FOOD TECHNOLOGY

Course Contents
MAJOR COURSES

FOOD CHEMISTRY (2+1)

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

Food chemistry-definition and importance, major food constituents and their physicochemical properties. Water: Role of water in food, water activity and shelf life of food. Concept of water activity. Carbohydrate: Structure, classification, properties & nutritive aspects, sugars, starch, cellulose, hemicellulose, gums, pectic substances polysaccharides.

UNIT II

Protein and amino acids: structure, classifications, sources, denaturation and functional properties of proteins. Maillard browning. Changes in milk and muscle protein during processing Lipids and fatty acids: classification and use of lipids in foods, physical and chemical properties; Processing aspects, of oil seeds including extraction, refining, hydrogenation and winterization of oil. auto-oxidation of lipids and rancidity, different groups of fats and oils; effects of processing on functional properties.

UNIT III

Properties of minerals, vitamins, anti-oxidants, flavor components, allergens, toxins and antinutritional factors in foods; Interaction of constituents in food systems; Effect of processing on vitamins and minerals; Browning reactions in foods. Enzymatic browning in foods and industrial applications of enzymes.

UNIT IV

Natural food flavours, extraction methods and characterization. Pigments in food and their industrial applications. Fiber: Classification and importance in human diet

UNIT V

Food and energy: PEV and GEV of food constituents, Bomb calorimeter and its functioning. 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 foods; calorific value of foods; TSS; pH; acidity; estimation of browning intensity; determination of vitamin C and beta-carotene, sugars; estimation of calcium, phosphorus and iron; antinutritional factors in foods.

Suggested Readings

Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport.

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

Belity & Grosch. Food chemistry.

Belitz HD.1999. *Food Chemistry*. Springer Verlag.

Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Dekker, New York.

DeMan JM. 1976. *Principles of Food Chemistry*. AVI.

Fenemma. Fundamentals of food chemistry .
Fennema OR.1996. *Food Chemistry*. Marcel Dekker.
Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel
Frank A Lee . Basic food chemistry
Meyer LH. 1987. *Food Chemistry*. CBS.
Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.
Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport.
Press, New York.
Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.
W.S.Wang .Mechanism and theory in food chemistry .

FOOD MICROBIOLOGY (2+1)

Objective

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

Theory

UNIT I

History of microbiology of food. Types of micro-organism normally associated with food-mold, yeast, and bacteria; sources of contaminations: air, water, soil, sewage, Factors influencing growth and survival of microorganisms in foods. Intrinsic factors and Extrinsic factors Microbial growth pattern, physical and chemical factors influencing destruction of microorganisms.

UNIT II

Micro-organisms in natural food products and their control. Biochemical changes caused by micro-organisms. Starter cultures, single and mixed strain cultures; propagation, maintenance and evaluation of cultures; factors affecting activity of cultures-bacteriophages, residual antibiotics and chemicals, mutations

UNIT III

Post-processing contamination of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat. Food Spoilage: spoilage of fresh and processed products: fruits and vegetables; meat, fish, egg and poultry, bread. Spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry. Spoilage of canned foods. Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms. 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. Food poisoning (Staphylococcus, Bacillus, Listeria, Salmonella) and microbial toxins, standards for different foods. Food borne infections and intoxicants. Microbial toxins and mycotoxins.

Practical

Practical

Microscopic examination of bacteria, and 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,

thermodurics, 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.
Branen A.L. and Davidson, P.M. 1983. Antimicrobials in Foods. Marcel Dekker, New York.
Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.
Robinson, R.K. Ed. 1983. Dairy Microbiology. Applied Science, London.

PRINCIPLES OF FOOD ENGINEERING (2+1)

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

Theory

UNIT I

Introduction to food engineering & processes: principles of thermodynamics and heat transfer applied to food engineering; fundamentals of heat and analogy to mass transfer in food processing.

UNIT II

Kinetics of biological reactions - kinetics of reactions occurring in processed foods, reaction velocity constant, order of reaction; quality changes during storage of foods; application of Arrhenius equation to biological reactions.

UNIT III

Method for thermal process evaluation - Commercial sterility, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; the process equivalence in terms of minutes at 121.1°C; calculation of process time for fluids on stream line flow and turbulent flow heated in heat exchangers; general introduction to aseptic canning process, hydrostatic sterilizer and aseptic packaging practices and design problems.

UNIT IV

Food chilling and freezing – Precooling and cold storage; CA and MA; Properties of frozen foods; freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for predicting rates of product freezing; Cryogenic freezing and IQF; design of food freezing equipment such as air blast freezers, plate freezers and immersion freezers.

UNIT V

Mechanical separation-filtration, membrane concentration, sieving, centrifugation, sedimentation, Mechanical handling-conveying and elevation. Size reduction and classification-mixing, kneading, blending.

Practical

Determination of viscosity of Newtonian fluid, Non-Newtonian fluids; Design of pumping systems; Determination of thermal properties of foods such as thermal conductivity, thermal diffusivity, calorific value and specific heat; Calculation of freezing time for some typical foods; Study of different types of freezers; Calculation of thermal process time in canning

of some foods; Determination of 'U' for PHE; Determination of 'U' for SSHE; Study of blast freezer; Visit to Food Processing Plants.

Suggested Readings

Aeldmam & Lunde Hand book of Food Engineering
Batty, J.C. and Folkman, S.L. 1983. Food Engineering Fundamentals. John Wiley and Sons, New York.
Fennema O.R. Ed. 1985, Principles of Food Science: Part-II Physical Principles of food
Harper, J.C. 1975. Elements of Food Engineering. AVI, Westport.
Heldman, D.R. and Lund, D.B. Ed. 1992. Handbood of Food Engineering Marcel Dekker, New York.
Preservation. Marcel Dekker, New York.
R.P. Singh Hand book of food Engineering
T.Toledo .Fundamentals of Food Process Engineering

PRINCIPLES OF FOOD PROCESSING (2+1)

Objective

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

Theory

UNIT I

Definition and scope of food processing; historical developments; national and international perspectives, causes of spoilage and general principles of food processing and preservation; preservations of foods by different methods. Food packing-function of primary packaging, design consideration and material suitable for rigid and flexible food containers. Preparation of food for processing- cleaning, selection and grading,
and size reduction

UNIT II

Processing and preservation by high temperature, Principles of thermal processing, Basic steps in thermal processing,– blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, microwave heating. Effect of temperature on microorganisms, effect of temperature on foods and use of different temperatures for processing food, various steps in canning, processing equipments used for canning foods, aseptic canning. Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization;

UNIT III

Method of calculation of process time; different time- temperature combination, TDT curve and TDR curve, margin of safety, 12 D value. pH classification of foods, microorganisms associated with spoilage of canned foods of different pH groups. concentration-its application in food industry, concentration processes, equipments for concentration of foods. Drying: concept of water activity and its effect on physic-chemical and microbial changes in food. Mechanism of drying, factors affecting drying rate, effect of drying on product quality; Intermediate moisture foods.

UNIT IV

Food preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro freezing. Mechanism of freezing of water in foods, effect of freezing on quality of foods; methods of freezing, storage and thawing of frozen foods.

UNIT V

Non-thermal preservation: Hydrostatic pressure, dielectric heating, microwave processing, high pressure, pulsed electric field, hurdle technology, membrane technology, irradiation. 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.

Practical

Seaming and testing of cans; Tin coating measurement and tests for sulphide stain and crystal size of tin plates; 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; Extrusion cooking of foods; Visit to a food processing plant.

Reference Books:

Food Science Norman N.Potter
Food Processing technology P. Fellows.
Technology of Food Preservation Desosier & Desosier
Unit operations in Food Processing R. K. Singh & Sahai
Food Packaging Khetrapaul & Pania
Food Dehydration. Arsdel WB, Copley MJ & Morgan AI. 1973. 2nd Ed. Vols. I, II. AVI Publ.
Technology of Food Preservation. Desrosier NW & James N.1977. 4th Ed. AVI. Publ.
Food Processing Technology: Principle and Practice. Fellows PJ. 2005.2nd Ed. CRC.
Introduction to Food Processing. Jelen P. 1985. Prentice Hall.
Food Science. Potter NN & Hotchkiss 1997.5th Ed. CBS.
Food Processing. Potty VH & Mulky MJ. 1993. Oxford & IBH.
Food Processing: Principles and Applications. Ramaswamy H & Marcotte M. 2006. Taylor & Francis.

FOOD PACKAGING TECHNOLOGY (2+1)

Objective

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

Theory

UNIT I

Introduction to packaging. Packaging operation, package-functions and design. Principle in the development of protective packaging. Packaging requirements and selection of packaging materials; Types of packaging materials: Paper; Glass; 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. Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life.

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.

UNIT III

Food packaging systems: Different forms of packaging such as rigid, semi-rigid, 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; Shrink packaging., aseptic packaging systems ; aseptic and retortable pauches; bottling machines; carton making machines. Flexible and laminated pouches, aluminium as packaging material. Bio-degradable packaging. Active packaging. Modified atmosphere packaging.

UNIT V

Special problems in packaging of food stuff, consideration in the packaging of perishables and processed foods. Evaluation of packaging, and package performance, packaging equipment, package standards and regulation, Bar coding material.

Practical

Identification and testing of packaging materials; Determination of wax from wax paper; Testing of lacquered tin plate sheets; To perform sulphide stain test; To conduct ferricyanide paper test for porosity; Determination of equilibrium moisture content; Grading of glass bottles for alkalinity; Determination of water vapour transmission rate of packaging material; To perform vacuum packaging of food sample and carry out its storage study; Testing the compression strength of the boxes; Packaging the food material in seal and shrink packaging machine and study its shelf life; Testing the strength of glass containers by thermal shock test;

Suggested Readings

Painy, F.A. and Painy, H.Y. 1983. A Handbook of Food Packaging. Leonard Hill, Glasgow, UK.

Scicharow, S. and Griffin, R.C. 1970. Food Packaging. AVI, Westport.

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

FOOD QUALITY SYSTEMS AND MANAGEMENT (1+1)

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-àvis* instrumental methods for testing quality. Objectives, importance and functions of quality control. Methods of quality, assessment of food materials-fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products.

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;

UNIT III

Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standard. Sanitation and hygiene, GMP, GLP, Statistical quality control. Food laws and standard, PFA, AGMARK.

Unit IV

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

Unit V

Sampling and specification of raw materials and finished products, Concept of Codex Almentarious/ /USFDA/ISO 9000 series , rules and regulations for waste disposals. Food adulteration and food safety. HACCP, Sensory evaluation-introduction, panel screening, Sensory and instrumental analysis in quality control, IPR and patents.

Practical

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

Suggested Readings

Amerine MA *et al* 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 Horwoood.

Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.

Macrae R. *et al.*1994. *Encyclopedia of Food Science & Technology & Nutrition*. Vol. XVI. Academic Press.

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

Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.

Export/import Policy by Govt of India

TECHNIQUES IN FOOD ANALYSIS (2+1)

Objective

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

Theory

UNIT I

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 colorimetry and others).

Practical

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; Separation of amino acids/coal tar 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; fatty acid analysis using GC; Identification and determination of organic acids by HPLC; Analysis of dietary fibre/glucose; Heavy metal analysis using atomic absorption spectrometry; Residue testing.

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.

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.

MINOR CPOURSES
GROUP I

POST HARVEST MANAGEMENT OF FRUITS AND VEGETABLES (2+1)

Objective

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

Theory

UNIT I

Importance & scope of post harvest management of fruits and vegetables in Indian economy. **Production and consumption fruits and vegetable in Uttarakhand**.

Principles and methods of fruit and vegetable preservation. Principles of storage of fruits and vegetables. Types of storage: natural, ventilated, low temperature storage. Freezing and freeze-drying of fruits and vegetables.

UNIT II

Morphology, structure and composition of fruits and vegetables; maturity indices and standards for selected fruits and vegetables; methods of maturity determinations.

UNIT III

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

UNIT IV

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

UNIT V

Physiological post harvest disorders - chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; Post Harvest handling system for fruits and vegetables of regional importance such as citrus, mango, banana, pomegranate, tomato, papaya and carrot etc., packaging house operations; principles of transport and commercial transport operations.

Practical

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

apple; Visit to commercial packaging house – grape, mango and pomegranate; Visit to commercial
storage structures- Onion, garlic and potato.

Suggested Readings

Bose, T.K. Ed. 1985. Fruits of India: Tropical and Sub-tropical. Naya Prokash, Calcutta.
Dauthy, M.E. 1997. Fruit and Vegetable Processing. International Book Distributing Co. Lucknow, India.
Hamson, L.P. 1975. Commercial Processing of Vegetables. Noyes Data Corporation, New Jersey.
Jagtiani J., Chan, H.T. and Sakal, W.S. Ed. 1988. Tropical Fruit Processing Academic Press, London.
Kadar, A. A. 1992. Postharvest Technology of Horticultural Crops. 2nd Ed. University of California.
Lai, G., Siddappa, G. and Tondon G.L. 1986. Preservation of Fruits and Vegetables, indian Council of Agril. Research, New Delhi.
Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker, New York.
Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Vegetable Science and Technology. Production, Composition, Storage and processing Marcel Dekker, New York.
Seymour, G.B., Taylor, J.E. and Tucker, G.A. Ed. 1993. Biochemistry of Fruit Ripening. Chapman and Hall, London.
Srivastava, R.P. and Kumar, S. 1998. Fruit and Vegetable Preservation: Principles and Practices. 2nd Ed. International Book Distributing Co. Lucknow.
Ting, S.V. and Rousett, R.L. 1986. Citrus Fruits and Their Products. Marcel Dekker, New York.
Thurme S. Ed. 1991. Food Irradiation. Elsevier Applied Science, London. Wills, R.B.H., McGlasson, W.B., Graham, W.B., Lee, T.H. and Hall, E.G. 1981.
Postharvest: An Introduction to the Physiology and Handling of Fruits and Vegetables. Granada, U.K.

TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING (2+1)

Theory

UNIT I

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

UNIT II

Processing for pulp, 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 III

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

UNIT IV

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

UNIT V

Dehydration of fruits and vegetables using various drying technologies like sun drying, solar drying (natural and forced convection), osmotic, tunnel drying, fluidized fed drying, freeze drying, convectional and adiabatic drying; applications to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables. Fruit powders using spray drying.

Practical

Evaluation of pectin grade; canning of mango/guava/papaya; preparation and quality evaluation of fruit jam: apple/ mango/ guava /papaya /aonla / strawberry and fruits of regional importance; fruit jelly, woodapple, 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 cheese; 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. **Preparation of processed products of wild fruits of Uttarakhand.**

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 (2+1)

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

Importance of oil seeds processing in India, Commercial edible oil sources. Processing of crude oils - oil extraction/expression and solvent extraction. Refining of crude oil-degumming, bleaching, deodourization. Hydrogenation and interesterification, Shortening-introduction, manufacturing and uses of shortening, types of shortening. Margarine-manufacturing and uses of Margarine. Confectionery coatings. Immitation dairy products -

peanut butter and vegetable ghee. Chemical adjuncts lecithins, GMS. Packing and storage of fats and oils, Cocoa butter, fat substitutes and low-calorie foods.

UNIT II

Wheat: Types and physicochemical characteristics; wheat milling -products and byproducts; 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. Technology of bread, biscuits, cakes, durum wheat, extruded products (pasta and noodles). Corn-wet milling and dry milling, corn flakes, corn starch and its hydrolyzed syrups.

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. Processed products of major and minor millets. **Production and consumption of cereals in Uttarakhand**

UNIT V

Legumes: 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. Preparation of protein concentrates and isolates and their use in high protein foods.

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.

Suggested Readings

Applied Science, London.
Baking. Royal Society of Chemistry, London.
Blanshard J.M.V., Frazier, P.J. and Galliard, T. Ed. 1986. Chemistry and Physics of
Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats*. Prentice Hall.
Chakraverty, A. 1988. Postharvest Technology of Cereals, Pulses and oilseeds. Oxford
Chemist. St. Paul, Minnesota.
Chemistry, Technology and Utilization. VNR, New York. CRC Press, Florida.
Dendy DAV & Dobraszczyk BJ. 2001. *Cereal and Cereal Products*. Aspen.
Durbey, S.C. 1979. Basic Baking: Science and Craft. Gujarat Agricultural University,
Hamilton RJ & Bhati A. 1980. *Fats and Oils - Chemistry and Technology*. App. Sci. Publ.
Hamilton, R.J. and Bharti, A. Ed. 1980. Fats and Oils: Chemistry and Technology.
Hoseney 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.
Kent, N.L. 1983. Technology of Cereals. 3rd Edn. Pergamon Press, Oxford, UK.

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. Marcel Dekker, New York.
Marshall WE & Wadsworth JI. 1994. *Rice Science and Technology*. Marcel Dekker.
Mathews RH. 1989. *Legumes Chemistry, Technology and Human Nutrition*. Marcel Dekker.
Mathews, R.H. Ed. 1989. Legumes: Chemistry, Technology and Human Nutrition.
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.
Pomeranz, Y. 1987. Modern Cereal Science and Technology. VCH Pub., New York.
Pomeranz, Y. Ed. 1978. Wheat: Chemistry and Technology. Am. Assoc. of Cereal Processing and Utilization, (3 vol. set). CRC Press, Florida.
Salunkhe, D.K., Kadam, S.S. Ed. 1989. Handbook of World Food Legumes: Chemistry,
Salunkhe, O.K. Chavan, J.K, Adsule, R.N. and Kadam, S.S. 1992. World Oilseeds:
Swern D. 1964. *Bailey's Industrial Oil and Fat Products*. InterSci. Publ.
Watson SA & Ramstad PE.1987. *Corn; Chemistry and Technology.*AACC.
Wolf, I.A. Ed. 1983. Handbook of Processing and Utilization in Agriculture. (2 vol. set).

BAKERY AND CONFECTIONARY TECHNOLOGY (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Quality characteristics of confectionery ingredients; technology for manufacture of flour, fruit, milk, sugar, chocolate, and special confectionary products; colour, flavour and texture of confectionary; standards and regulations; machineries used in confectionery industry.

Practical

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

consistency and temperature on the quality characteristics of hardboiled sweets; Preparation and quality evaluation of chocolate; Visit to bakery and confectionery industries.

Suggested Readings

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

TECHNOLOGY OF PLANTATION CROPS AND SPICES (2+1)

Objective

To provide an understanding of the science and technology for processing coffee, tea, cocoa products and Spices.

Theory

UNIT I

Coffee: Occurrence, chemical constituents; harvesting, fermentation of coffee beans; changes taking place during fermentation; drying; roasting; process flow sheet for the manufacture of coffee powder; instant coffee technology; chicory chemistry; quality grading of coffee.

UNIT II

Tea: Occurrence, chemistry of constituents; harvesting; types of tea – green, oolong and CTC; chemistry and technology of CTC tea; manufacturing process for green tea and black tea manufacture; instant tea manufacture; quality evaluation and grading of tea.

UNIT III

Cocoa: Occurrence, chemistry of the cocoa bean; changes taking place during fermentation of cocoa bean; processing of cocoa bean; cocoa powder; cocoa liquor manufacture; chocolates–types, chemistry and technology of chocolate manufacture; quality control of chocolates.

UNIT IV

Major spices: Pepper, cardamom, ginger, chili and turmeric–Oleoresins and essential oils; method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavour identicals; quality control; fumigation and irradiation of spices.

UNIT V

Other spices: Cumin, coriander, cinnamon, fenugreek, garlic, mace, clove, mint and vanilla; present trends in synthesis of volatiles; microbial and chemical contaminants, plant suspension cultures.

Practical

Estimation of extractives, caffeine in tea and coffee; the aflavin and thearubigens of tea and total solids; moisture and volatile oil content of spices; detection of microbial quality and adulteration in spices; aromatic compounds in spices; capsaicin content and Scoville Heat Units in chilies, curcumin content of turmeric; storage and packaging of spices; visit to spice processing Units.

Suggested Readings

Banerjee B. 2002. *Tea Production and Processing*. Oxford Univ. Press.
Minifie BW. 1999. *Chocolate, Cocoa and Confectionery Technology*. 3rd Ed. Aspen Publ.
NIIR. 2004. *Handbook on Spices*. National Institute of Industrial Research
Board, Asia Pacific Business Press Inc.
Sivetz M & Foote HE. 1963. *Coffee Processing Technology*. AVI Publ.

TECHNOLOGY OF MILK AND MILK PRODUCTS (2+1)

Unit-1

Sources, and composition of milk, processing of market milk, standardization, toning of milk, homogenization, pasteurization, sterilization, storage, transportation and distribution of milk. Technology of fluid milk: collection, chilling, transportation, cream separation, standardization, pasteurization, sterilization, homogenization, packaging, storage and distribution of fluid milk, flavoured milk, enriched milk.

Unit-2

Milk product processing-cream, butter, condensed milk, evaporated milk, whole and skimmed milk powder.

Unit-3

Instantization of milk and milk products, ice cream, khoa, channa, paneer, milk sweets. Judging and grading of milk and its products.

Unit-4

Technology of fermented milk: principles and practices of manufacture, packaging, storage and marketing of dahi, cultured butter milk, acidophilus milk,yoghurt, shrikhand. Technology of cheese: standards of manufacture of hard, semi hard, soft and processed cheeses.Storage and marketing of cheese. Cheese defects and their control. Dairy equipments and sanitization.

Unit 5

Technology of fat rich dairy products: manufacture, packaging, storage and marketing of butter & cream and butter defects and their control. Technology of frozen milk products: classification, standards manufacture, packaging, storage and marketing. Defects of frozen products and their control. Technology of concentrated, evaporated and dried milk: standards manufacture, packaging, Storage, defects and their control. Technology of Indigenous dairy products – Khoa (manufacture, classification and use) Paneer, Ghee. Technological aspects of casein manufacture; by- products utilization

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

B.L.Herrington .Milk and Milk Processing
Considine, D.M. Ed. 1982. Foods and Food Production Encyclopaedia, VNR, NewYork.
Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi.
Edgar Spreer .Milk and Dairy Technology
Fox Cheese – chemistry , physics & microbiology vol. I & II
Gregory D.Miller. Handbook of Dairy Foods and Nutrition.
MaCrae, R., Robinson, R.K. and Sadler, M.J. Ed. 1993. Encyclopaedia of Food Science,Food Technology and Nutrition Academic Press, London.
Robinson, R.K. (2 vol. set). 1986. Modern Dairy Technology Elsevier Applied Science, UK.
Rosenthal, I. 1991. Milk and Milk Products. VCH, New York.
Su Kumar De.Outlines of dairy technology.

V.Cheke. Cheese and Butter
Walastra, Geuts, Normen .Dairy Technology.
Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi.
Yarpar, WJ. and Hall, C.W. 1975. Dairy Technology and Engineering AVI, Westport

TECHNOLOGY OF MEAT AND MEAT PRODUCTS (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Lay-out and design of poultry processing plants, Plant sanitation; Poultry meat processing operations, equipment used – Defeathering, bleeding, scalding etc.; 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 V

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

Practical

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

Suggested Readings

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

Govindan TK. 1985. *Fish Processing Technology*. Oxford & IBH.
Hui YH. 2001. *Meat Science and Applications*. Marcel Dekker.
Kerry J. *et al.* 2002. *Meat Processing*. Woodhead Publ. CRC Press.
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.

BEVERAGE TECHNOLOGY (1+1)

Objective

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

Theory

UNIT I

Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages; technology of still, carbonated, lowcalorie and dry beverages; isotonic and sports drinks; role of various ingredients of soft drinks, carbonation of soft drinks.

UNIT II

Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy-based beverages.

UNIT III

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

UNIT IV

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

Practical

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

Suggested Readings

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

Group II

FOOD BIOTECHNOLOGY (2+1)

Objective

To acquaint with the fundamentals and application of biotechnology in relation to raw materials for food processing, nutrition, food fermentations, waste utilization and use better genetic resources.

Theory

UNIT I

Prospectus of 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

Biological role of DNA in cell metabolism, Molecular genetics i.e. fundamentals of molecular biology with special reference to chemistry and biology and DNA, (Primary secondary and tertiary) structures.

UNIT III

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 IV

Applications of genetical control mechanism in industrial fermentation process, (Induction, manipulation and recombination).

UNIT V

Cell and tissue culture, Continuous cultures, Secondary metabolites synthesis.

Practical

Study of auxotroph, Micropropogation through tissue culture, Strain improvement through U.V. mutation for lactose utilization, Chemical mutagenesis using chemical mutagens (Ethidium bromide), Determination of survival curves using physical and chemical mutagens, Isolation and analysis of chromosomal / genomic DNA from *E.coli* and *Bacillus cereus,*

Separation of protoplast using cellulytic enzymes, Production of biogas from organic waste, Introduction of ELISA / Southern blot / DNA finger printing etc., Agarose gel electrophoresis of plasmid DNA, Pesticide degradation by *pseudomonas spp.*

Suggested Readings

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

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

Knorr D.1982. *Food Biotechnology*. Marcel Dekker.
Lee BH. 1996. *Fundamentals of Food Biotechnology*. VCH.
Perlman D. 1977-1979. *Annual Reports of Fermentation Processes*.
Prescott SC & Dunn CG. 1959. *Industrial Microbiology*. McGraw Hill.
Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall

FOOD ADDITIVES, CONTAMINANTS AND TOXICOLOGY (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods and as nutraceuticals. Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX.

UNIT IV

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

UNIT V

Toxicants and allergens in foods derived from plants, animals, marine, algae & mushroom; Derived Food toxicants- Processing & Packaging; Toxicants generated during food processing such as nitrosamines, acrylamide, benzene, dioxins and furans; persistent organic pollutants. Toxicology & food additives; Toxicological aspects of nutrient supplements; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, agrochemicals; heavy metals; intentional and unintentional additives.

Practical

Estimation of preservatives, sweeteners, fibres, colours, antioxidants, flavour enhancers; Isolation, modification, and functional properties of native and modified proteins, starches

and lipids; extraction of essential oil and oleoresins; applications of additives and ingredients in foods

Suggested Readings

Branen A.L. and Davidson, P.M. 1983. Antimicrobials in Foods. Marcel Dekker, New
Branen AL, Davidson PM & Salminen S. 2001. *Food Additives*. 2nd Ed. Marcel Dekker.
Dekker, New York.
Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel
Furia, T.E. 1980, Handbook of food additives, Vol I and Vol II.
Gerorge AB. 1996. *Encyclopedia of Food and Color Additives*. Vol. III. CRC Press.
Gerorge AB. 2004. *Fenaroli's Handbook of Flavor Ingredients*. 5th Ed. CRC Press.
Madhavi DL, Deshpande SS & Salunkhe DK. 1996. *Food Antioxidants: Technological, Toxicological and Health Perspective*. Marcel Dekker.
Morton ID & Macleod AJ .1990. *Food Flavours*. Part A, BC. Elsevier.

INDUSTRIAL MICROBIOLOGY (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Principles and production of microbial proteins, lipids, polysaccharides and vitamins – properties and applications; mushroom cultivation.

UNIT IV

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

Practical

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

Suggested Readings

Perman D. 1977-79. *Annual Reports of Fermentation Processes*. Vols. I-III.
Prescott SC & Dunn CG. 1959. *Industrial Microbiology.* Mc Graw Hill.
Waits MJ. 2001. *Industrial Microbiology*. Blackwell Science.
Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall

NUTRACEUTICALS AND FUNCTIONAL FOODS (2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Clinical testing of nutraceuticals and health foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity of nutraceuticals; nutrigenomics – an introduction and its relation to nutraceuticals.

Practical

Market survey of existing health foods; identification and estimation of selected nutraceuticals; production and quality evaluation of foods containing nutraceuticals; development of labels for health foods; visit to relevant processing Un**its**

Suggested Readings

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 PROCESSING (2+1)

Objective

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

Theory

UNIT I

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 II

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

UNIT III

Enzymes as processing aids: Role of enzymes in cheese making and whey processing; fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanses 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.

UNIT IV

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

Practical

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

Suggested Readings

Flickinger MC & Drew SW. 1999. *Encyclopedia of Bioprocess Technology*. A Wiley- Inter Science Publ.

Kruger JE. *et al*. 1987. *Enzymes and their Role in Cereal Technology*. American Association of Cereal Chemists 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. *Enzymes in Food Technology*. Blackwell Publ.

PRINCIPLES OF FOOD ANALYSIS AND SENSORY EVALUATION (1+1)

Objective

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

Theory

UNIT I

Scope and importance of food evaluation in food industry. Importance of proximate composition analysis. Determination of different constituents in different food sample along with the principle involved in their estimation. Fractionation of ash and their importance in food analysis. Principles and methods involved in the estimation of calcium, phosphorus and iron in food samples.

UNIT II

Principles and procedures involved in estimation of starch and sugars. Principles and procedures involved in estimation of vitamins: Vitamin A, C, Riboflavin and thiamin.

Determination of enzymatic and non-enzymatic browning in food samples. Importance of rheological properties in food. Techniques and principles involved in their estimation.

UNIT III

Introduction to sensory analysis; general testing conditions, Requirements of sensory laboratory; organizing sensory evaluation programme.Selection of sensory panelists; Factors influencing sensory measurements; Sensory quality parameters -Size and shape, texture, aroma, taste, color and gloss; Detection, threshold and dilution tests.

Unit IV

Different tests for sensory evaluation– discrimination, descriptive, affective; Flavour profile and tests; Ranking tests; Methods of sensory evaluation of different food products.
Computer-aided sensory evaluation of food & beverage, statistical analysis of sensory data.

Practical

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

Suggested Readings

Amerine MA, Pangborn RM & Rossles EB. 1965. *Principles of Sensory Evaluation of Food.* Academic Press.
Early R.1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwoood.
Lawless HT & Klein BP. 1991. *Sensory Science Theory and Applicatons in Foods*. Marcel Dekker.
Macrae R, Rolonson Roles & Sadlu MJ.1994. *Encyclopedia of Food Science & Technology &*
Nutrition. Vol. XI. Academic Press.
Maslowitz H. 2000. *Applied Sensory Analysis of Foods*. Vols. I, II. CRC Press.
Piggot JR. 1984. *Sensory Evaluation of Foods*. Elbview Applied Science Publ.
Potter NN & Hotchleiss JH. 1997. *Food Science*. 5th ed. CBS.
Rai SC & Bhatia VK. 1988. *Sensory Evaluation of Agricultural Products.*Indian Agricultural Statistics Research Institute (ICAR).
Stone H & Sidel JL. 1985. *Sensory Evaluation Practices*. Academic Press.
Watts CM, Ylimaki CL, Jaffery LE & Elias LG. 1989. *Basic Sensory Methods for Food Evaluation*. Int. Dev. Res. Centre, Canada.

SUPPORTING COURSES

STATISTICAL METHODS FOR FOOD SCIENCE (1+1)

Objective

The students will be exposed to various statistical tools required to analyze the experimental data in food research and industry.

Theory

UNIT I

Descriptive statistics, Mean, variance, probability, conditional probability, Probability distribution.

UNIT II

Density functions, Mean variance.

UNIT III
Data and its nature; data representation; diagrams and graphs using MS Excel, Measures of Central tendency; Dispersion, Swekness and Kurtosis; Binomial and Normal Distributions.

UNIT IV
Confidence Interval of mean; Test of significance; Non-parametric tests; Simple, Partial and Multiple correlations.

UNIT V
Estimation, confidence intervals hypothesis testing, Basic principles of Experimental Designs; Analysis of Variance; Elements of Quality Control.

Practical
Exercises as per each of the Units in theory.

Suggested Readings
Aggarwal BL. 2003. *Basic Statistics*. New Age.
Brookes CJ, Betteley IG & Loxston SM. 1966. *Mathematics and Statistics for Chemists*. John Wiley & Sons.
Gupta SC & Kapoor VK. 2003. *Fundamentals of Mathematical Statistics*. S. Chand & Sons.

COMPUTER APPLICATIONS IN FOOD INDUSTRY (1+2)

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, 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.

BUSINESS MANAGEMENT & INTERNATIONAL TRADE (3+0)

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

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

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

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.

APPLIED NUTRITION (2+1)

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.

Practical

Assessment of nutritional status; planning balanced diets for normal and therapeutic nutrition; Formulation of nutrient rich foods, Assessment of nutritional quality of food.

Suggested Readings

Bamji MS, Rao NP & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.
Joshi SA.1999. *Nutrition and Dietetics*. Tata McGraw Hill.
Khanna K, Gupta S,Passi SJ, Seth R & Mahna R. 1997. *Nutrition and Dietetics*. Phoenix Publ.
Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.

DEFICIENCY COURSES

MATHEMATICS (3+0)

Objective

To provide basic knowledge and fundamentals of mathematics in order to provide a sound foundation for engineering related subjects.

Theory

UNIT I

Sets, Relations and Functions Sets and their Representations, Union, intersection and complements of sets, and their algebraic properties, Relations, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings.

UNIT II

Complex Numbers Complex numbers in the form a+*i*b and their representation in a plane. Argand diagram, Algebra of complex numbers, Modulus and Argument (or amplitude) of a complex number, square root of a complex number, Cube roots of Unity, triangle inequality.

UNIT III

Matrices and Determinants: Determinants and matrices of order two and three, properties of determinants, Evaluation of determinants. Area of triangles using determinants, Addition and multiplication of matrices, adjoint and inverse of matrix, Test of consistency and solution of simultaneous linear equations using determinants and matrices.

UNIT IV

Quadratic Equations Quadratic equations in real and complex number system and their solutions. Relation between roots and co-efficient, nature of roots, formation of quadratic

equations with given roots; Symmetric functions of roots, equations reducible to quadratic equations – application to practical problems.

UNIT V

Permutations and Combinations Fundamental principle of counting; Permutation as an arrangement and combination as selection, Meaning of P(n,r) and C(n,r). Simple applications.

UNIT VI

Mathematical Induction and Its applications.

UNIT VII

Binomial Theorem and its Applications Binomial Theorem for a positive integral index; general term and middle term; Binomial Theorem for any index. Properties of Binomial Co-efficient, Simple applications for approximations.

UNIT VIII

Sequences and Series Arithmetic, Geometric and Harmonic progressions, Insertion of Arithmetic Geometric and Harmonic means between two given numbers, Relation between A.M., G.M. and H.M. Special series: Sn, Sn2, Sn3. Arithmetic-Geometric Series, Exponential and Logarithmic series.

Suggested Readings

Grewal BS. 2007. *Higher Engineering Mathematics*. Khanna Publ.
James G. *Advanced Modern Engineering Mathematics.* Pearson Edu.

GENERAL MICROBIOLOGY (1+1)

(Prerequisite for Food Microbiology)

Objective

To provide basic knowledge about growth, reproduction, requirements of different groups of micro organisms and techniques of isolation, identification and enumeration of microorganisms.

Theory

UNIT I

Microbiology and its significance; Brief history of microbiology; Prokaryotes and Eukaryotes morphology; structure and function of microbial cells and their components; mode of reproduction in microorganisms.

UNIT II

Major groups of microorganisms: Role of bacteria, fungi and viruses in foods; Growth cycles, growth patterns; Nutrient requirements and physiology of microorganisms.

UNIT III

Physical and chemical factors affecting growth and destruction of microbes-aerobes and anaerobes, psychrophiles, psychrotrophs, mesophiles, thermoduric, thermophiles, halophiles osmophiles and spore formers.

Practical

Study and use of compound microscope; Staining techniques-simple, gram staining, capsule, spore, flagella and negative staining; Sterilization methods; Preparation and types of media; Techniques for isolation, identification and enumeration of microorganisms.

Suggested Readings

Black, JG. 2005. *Microbiology: Principles and Explorations*. John Wiley
Frobischer M. 1968. *Fundamentals of Microbiology*.
Hans G. 1986. *General Microbiology*. Cambridge Univ. Press.
Pelczar JM & Reid RD. 1974. *Microbiology*. Tata McGraw Hill.
Singh RP. 2005.Microbiology. Kalyani Publ
Stanier R. 1978. *General Microbiology*. MacMillan.

CROP PRODUCTION: CONCEPTS AND PRACTICES (2+1)

(Compulsory for non-agriculture graduates of Masters Programme in all disciplines of Basic Sciences)

Objective

To impart theoretical and practical knowledge about crop production under different agro-ecological conditions.

Theory

UNIT I

Agriculture and its role in national development, food security; General features of climate - India; Crop environment, weather and significance of various weather elements; Crop production - definition and scope, crop classification based on season, life cycle, taxonomy and economic use; Growth and yield of crops, growth parameters, yield attributes and factors affecting them; Thermal and photo response of plants, thermal indices and growing degree day concept in crop phenology.

UNIT II

Quality of good seed, ideal condition for germination, seed treatment, hybrid and composite seeds, categories of seeds (certified, foundation and breeder seed); Importance of sowing time, seed rate, sowing methods, plant
population; Tillage and intercultural operations - objectives and methods; Weeds in crop production; Irrigation - scheduling, methods and water use efficiency; Harvesting, threshing, winnowing, storage and processing.

UNIT III

Crop rotations, mixed cropping, inter cropping, its objectives and importance; Definitions of mono-cropping, double cropping, multiple/intensive cropping, relay cropping with example in brief; Farming system and sustainable agriculture.

UNIT IV

Rain fed agriculture and dry farming, soil moisture conservation; Agronomic techniques to improve crop yields and watershed management.

UNIT V

Soil as a three phase disperse system, its physical chemical and biological properties; Soil fertility and soil productivity, manures and fertilizers, integrated nutrient management; Soil and water testing: objectives, sampling techniques, interpretation of results and recommendations; Selection of soil, and management of water and nutrients in pot culture experiments; Problem soils and their management; Soil and water pollution.

UNIT VI

Classification of vegetable crops; Types of vegetable farming; Principles of vegetable production; Raising of vegetable seedlings under different environmental conditions; Important practices of cool and warm season vegetable crops.

UNIT VII

Concepts in Horticulture - methods of propagation, systems of planting and layout, training and pruning, fruit growth and development, fruit maturity and ripening; Post harvest management of fruits and flowers; Production technology of fruit and flower crops.

Practical

Identification of seeds of different crops, germination test and seed rate calculations; Visit to farm for identification of different crop plants and measurement of growth; Herbicide formulations, delivery systems; Field layout of different sowing methods. Sampling, processing, storage and analysis of soil samples for available nutrients (N, P, K, S, Fe, Zn, Mn and Cu); Sampling, processing, storage and analysis of plant samples for N, P, K, S, Fe,

Zn, Mn and Cu content. Raising nursery in field and protected conditions; Practices in methods of propagation; various methods of training system and pruning, system of planting; Post harvest processing.

COMPULSORY COURSES (NON-CREDIT)

LIBRARY AND INFORMATION SERVICES

(CREDIT- 0+1)

Objective

To equip the library users with skills: to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM, Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods

TECHNICAL WRITING AND COMMUNICATIONS SKILLS
(CREDIT- 0+1)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical writing

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication skills

Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek, Chandigarh.
Chicago Manual of Style. 14th Ed. 1996. Prentice-Hall of India, New Delhi.
Collins' Cobuild English Dictionary. 1995. Harper Collins, New York.
Gibaldi, Joseph. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press, New Delhi.
Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford UP, Oxford.
Krishna Mohan 2005. Speaking English Effectively. Macmillan India, New Delhi.
Mills Gordon H & John A Walter. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston, New York.
Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice-Hall of India, New Delhi.
Shelton James H. 1994. Handbook for Technical Writing. NTC Business Books, Chicago.
Smith Richard W. 1969. Technical Writing. Barnes & Noble, New York.
Wren PC & Martin H.2006. High School English Grammar and Composition. S. Chand, New Delhi.

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (CREDIT 1+0)

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

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; 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; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and

Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

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.

DISASTER MANAGEMENT

(CREDIT- 1+0)

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and Local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.
Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A*

Handbook of Disaster Management. Routledge.
Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.

AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES
(CREDIT- 1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
Punia MS. *Manual on International Research and Research Ethics*. CCS,
Haryana Agricultural University, Hisar.
Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
Singh K.. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

BASIC CONCEPTS IN LABORATORY TECHNIQUES
(CREDIT- 0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;

washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co