

CURRICULUM
OF
Food Science & Technology
B.Sc (Hons)
M.Sc/M.Sc (Hons)
Ph.D

(Revised 2004)



HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

Prof. Dr. Altaf Ali G. Shaikh	Adviser (HRD)
Qazi Riaz Ahmad	Director Curriculum
Malik Ghulam Abbas	Deputy Director
Miss Ghayyur Fatima	Deputy Director
Mr. M. Tahir Ali Shah	Assistant Director
Mrs. Noshaba Awais	Assistant Director

Composed by Mr. Zulfiqar Ali, HEC Islamabad

CONTENTS

1.	Introduction	6
2.	Scheme of Studies for B.Sc (Hons)	10
3.	Detail of Courses for B.Sc (Hons)	11
4.	Scheme of Studies for M.Sc/M.Sc (Hons)/ Ph.D	25
5.	Detail of Courses for M.Sc/M.Sc (Hons)/ Ph.D	26
6.	Recommendations	43

PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

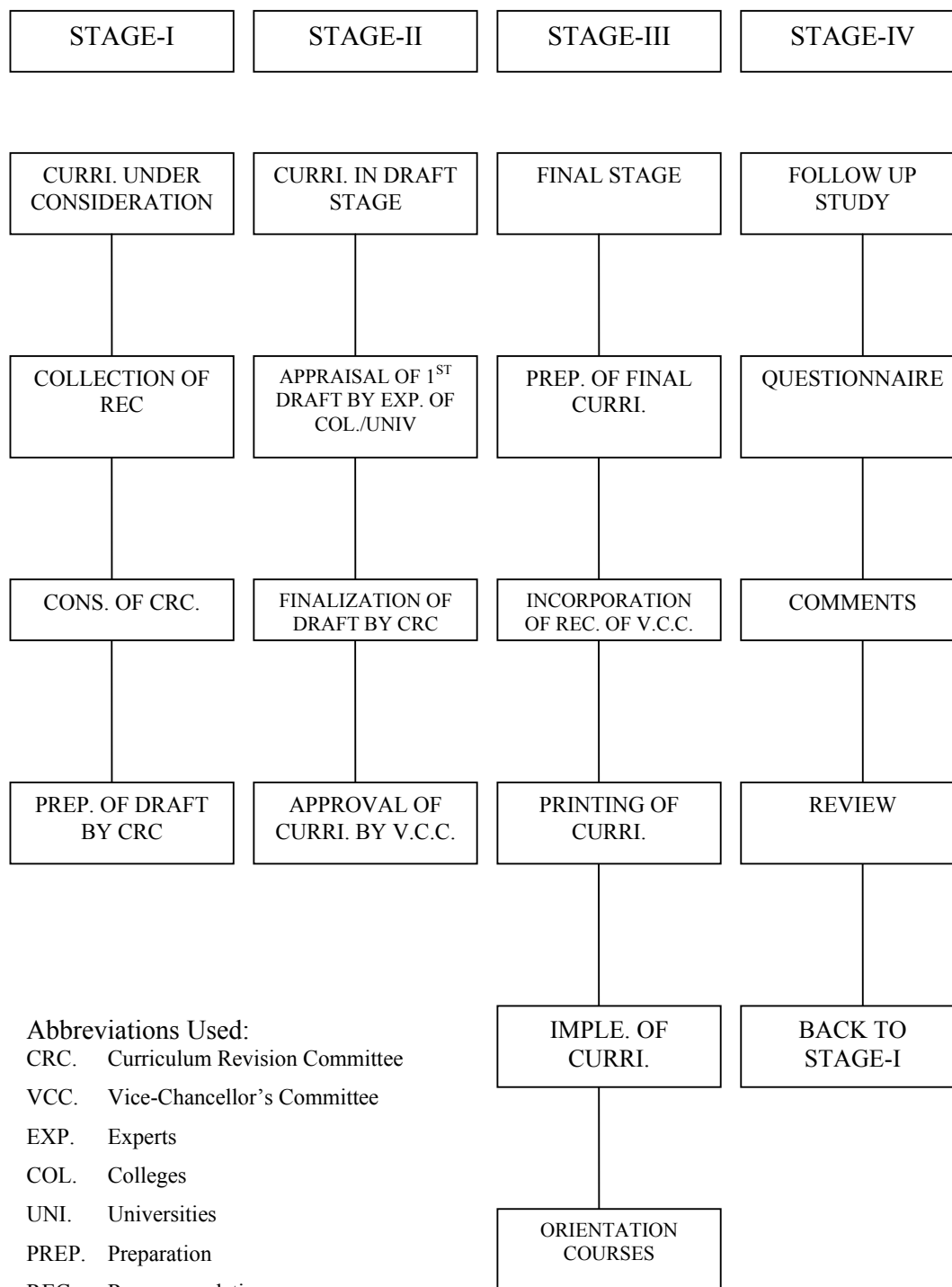
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Food Technology in its meeting held in July 2004 at the HEC Regional Centre, Lahore revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by architectural institutions.

(PROF. DR. ALTAF ALI G. SHAIKH)
Adviser (HRD)

August 2004

CURRICULUM DEVELOPMENT



- | | | |
|-----|--|--|
| 8. | Mr. Muhammad Ashraf Chaudry
CSO/Head Food Science Division
Nuclear Institute for Food and Agriculture (NIFA)
P.O. Box-446, Peshawar | Member
(Attended 1 st meeting
only) |
| 9. | Dr. Wazir Hussain Shah
Director General
PCSIR Labs. Complex
Ferozepur Road, Lahore | Member |
| 10. | Mr. Saifullah Khan
Associate Professor
Department of Food Technology
Faculty of Agriculture, Gomal University
D.I. Khan. | Member |
| 11. | Prof. Dr. Mushtaq A. Saleem
Principal
University College of Agriculture
B. Z. University, Multan | Member |
| 12. | Dr. Habib Ahmed Rathore
Assistant Professor
Department of Food Technology
University College of Agriculture
Rawalakot, AJK | Member |
| 13. | Dr. Javaid Aziz Awan
Professor (Retd)
Institute of Food Science & Technology
University of Agriculture
Faisalabad | Member
(Attended 2 nd meeting
only) |
| 14. | Dr. Muhammad Shafiq Chaudhry
Director
Ramna Foods (Pvt) Ltd.
Kot Lakhpat, Lahore | Member
(Attended 2 nd meeting
only) |
| 15. | Dr. Abid Hasnain
Chairman
Department of Food, Science & Technology
University of Karachi
Karachi | Member/Secretary |

The meeting started with recitation from the Holy Quran. Prof. Dr. Altaf Ali G. Shaikh, Adviser (HRD) HEC, Islamabad welcomed the participants and briefed them of the obligations of the Commission for review, revision and development of curricula. He informed the Committee that the curriculum of B.Sc. (Hons.), M.Sc. (Hons.) and Ph.D. degrees in Food Technology was revised in May, 2001.

Dr. Shaikh in his opening remarks informed the members that the Government is striving hard to enhance quality of education in public sector universities/institutions by making curriculum more compatible with international standard, job oriented and to match the needs of society. He apprised the members of the Committee about different Academic Programmes of the Commission aimed at facilitating the universities in executing their programmes including repair and maintenance of laboratories, provision of books for libraries, institution of indigenous Ph.D. scholarships, provision of computer and other modern tools like internet and e-mail etc.

Prof. Dr. Faqir Muhammad Anjum, Convener, expressed his gratitude for the presence of Prof. Dr. Shafiq Ch. and Dr. Javed Aziz Awan as new members.

The courses of B.Sc.(Hons), M.Sc.(Hons) and Ph.D degrees in Food Technology were discussed in full length and amendments/modifications were suggested by the learned members.

The Committee, after three days of discussion, revised the existing curriculum.

OBJECTIVES

- i. To provide graduate and post-graduate level education for students interested in applying food science and technology to the theoretical and practical aspects of the entire food chain from production of the raw material to the utilization of the product by the consumer.
- ii. To provide a focus for graduate study and research in food science & technology.
- iii. To help promote interactions with other disciplines which relate to the study of food science and technology.

SCHEME OF STUDIES FOR B.Sc. (Hons)

S. No.	Title of the Course
1.	Introduction to food science and technology
2.	Food processing and preservation
3.	Food Processing–I
4.	Food processing–II
5.	Oils and fats technology
6.	Sugar technology
7.	Meat, poultry and fish processing
8.	Cereal technology
9.	Dairy technology
10.	Beverage technology
11.	Food and factory laws
12.	Food microbiology
13.	Food chemistry
14.	Food analysis and sensory evaluation
15.	Post-harvest
16.	Food Safety
17.	Confectionery and snack foods
18.	Internship
19.	Preparation of Research Project and Scientific Writing
20.	Food and Nutrition

DETAIL OF COURSES FOR B.Sc (Hons)

Introduction to food science and technology

Theory

Definitions: Food science, food technology, food processing, food preservation.

Sources of food: plants, animals, marine.

Important food industries in Pakistan.

Role of food science and technology in national economy.

Classification of foods: pH and perishability basis.

Food constituents: water, carbohydrates, proteins, lipids, vitamins, mineral elements, other constituents – functions, role in human health, recommended dietary allowances.

Food spoilage: mode, causes.

Spoilage agents: Chemical, biochemical, biological.

Food poisoning: causes and remedies.

Practicals

Use of lab. equipment. Estimation of moisture, fat and ash etc. in food samples. Determination of specific gravity, soluble solids, pH, acidity, total solids, refractive index, free fatty acids.

Text Book

1. Awan J A 2001. Elements of food science and technology. Unitech Communications, Faisalabad.

Recommended Book

1. Potter N N and Hotchkiss J H. 1995. Food Science. 5th ed. Chapman and Hall, New York.

Practical Manual

1. Awan J A and Rehman S U. 2003. Food Analysis Manual. Unitech Communications, Faisalabad.

Food processing and preservation

Theory

Preparatory operations in food processing: Cleaning, sorting and grading, peeling, removal of inedible constituents, size reduction, mixing, filtration and prevention of enzymatic browning - applications.

Principles of food preservation.

Preservation by high temperature: Canning - unit operations and their significance.

Preservation by low temperature: Distinction between refrigeration and freezing.

Cold storage: Factors affecting

Freezing and frozen storage: unit operations, effect on food and micro-organisms.

Preservation by removal of moisture: Sun drying, dehydration - equipment, procedures, precautions. Defects in dried foods.

Types of dehydrators. Still air, forced draft.

Food additives: Chemical additives, contaminants and adulterants - differentiation.

Uses of food additives: Non preservative, preservative.

Fermentation techniques: alcoholic, acetic and lactic fermentations – applications, procedures.

Irradiation technology: Applications in food preservation. Merits and demerits.

Food Packaging: Packaging materials, protective packaging in tropical environment, Aseptic packaging.

Practicals

Equipment and instruments used in food processing. Blanching. Canning, bottling, freezing, dehydration of fruits and vegetables. Preservation of fruits and vegetables by the use of food additives and fermentations.

Text Books

1. Awan J A. 2002. Food processing and preservation. Unitech Communications, Faisalabad.
2. Potter N N and Hotchkiss J H, 1995. Food Science. The AVI Publishing Co. Inc, Westport, Connecticut.

Practical Manual

1. Awan J A and Rehman S U, 2004. Food preservation manual. Unitech Communications, Faisalabad.

Food Processing-I

Theory

Heat processing: Principles, heat processing of foods: Sterilization, commercial sterilization, pasteurization, blanching, exhausting, high temperature short time processing, ultra high temperature processes - definitions and applications. Ohmic and dielectric heating of foodstuff and temperature distribution.

Canning: Unit operations. Basis for selection of heat processing treatment: heat resistance of micro-organisms, heat processing characteristics of food and container, heat transfer, determining process time and lethality, inoculated pack studies.

Heat processing equipment: Still and agitating retorts - instrumentation, operation.

Aseptic packaging: process and system requirements, packaging materials.

Parameters for canning fruits, vegetables, meat and fish.

Spoilage of heated canned foods, can defects.

Low temperature preservation of foods: Principles. Definitions - refrigeration, cold storage, freezing. Refrigeration plant systems, monitoring and control.

Cold storage: Requirements - insulation, air circulation, humidity. Controlled atmospheric storage. Racking systems.

Requirements for cold storage of food commodities.

Freezing and frozen storage: Freezing point, freezing curve, freezing rate, changes during freezing, damages during intermittent thawing. Calculation of refrigeration load.

Freezing methods: Slow, quick. Packaging of frozen foods.

Freezing parameters for different food commodities.

Dehydration and concentration: Principle. Role of water activity and solutes in food preservation by dehydration and concentration, equipment used, factors affecting rate of drying and dehydration, surface drying and case hardening.

Parameters for dehydration food commodities.

Practicals

Equipment and instruments used in: Heat processing, cold storage, freezing, dehydration and concentration. Canning, cold storage, freezing and dehydration of fruits and vegetables.

Text Books

1. Awan J A, 2002. Food processing and preservation. Unitech Communications, Faisalabad.
2. Gindhari L, Siddappa G S and Tandon G L, 1998. Preservation of fruits and vegetables. Publications and Information Division, Indian Council of Agricultural Research, New Delhi.

Recommended Books

1. Potter NN and Hotchkiss J H, 1995. Food Science. The AVI Publishing Co Inc, Connecticut.
2. Micea B D, 1995. Fruit and vegetable processing. FAO Bulletin No.199. FAO, Rome.

Practical Manual

1. Awan J A and Rehman S U, 2004. Food preservation manual. Unitech Communications, Faisalabad.

Food Processing-II

Theory

Use of food additives: principles of preservation, applications,
Food additives: Properties, criteria of selection, mode of action, permissible limits in relation to food safety standards, GRAS additives.
Chemical additives in food processing
Technologies for manufacture and preservation of products from fruits and vegetables,
Edible coating for fruits: Selection, wet ability, coating effectiveness.
Modified atmospheric packaging: Use of O₂ MAP, argon and nitrous oxide, non-sulphite dipping, testing effectiveness of MAP techniques.
Preservation by fermentation technology: Principle.
Alcoholic fermentation: manufacture of ethyl alcohol and bread
Acetic acid fermentation: Production of vinegar, use of vinegar in food formulations
Lactic acid fermentations: Applications in fruits, vegetable, dairy and meat industries.
Irradiation of foods: Food irradiation technology: effect of irradiation on food components and microbes.
Food packaging: Concept, application.
Packaging requirements, packaging classification, packaging materials,
Waste management in food industries.

Practicals

Storage of fruits and vegetables for further processing by chemical methods.
Preparation of different fruit and vegetable products. Preparation of fermented foods, production of vinegar, yogurt and pickles Identification of spoilage organisms. Visit to fruit and vegetable processing and packaging industries.

Text Books

1. Gindhari L, Siddappa G S and Tandon G L, 1998. Preservation of fruits and vegetables. Publications and information Division Indian Council of Agricultural Research, New Delhi-110012
2. Potter N N and Hotchkiss J H, 1995. Food science. The AVI Publishing Co. Inc, Westport, Connecticut.

Recommended Books

1. Awan J A, 2002. Food processing and preservation. Unitech Communications, Faisalabad.
2. Micea B D, 1995. Fruit and vegetable processing. FAO Bulletin No.199. FAO, Rome.

Practical Manual

1. Awan J A and Rehman S U, 2004. Food Preservation Manual. Unitech Communications, Faisalabad.

Oils and Fats Technology

Theory

Oils and fats: importance, uses; sources.

Extraction methods: rendering, expression, solvent.

Processing: degumming, refining, bleaching, deodorization, fractionation, winterization, hydrogenation, interesterification, esterification, emulsification.

Characteristics of oils and fats: physical, chemical.

Spoilage: oxidative and hydrolytic rancidity, polymerization.

Frying oils, margarine, mayonnaise: manufacture.

Practicals

Extraction of oils and fats. Determination of physical and chemical constants: refractive index, colour, cold test, melting point, smoke point, acid value, specific gravity, peroxide value, iodine value, saponification value and solid fat index. Visit to oil and fat industries.

Text Book

1. Hui Y H, 1996. Bailey's industrial oils and fat products. Vol. 1-5. John Wiley and Sons, Inc New York.

Recommended Books

1. O'Brien R D, 2000. Fats and oils formulating and processing for application. 2nd ed. CRC Press London. UK.
2. AOAC, 1995. Official methods of analysis. Association of official analytical chemists, Arlington.

Sugar Technology

Theory

Sugar Industry in Pakistan,

Sugarcane and sugar beet: production and quality. Utilization of sugar.

Indigenous technology for small scale sugar production: Gur, khund, shakar.

Raw sugar manufacturing: Unit operations - juice extraction, purification, heating, evaporation, crystallization and crystallization in motion.

Refining: Affination, clarification, decolourisation crystallization, centrifugation, drying, bagging, storage.

Factors affecting sugar processing. Quality criteria: Raw and refined sugar.

Practicals

Analysis of sugar cane, sugar beet for TSS, pH, fibre, ash and polarization.

Clarifications of raw juice. Analysis of sugar and its intermediate products.

Inversion of sugar. Visit to sugar industries.

Text Books

1. Chen J C P, 1985. Meade-Chen Cane Sugar Handbook. John Wiley and Sons, New York.
2. Lionnet G R E, 1999. Sugar technology for students. Lang Fred, Durban.

Recommended Book

1. Chen C, 2001. The sugar refining — A manual for the design and refining facilities. John Wiley and Sons. London.

Meat, poultry and fish processing

Theory

Mutton and beef: Slaughter house operations, dressing, anti- and post-mortem changes in carcass Composition and grading of meat. Meat cuts.

Processing and preservation: canning, freezing, salting, smoking, dehydration.

Spoilage and its control.

Poultry: Classes of poultry meat. Nutritional value of poultry meat. Commercial methods of slaughtering, dressing.

Post-slaughter handling, storage and preservation of poultry. Spoilage and its control.

Freezing of poultry: whole, cuts

Eggs: Composition, handling, candling washing, coating, packaging and storage. Egg processing. Spoilage and its control

Fish: Fresh water and marine fish – Classification, quality characteristics.

Commercial handling, criteria for freshness.

Fish processing. Canning, freezing, drying.

Spoilage and its control.

Practicals

Tests for freshness of meat, poultry, fish and eggs. Preparation of meat, poultry, fish and egg products. Preparation of sausages. Salting and freezing of fish. Preservation of meat, fish, poultry and eggs by canning, freezing, drying, smoking and curing. Visit to relevant industries.

Recommended Books

1. Stadelman W J, Olson V M, Shemwell G A and Pasch S, 1988. Egg and poultry meat processing. Elliswood Ltd, Chichester.
2. Davies A and Board R, 1998. Microbiology of meat and poultry. Blackie. Academic and Professional, New York.
3. Govindon T K, 1985. Fish Processing Technology. Oxford and IBH Publishing Co Pvt. Ltd, Calcutta.
4. Kerry J, Kerry J and Ledward D, 2002. Meat processing — improving quality. Woodhead Pub. Ltd. Cambridge.

5. Pearson A M and Gillett T A, 1996. Processed meats 3rd ed. Chapman and Hall, New York.

Cereal technology

Theory

Cereal grains: Importance, production, structure, composition, grades and grading. Storage of cereals: Storage, role of moisture, functional changes.

Dry milling: process: products, flour treatment, quality.

Wet milling: production of starch, oil and protein.

Rice, oat and barley processing: Malting,

Production technologies: Leavened products (yeast and chemical), soft wheat products, Durum wheat products: Pasta, noodles and breakfast cereals.

Practicals

Grading of grains, tempering and milling of wheat. Flour quality assessment. Preparation of vermicelli, bread, biscuits and cakes etc. Visit to industries.

Text Books

1. Kent N L and Evers A D, 1994. Technology of cereals. Pergamon Press, London.
2. Hosney R C, 1994. Principles of cereal science and technology. American Association Cereal Chemists Inc, St Paul, Minnesota.

Recommended Books

1. Kulp K and Pont J G, 2000. Handbook of cereal science and technology. 2nd ed., Chips Ltd. USA.
2. AACC, 2000. Approved methods of American Association of Cereal Chemists. American Association of Cereal Chemists Inc, St. Paul, Minnesota.

Dairy technology

Theory

Milk: sources, production, handling, distribution, composition.

Dairy industry in Pakistan. Methods of procurement, collection and reception.

Milk processing: cream separation, standardization, homogenization, pasteurization, HTST and UHT technologies, packaging.

Milk products technology: Evaporated milk, powdered milk, butter, yoghurt, cheese, ice-cream, flavoured milks.

Quality control in dairy products.

Plant hygiene and sanitation.

Practicals

Analysis of milk and milk products: fat, COB, APT, proteins, lactose, ash, moisture, acidity, pH, specific gravity, SNF, phosphates test. Microbiological and adulteration tests for raw, pasteurized and UHT processed milk. Efficacy of refrigeration, pasteurization, concentration, homogenization and packaging of milk. Visit to dairy industries.

Text Book

1. ALFA-LAVAL — Dairy handbook. Alfa-Laval AB Pub. Sweden.

Recommended Books

1. Hui Y H, 1993. Dairy science and technology handbook. VCH Publishers Inc, 220 East 23rd Street, New York..
2. APHA (American Public Health Association), 1993. Standard methods for the examination of dairy products. Port City Press, Baltimore.

Beverage technology

Theory

Beverages: Introduction, classification, beverage industry in Pakistan.

Ingredients for beverages: Water - sources and purification, types of water purification systems. Fruit pulps, juices, concentrates, and other additives; Sweeteners - sugars, artificial sweeteners. Colours, flavours, preservatives, Beverages: Unit operations in production.

Fruit based beverages: Nectar, cordial, squash, syrup, juice concentrates, fruit flavoured powders. Barley water. Carbonated beverages, synthetic, low calorie beverages, dry mix. formulation.

Tea processing.

Bottled water: manufacture.

Traditional beverages: production.

Quality control in beverage industry. Plant sanitation.

Practicals

Water treatment. Preparation of syrups. Preparation of carbonated and non-carbonated beverages, Chemical analysis of beverages. Visit to beverage plants.

Recommended Books

1. Lea AGH and Piggott J R (eds.), 1995. Fermented beverage production. Blackie Academic and Professional, London.
2. Mitchell A J (Ed). 1990. Formulation and production of carbonated soft drinks. The AVI Pub. Co. Inc, Westport, Connecticut.
3. Sirivastava R P and Sanjeev K, 2002. Fruit and vegetable preservation —principles and practices. 3rd ed. International Book Distributing Co. Lucknow, India.

Food and factory laws

Theory

Food laws and legislation: concept, significance.

Pure Food Rules 1965; enforcement, amendments.

Powers of food inspector, sampling techniques, food standards and specifications, the AGMARK standards.

Food adulteration and health hazards, adulterants and methods of detection.

Flour and rice milling control and management ordinance 1977, Ghee Industry Act 1973, Pakistan Hotel and Restaurants Act 1976.

Food labelling: perspectives on nutrition labelling, education act, NLEA in cereal and baking product, international harmonization and compliance, WTO implications to food business. Codex Alimentarius Food Standards.

Factory laws: food and workers safety.

Text Books

1. Awan E A 2004. Food laws manual. Lahore Law Times Publications, Lahore.
2. Rees N and Watson D, 2000. International Standards for Food Safety.

Recommended Books

1. Srilakshma B, 2003. Food science. 3rd edition. New Age International (P) Ltd, Publishers, New Delhi.
2. Shapiro R, 1995. Nutrition labelling handbook. Marcel Dekker, Inc, New York.

Food microbiology

Theory

Food microbiology: Importance.

Micro-organisms important in foods: Molds, yeasts, bacteria, viruses - general, morphological, cultural and physiological characteristics.

Contamination of foods: sources, micro-organisms

Microbiology of food and food products: fruits, vegetables, cereals, milk, meat, poultry, eggs, fish, snack foods, water and beverages, sugar and sugar products,.

Food borne intoxications: *Clostridium botulinum*, *Bacillus cereus*, *Staphylococcus aureus*

Food borne infections - *Clostridium perfringens*, *Salmonella* sp, *Shigella* sp, *Escherichia coli*, *Vibrio* sp.

Fungal food poisoning: *Aspergillus* sp.

Control of microorganisms: Physical, chemical, thermal and radiations.

Practicals

Laboratory protocols and safety measures. Applications of microbial techniques. Micrometry. Enumeration of micro-organisms in food samples. Examination of foods for spoilage and pathogenic organisms. Identification of micro-organisms important in foods through biochemical techniques.

Text Books

1. Jay M J, 1996. Modern food microbiology. CBS Publishers, New Delhi.
2. Frazier W C, 1998. Food microbiology. McGraw-Hill Book Co, New York.

Recommended Book

1. Tortora G J, Funke B R and Case C L, 1995. Microbiology — An introduction. The Benjamin/Cummings Pub Co Inc, California.

Practical Manual

1. Awan J A and Rehman S U, 2002. Microbiology manual. Unitech Communications, Faisalabad.

Food chemistry

Theory

Food components: Water, carbohydrates, lipids, proteins, vitamins, minerals, colours, flavours, acidulants and others - Structure, chemistry, physico-chemical and functional attributes in relation to food quality.

Food hydrocolloids: nature and stabilization of colloidal systems, emulsions, gels, foams, crystallization and its effects on the texture of foods.

Chemical changes occurring during food processing, storage.

Text Books

1. Coultate T P, 1999. Food; the chemistry of its components. The Royal Society of Chemistry, Cambridge.
2. Belitz H D and Grosch W, 1999. Food chemistry. 2nd ed. Springer-Verlag Heidelberg.

Recommended Book

1. Fennema. O R, 1992. Food chemistry, Marcel Dekker, Inc, New York.

Food analysis and sensory evaluation

Theory

Physical analysis: sampling techniques, sample preparation and preservation.

Methods for physical properties of foods and food products: appearance, texture, specific gravity, refractive index, rheology.

Chemical Analysis: Proximate composition (moisture, ash, protein, fat, fibre, NFE), acidity, pH, sugars, mineral elements and vitamins.

Instrumental analytical techniques: Chromatography, spectroscopy, N.M.R, Electrophoresis, differential scanning calorimetry, etc. – scope, theory, applications.

Sensory evaluation: Requirements and methods. Sensory parameters: colour, flavour, texture, taste, aroma, general acceptability. Difference test and preference tests.

Practicals

Determination of specific gravity, viscosity, refractive index, colour.

Determination of protein, fat, fibre, pH, acidity, sugars, mineral elements. Paper and thin layer chromatography, GC, HPLC and electrophoresis etc. Sensory evaluation of food.

Text Books

1. Pomeranz Y and Meloan C E, 1996. Food analysis: Theory And Practice. 3rd ed. CBS Publishers, New Delhi.
2. Nielsen S S, 1994. Introduction to the chemical analysis of foods. Jones and Bartlett Publishers, London.

Recommended Books

1. Nielson S S. 2003. Food analysis laboratory manual. Chips Ltd, USA.
2. Lawless H T and Heymann H 1998. Sensory Evaluation of Foods: Principles And Practices, Chapman and Hall, New York.
3. AOAC, 1995. Official methods of analysis. Association of Official Analytical Chemists, Arlington.

Post harvest

Theory

Grains and legumes: Physical and thermal properties, harvesting and threshing operations. Grain drying, handling and storage, Role of temperature and humidity: Deterioration during storage, causes, loss assessment, control, mycotoxin production. Controlled atmospheric storage. Grain sanitation operations.

Fruits and vegetables: Physiology and biochemistry, maturity and quality grades. Methods of harvesting, handling, removal of field heat, packaging, transportation and storage.

Water loss, respiration activity, vapour heat treatment, mechanical injuries. Drying of fruits and vegetables.

Recommended Books

1. Ramaswamy H, 2003. Handbook of post-harvest technology, cereals, fruits, vegetables tea and species. Marcel Dekker Inc.
2. Yamashita R, 1993. New technology in grain post-harvesting. Farm Machinery Industrial Research Corp, Tokyo.
3. Jongen W, 2002. Fruits and vegetable processing-improving quality. CRC Press, Woodhead Publishing Limited, England.

Food Safety

Theory

Food safety: characterization and risk analysis.

Food hazards: Physical, chemical and biological Systems for food safety surveillance.

Food safety operations in processing: Concept of GMP, GLP and HACCP.

Worldwide food safety issues: ISO 9000 related standards, impact on food safety and WTO; implementation of GAP, FAO/WHO food standards programme.

Food Sanitation.

Text Books

1. Schmidt R H and Rodrick G E, 2003. Food safety handbook. John Wiley and Sons Inc.
2. Jones J M, 1992. Food Safety. AACC. Paul, Minn, USA.

Confectionery and snack foods

Theory

Confectionery: Industry in Pakistan.

Sugar confectionery: formulations, manufacture.

Processing of hard boiled sweets, toffee and fudge: formulations and manufacture Processing of gums and jellies: formulations and manufacture.

Chocolate confectionery

Quality Control

Snack foods: Classification, snack foods of dairy origin, fish snacks, meat based snacks, fruit based snacks, potato based snacks; extruded snacks, doughnuts, pastries, cookies, crackers and other flour confectionery – formulations and manufacture.

Storage and packaging of snack foods.

Practicals

Processes and products for potato, fruits, nuts, meat, and dairy based snacks. Puffed, baked products and extruded snacks.

Preparation of: candy, toffee, chocolates, and other sugar based confectionery.

Recommended Books

1. Booth R G, 1997. Snack foods. CBS Publishers and Distributors, New Delhi.
2. Jackson E B, 1995. Sugar confectionary manufacture. 2nd ed. Blackie Academic and Professional Wester Cleddens Road, Bishophiggs, Glasgow.

Internship

Every student will undertake practical training in an approved food industry or research organization. He/she will maintain a daily diary duly signed by the industrial/research supervisor and submit a written report. At the end of the internship, the student will be evaluated by a committee on the basis of his/her performance in the industry/research organization, final written report and oral presentation.

Preparation of Research Project and Scientific Writing

Theory

Scientific Presentations: types. Collection of literature from printed and electronic sources. Organizing literature: Initiating write up. Writing review of literature. Writing synopsis. Writing scientific paper. Quoting references in the text and bibliography. Delivering oral presentations. Writing internship reports.

Text Book

1. Awan J A, 2003. Scientific presentations. Unitech Communications, Faisalabad.

Food and Nutrition

Theory

Nutrition; relation of nutrition to health, essentials and planning for good nutrition, basic food groups, formulation of balanced diet, diet planning.

Food nutrients: water, carbohydrates, proteins, lipids, vitamins, mineral elements - functions, sources, problems of over and under nutrition, nutritional deficiency disorders, recommended dietary allowances.

Digestion and transport; Alimentary tract, digestive juices and secretions, absorption and metabolism of nutrients.

Nutrition throughout the life cycle: Infants, children, adolescents, adults, pregnant and lactating women.

Diet related diseases; Obesity, hypercholesterolemia, coronary diseases, lactose intolerance, dental caries, gastrointestinal problems, diabetes, hypertension and cancer.

Text Book

1. Awan J A, 2000. Elements of food and nutrition. Unitech Communications, Faisalabad.

Recommended Books

1. Dowd M T and Dent A, 2003. Elements of foods and nutrition. Biotech Books, New Delhi.
2. Bamji M S, Rao N P and Reddy V. 1996. Text-book of human nutrition. Oxford and IBH Publishing Co Pvt, Ltd, New Delhi.

SCHEME OF STUDIES FOR M.Sc/M.Sc (Hons)/Ph.D

S. NO.	TITLE OF THE COURSE
1.	Food Biotechnology
2.	Food Additives
3.	Food Enzymology
4.	Food Plant Design and Layout
5.	Food Toxicology
6.	Milling of Cereals
7.	Baking Science & Technology–I
8.	Baking Science & Technology–II
9.	Starch Chemistry and Technology
10.	Dairy Processing-I
11.	Dairy Processing-II
12.	Advanced Food Microbiology
13.	Advanced Food Chemistry
14.	Chemistry of Edible Oils & Fats
15.	Industrial Processing of Edible Oils and Fats Products
16.	Meat Science
17.	Technology of Processed Meat
18.	Chemistry and Technology of Sugar Processing
19.	Food Quality Assurance Management
20.	Food Industrial Waste Management
21.	Advanced Beverage Technology
22.	Post-Harvest Management
23.	Food Packaging
24.	Physical Properties of Food
25.	Recent Advances in Food Science and Technology
26.	Marine Foods

DETAIL OF COURSES FOR M.Sc./M.Sc. (Hons)/ Ph.D.

Food Biotechnology

Theory

Food Biotechnology: Introduction, importance, advances and trends, techniques and applications.

Fermentation: Types, equipment, factors affecting, fermentation control conditions.

Yeast based products: Alcoholic beverages, industrial alcohols, baker's yeast, bread and related products.

Bacteria based fermented products: Dairy, meat fish, vegetable products; production of vinegar organic acids, bacterial biomass.

Mold based products: Enzymes, antibiotics.

Other microbial based products: Sweeteners, flavours, amino acids, vitamins.

Safety evaluation of novel food products, genetically modified foods.

Practical

Isolation, purification and maintenance of yeast and bacterial cultures, aerobic and anaerobic fermentation, production of various fermented food products. Production of metabolites and enzymes.

Text Books

1. Mittal G S, 1992. Food biotechnology: Techniques and applications. Technomic Pub Inc, Lancaster.
2. Lee B H, 1996. Fundamentals of food biotechnology, VCH Publishers, Inc, New York.

Recommended Books

1. Awan J A and Rehman S U, 2002. Microbiology manual. Unitech Communications, Faisalabad.
2. Capuccino J G and Sherman N, 1996. Microbiology, the Laboratory Manual. The Benjamin/Cummings Pub Co, Inc, New York.
3. Stanbur P F and Allan W, 1984. Principles of fermentation technology. Pergamon Press Oxford.

Food Additives

Theory

Food additives: Generally recognized as safe (GRAS) food additives, regulatory status, functions, types, mode of action, uses, risks and benefits.

Consumer attitude towards food additives.

Nutritional and non-nutritional additives, antimicrobial agents, antioxidants, anti-browning agents.

Fat and sugar substitutes.

Flavouring agents and flavour enhancers, Sweeteners, natural and synthetic emulsifiers and acidulants.

Food additives for special dietary purposes. Food additives and hypersensitivity of Food Additives; Safety evaluation

Practical

Estimation of preservatives: Sorbates, benzoates and sulphur dioxide.
Determination of antioxidants, emulsifiers, flavours, sweetener and colours in different food commodities.

Text Books

1. Branen A L, Davidson R M, Salminen S and Thorngate J H, 2001. Food additives. 2nd ed. Marcel Dekker, Inc, Madison Avenue, New York.
2. Wood R, Foster L, Damant A and Key Pauline. 2004. Analytical methods for food additives. CRC Press, Boca Raton, Florida.

Recommended Book

1. Madhavi D L, Deshpande S S and Salunkhe D K, 1996. Food Antioxidants. Marcel Dekker Inc New York.

Food Enzymology

Theory

Enzymes: Nomenclature and classification. Enzyme classes: proteases, amylases, cellulases, transferases, hydrolases, isomerases, lipases, redox enzymes. Nonlinear enzyme kinetics and inhibition. Enzyme immobilization and methods, enzyme reactions. Nonlinear analysis of enzyme activity. Separation, purification and assay of enzymes. Nonlinear application of enzymes: baking, starch hydrolysis, dairy, beverages, fruit juice processing, meat, fat and others.

Practical

Extraction and purification of enzymes. Estimation of amylases, proteases and peroxidases. Effect of temperature and pH on enzyme stability and activity. Use of enzymes in bread, juice clarification, meat tenderization and other food products.

Text Books

1. Whitaker J R, Voragen AGJ and Wong DWS, 2003. Handbook of food enzymology. Marcel and Dekker, New York.
2. Whitehurst J and Law B A, 2002. Enzymes in food technology. CRC Press, Boca Raton. Florida.

Recommended Book

1. Mathewson P R, 1998. Enzymes. American Association of Cereal Chemists, Inc, St Paul, Minnesota.

Food Plant Design and Layout

Theory

Plant design and layout: objectives and functions. Financial requirements, Plant location, site selection, space requirement, building design and construction, use of computer for layout, environmental impact, layout of equipment, material handling and equipment process flow chart. Just in time manufacturing (JIT), Utilities and services.

Water supply system and waste disposal. Workers health check up system.

Text Book

1. Sheth V S, 1995. Facilities planning and materials handling; method and requirements. Mercel Dekker, Inc, New York.

Recommended Book

1. Strom, D R, 1996. Urinary utilities — planning design and operation. Chapman and Hall, International Thomson Publishing, New York.

Food Toxicology

Theory

Food toxicology: Principles of toxicology, manifestations of organ toxicity, measurement of toxicants and toxicity.

Naturally occurring toxicants in foods: Carcinogenesis, mutagenesis and teratogenesis.

Toxicity: Extraneous chemicals, adulterants, metallic contaminants, packaging materials, pesticides, industrial contamination, drug residues, food additives.

Microbiological toxins: Mycotoxins, bacterial food intoxications, food borne infections.

Intolerance and allergy to food. Detoxification mechanisms.

Wholesomeness of irradiated food, cyanogens, sea food toxins and poisoning.

Toxic factors induced by processing, heat treatment and maillard reaction products.

Text Book

1. Deshpande S S, 2002. Handbook of food toxicology. Marcel and Decker, New York.

Recommended Book

2. Liner I E, 1980. Toxic constituents of plant food stuffs. Academic Press, New York.

Milling of Cereals

Theory

Wheat milling: Handling, storage, blending, cleaning, tempering and conditioning. Types of mills, principles, methods and equipment.

Grinding process: Types of grinding machines, extraction rates of flour. Operations of roller mill.

Grinding systems: Break, reduction and tailings. Sieving process: Principles and types of sifters. Purification process. Flour handling and storage.

Air classification and fine grinding. Whole wheat products. Milling of soft and durum wheats.

Wet milling of corn: Production of starch, oil, gluten. Milling of rice.

Developments in milling of cereal grains.

Practical

Test weight and kernel hardness measurement. Effect of tempering time and moisture content on flour yield. Experimental milling. Flour mill stream analysis: colour, moisture, protein, ash, pH and particle size.

Flour performance test; farinograph, mixograph and amylograph. Gluten washing tests, alkaline water retention capacity, Pelshenke value and SDS sedimentation test.

Text Book

1. Posner E S, and Hibbs A N, 1997. Wheat flour milling. American Association of Cereal Chemists Inc, St Paul, Minnesota.

Recommended Book

2. AACC. 2000. Approved Methods of American Association of Cereal Chemists. American Association of Cereal Chemists Inc, St Paul, Minnesota.

Baking Science & Technology–I

Theory

Bread types and Formulations.

Wheat flour: components and functions. Shortenings: Types, functions, sources and mechanisms.

Sweeteners: Types, functions.

Yeast: Types, functions, factors influencing fermentation.

Minor ingredients: yeast nutrients, enzymatic supplements, oxidizing agents, salt, mold inhibitors and dough improvers.

Bread making processes: Straight dough, sponge dough, rapid processing, mechanical dough development.

Mixing and dough processing: Functions, mixer types, fermentation, dough transfer systems, dough make up; dividing, rounding and moulding, panning and proofing.

Baking process: Stages, baking reactions, thermal reactions, bread cooling, shelf-life properties of bread and related products. Bread packaging and storage. Bread spoilage and staling, factors and control measures.

Flat bread technology: Frozen dough products and pizza.

Practical

Bread baking, types of breads, effects of water absorption and dough mixing time. Variations in fermentation and proofing time. Effects of shortenings, emulsifier, oxidants, flour protein variation, amylases and sweeteners on bread. Comparison of various dough making procedures. Field visit to the baking plant.

Text Books

1. Cauvain, S P and Linda S Y, 1998. Technology of bread making. Blackie Academic & Professional, London.
2. Pylar E J, 1988. Baking science and technology (Vol-I and II). Sosland Pub. Co, Kansas.

Recommended Books

1. Matz, S A, 1996. Bakery technology and engineering. CBS Pub. & Distributors, New Delhi.
2. Quail, K J, 1996. Arabic bread production, American Association of Cereal Chemists, Inc, St. Paul, Minnesota.
3. Cauvain, S P, 2003. Bread making – improving quality. Woodhead Publishing Ltd, Cambridge.

Baking Science & Technology–I

Theory

Biscuits, cookies, and crackers: Ingredients and their functions, wheat flour, chlorine treatment of flour, granulation, shortening, sweeteners.

Types of leavening agents: Baking powder - function, composition, reactivity rates, neutralizing value.

Preparation of biscuit doughs: Mixer types, formation of shaped dough pieces. Biscuit baking, heat transfer mechanism, changes during baking. cooling, packaging and storage.

Cakes: Varieties, ingredients and functions - wheat flour, shortening, eggs, minor ingredients. Types of icings and confectionery coating, formulations, formula balance for cake making. Methods and objectives of mixing. Batter specific gravity, temperature and pH, baking reactions.

Wafers: Ingredients and functions: Flour, water, shortening, aerating agents, minor ingredients. Mixing, storage and depositing of wafer batter, baking, cooling and conditioning of wafer sheets.

Miscellaneous products: doughnut, pizza.

Practicals

Biscuits and cakes manufacture. Decoration of cakes.

Use of layer cake measuring template. Preparation and sensory evaluation of variety cakes, cookies and wafers, Pastry and cake icing. Preparation of wafers, pizza and doughnuts. Preparation and evaluation of flat breads, chapaties and naans etc.

Baking powder preparation by using different ingredients.

Text Book

1. Almond N, 1988. Biscuits, cookies and crackers. Vol I & II. Elsevier Applied Science, New York.

Recommended Books

1. Amendola J and Lundberg D, 1992. Understanding baking. Van Nostrand Reinhold, New York.
2. Wade P, 1988. Biscuits, cookies and crackers. Vol-I Elsevier Applied Science, New York.
3. Pylar E J, 1988. Baking science and technology (Vol-I and II). Sosland Pub Co, Kansas.

Starch Chemistry and Technology

Theory

Starch: Structure, amylose and amylopectin.

Sources: Cereal starches, root and tuber starches.

Manufacturing process: physical properties, functional properties, viscoamylography, gelatinization, thermal properties, starch swelling, starch pastes, retrogradation and starch films.

Modification: Pregelatinization, acid modification, oxidation, cross linking, acetylation, esterification, multiple modification.

Applications: Soups and dressings, sauces, pie filling, gravies, snacks, cereals and batters.

Practicals

Qualitative and quantitative tests for starch, physicochemical properties, pH, moisture absorption, hydration capacity, solubility, swelling power and freeze thaw stability.

Functional properties: Viscosity behaviour, gelatinization, film formation,

Modification of starch: Effects of ingredients, salt and sugar on viscosity and gelatinization.

Text Books

1. Whistler R L Bemiller J N and Paschall E F, 1984. Starch: chemistry and technology. Academic Press, New York.
2. Whistler R L and Daniel J R, 1985. Carbohydrates: In food chemistry, 2nd ed. Marcel Dekker. New York.
3. Thomas D J and Atwell W A, 1999. Starches. American Association of Cereal Chemists Inc St Paul, Minnesota.
4. Geirwyr S J, 1995. Analytical chemistry of food. Chapman and Hall, Glasgow.

Recommended Books

1. Swinkeles IJMR (undated) Industrial starch chemistry product information, Ref No: 05.00.02.006 EF AVE. BE ba. International Marketing and Sales, Foxhole.
2. Thomas D J and Atwell W A, 1999. Starches. American Association of Cereal Chem Inc, St Paul, Minnesota.

Dairy Processing-I

Theory

Physical, chemical and functional properties of milk constituents: lactose, lipids, proteins, minerals, vitamins and enzymes. Classification and composition of milk products.

Milk microbiology: Sources of contamination and control.

Milk processing: Cream separation, standardization, pasteurization, UHT treatment, evaporation, drying, condensation, membrane fractionation. Heat induced changes in milk.

Milk products: Toned milk, flavoured milk, gulfa, khoya, rubri, ice-cream.

Milk packaging: Effect of packaging on milk quality.

Biological functions of milk components: Heat, evaporation, membrane fractionation, drying, condensing. Heat induced changes in milk and milk products. Freezing: ice-cream and frozen desserts.

Practicals

Sampling techniques: Raw milk, processed milk. Production of ice-cream, dried milk powder, condensed milk, flavoured milk.

Quality assurance and safety tests: Operational, laboratory equipment, raw material, control measures.

Microbial examination of milk and milk products: Total viable count, yeast and mold, somatic cells, coliforms, E. coli, Salmonella

Microbial examination of water, air, containers and equipment.

Text Books

1. Robinson R K, 1996. Modern Dairy Technology. 2nd ed.Vol.1 Advances in milk processing, Chapman and Hall, London.
2. APHA (American Public Health Association), 1993. Standard methods for the examination of dairy products. Port City Press, Baltimore.

Recommended Books

1. Varnam A H and Suthaland J P, 1994. Milk and milk products: Technology, chemistry, and microbiology. Chapman and Hall, London.
2. Fox P F and McSweeney PLH, 1998. Dairy chemistry and biotechnology. Chapman & Hall, London.

Dairy Processing II

Theory

Fermented milk products: Importance and production. Micro-organisms in milk. Starter culture. Processing technology of yoghurt, butter and cheese.

Major control points and physicochemical changes in milk during manufacturing of fermented dairy products. Chemistry of flavour development.

Microbiological hazards and pattern of spoilage. Factors affecting shelf-life of milk and milk products.

Utilization of dairy by-products: Casein, whey and butter milk.

Packaging: Faults, causes and remedies.

Practical

Preparation of fermented milk products: Yoghurt, cheese, butter, butter milk, whey and casein. Physical, chemical, microbial and sensory evaluation of yoghurt, cheese, butter, butter milk, whey and casein. Cheese faults and grading methods.

Text Books

1. Varnam A H and Sutherland J P, 1994. Milk and milk products: Technology, chemistry, and microbiology. Chapman and Hall, London.
2. APHA (American Public Health Association), 1993. Standard Methods for the Examination of Dairy Products. Port City Press, Baltimore.

Recommended Books

1. Fox P F, Guinee T P, Cogon T M and McSweeney PLH, 2000. Fundamental of cheese science.
2. Tamime A Y and Robinson R K, 1985. Yoghurt Science and Technology Pergamon Press. Oxford.

Advanced Food Microbiology

Theory

Food microbiology: Advances in advanced Food Microbiology. Physiology and biochemistry of food borne micro-organisms, microbial metabolism and genetics.

Culture Types: Collection and maintenance of variance microbial cultivars.

Detection of micro-organisms in foods: Principles and techniques, rapid vs conventional methods, estimation of microbial toxins, metabolites, inhibitory substances and pathogens.

Differentiation of bacterial strains by electrophoretic protein profiles. Probiotic and proteolytic properties of important bacteria. Isolation and titration of bacteriophages. Traditional and current approaches to microbial food safety and quality. Genetically modified micro-organisms.

Practicals

Microbial techniques, detection of micro-organism in food samples, use of automated rapid and conventional methods for microbial toxins, metabolites, inhibitory substances, pathogens and bacteriophages through HPLC and GC.

Text Books

1. Spencer JFT and De Spancer ALR, 2001. Methods in biotechnology and food microbiology protocols. Human Press Totowa, New Jersey.
2. Adams M R and Moss M O, 2000. Food microbiology. Royal Society of Chemistry, London.

Recommended Books

1. Benson H J, 1998. Microbiological applications. Lab. Manual in general microbiology WCB McGraw-Hill, New York.
2. Tortora G J, Funke B R and Case C L, 1995. Microbiology — An introduction. The Benjamin/Cummings Pub Co Inc, California.

Advanced Food Chemistry

Theory

Carbohydrates: Nomenclature, classification and structure of carbohydrates. Sugars: properties, functions in food, structural and functional changes during processing.

Polysaccharides: Starch – structure, properties, gelatinization, retrogradation. Celluloses /Pectins /Gums – structure, properties, industrial uses.

Proteins: structure, classification and functional properties, denaturation.

Lipids: Classification, reactions of industrial importance, hydrogenation, halogenation, saponification, trans-esterifications. Rancidity: Oxidative and hydrolytic. Vitamins: Structure, sensitivity to processing conditions.

Flavours and aromatic compounds: Carbonyl compounds, phenols, alcohols, esters, terpenes and their interactions with other food constituents, synthetic and natural aroma compounds

Practicals

Isolation and extraction of different food components. Chromatographic techniques for determination of sugars, vitamin C, Iodine etc. Separation of natural food colours. Extraction of pectin from fruit waste. Estimation of starch, cholesterol, total dietary fibre, glucose, pigments etc.

Recommended Books

1. DeMan J, 1990. Principles of food chemistry. Van Nostrand Reinhold, New York.
2. H D Belitz and Grosch W, 1999. Food chemistry. 2nd Ed. Springer-Verlag Berlin Heidelberg, Germany.
3. Fennema O R, 1996. Food chemistry. 1996. Marcel Dekker, Inc, New York.

Chemistry of Edible Oils & Fats

Theory

Edible oils and fats: Nomenclature, classification, physical, and chemical properties, factors affecting physical characteristics.

Fatty acids: Structure, occurrence, saturated and unsaturated fatty acids (monoenoic, dienoic, trienoic and polyenoic acids), alpha anion of carboxylic acids, peroxy acids and others, isomerisms.

Rancidity: Causes, inhibition, epoxidation, hydroxylation. Halogenation, metathesis, stereomutation, double bond migration, cyclisation, dimerisation. Reactions of carbonyl group, hydrolysis, esterification, alcoholysis, acidolysis, interesterification, nitrogen and sulfur containing derivatives.

Chemistry of frying fats and oils: Chemical aspects in deep fat frying. Safety of heated, oxidized and hydrogenated fats.

Practicals

Extraction techniques of fats and oil from food samples. Physical tests: Melting, smoke, flash and turbidity points, refractive index, specific gravity, consistency, etc. Chemical tests: Reichert Meussel number, saponification and peroxide values, Iodine number. Butyric acid in fats, polymers and oxidation products of heated vegetable oils, cis, cis-methylene interrupted polyunsaturated fatty acids in oils, synthetic colours, etc.

Text Book

1. Gunstone F D and Norris F A, 1983. Lipids in foods. Chemistry, biochemistry and technology. Pergamon Press, New York.

Recommended Books

1. AOAC, 1995. Official Methods of Analysis. Association of Official Analytical Chemists, Arlington.
2. DeMan J, 1990. Principles of food chemistry. Van Nostrand Reinhold, New York.
3. Perkins E G, 1993. Analysis of fats, oils and derivatives. AOCS Press, Champaign.

Industrial Processing of Edible Oils and Fats Products

Theory

Edible oils and fats: Natural sources, raw material for oils and fats.

Extraction: Rendering process, mechanical expression, solvent extraction.

Production of vegetable ghee: Refining, bleaching, deodorization and hydrogenation operations. Specification of vegetable ghee.

Production of salad and cooking oils, margarine, food dressings, toppings, coatings and all purpose shortenings.

Specialty oils: Production and characterization.

Quality control in oils and fats processing.

Practicals

Oil extraction, refining, bleaching, deodorization and hydrogenation.

Preparation of different fat products: margarine, dressings, toppings etc.

Visits to various oil processing plants.

Text Book

1. O'Brein R D, 2003. Fats and oils. Formulating and processing for applications. 2nd ed. CRC press. Boca Raton, Florida.

Recommended Books

1. Lawson H 1995. Food oils and fats. Technology, utilization and nutrition. Chapman and Hall, Inc, New York.

2. Wan P J, 1991. Introduction to fats and oils technology. AOCS Press, Champaign.
3. Hamm W, Hamilton R J, 2000. Edible oil processing. CRC Press, Boca Raton, Florida

Meat Science

Theory

Meat: Types, chemical, biochemical.

Muscle: Muscle proteins, intramuscular fat, muscle function in vivo, post-mortem glycolysis, onset of rigor mortis.

Factors reflected in specialized muscle function and constitution: Species, breed, sex, age, anatomical location of muscles and myofibres.

Conversion of muscle to meat: Pre-slaughter handling, moisture loss, glycogen loss, stunning and bleeding, dressing and cutting.

Ageing of meat: Protein denaturation, proteolysis and other chemical changes.

Meat spoilage: Endogeneous, exogeneous infections. Factors affecting growth of meat spoilage micro-organisms.

Prophylaxis: Hygiene, biological control, antibiotics, ionizing radiations.

Practicals

Determination of chemical composition of meat.

Protein profiling of various meats.

Determination of minerals, vitamins, fatty acids and toxins

Text Book

1. Lawrie R A, 1998. Lawrie's Meat Science. 6th ed. Woodhead Publishing Ltd Cambridge, England.

Recommended Book

1. Aushurst P R and Dennis M J, 1996, Food authentication. Blackie Academic & Professional, London.

Technology of Processed Meat

Theory

Meat: Handling, transportation and storage.

Curing of meat: Curing ingredients and curing methods.

Meat smoking: Purpose, production, deposition of smoke on meats, methods of smoking, liquid smoke preparation and its application.

Meat cookery, cooked meat products

Sausages: classification, fermented meat products, sausage formulations, casings, extruders, additives.

Herbs, spices & condiments in processed meats. Types of cured and smoked meats.

Reduced and low fat meat products.

Canned meat formulations, restructured meat products, procedures, raw materials and formulations.

Cold storage, food freezing of meat.

Quality control and sanitation. Visits to the meat industries.

Practicals

Preparation of local meat products: Beef stew, sausages, meat balls with gravy, sliced dried beef, potted meat, smoked meat and other meat products, restructured meat products.

Text Book

1. Pearson A M and Gillet T A, 1996. Processed meat. 3rd ed. Chapman & Hall, New York.

Recommended Books

1. Lawrie R A, 1998. Lawrie's Meat science. 6th ed. Woodhead Publishing Ltd. Cambridge, England.
2. Footitt R J and Lewis A S, 1995, The canning of fish and meat, 1st ed, Blackie Academic & Professional London.
3. Von Loesecke H W, 2001. Outlines of food technology. 2nd ed. Agro House, Jodhpur, India.

Chemistry and Technology of Sugar Processing

Theory

Sugar processing: Basic concepts and terminologies used.

Raw material: Juice extraction from sugar cane and sugarbeet. Chemistry of mono- and disaccharide carbohydrates.

Physical and chemical properties of sugars: Invert sugars and sucrose. Sources of colour and turbidity in raw and clarified juices.

Clarification: Action of lime. Physical and chemical reactions, diffusion and evaporation, heat transmission through evaporators, calculation of evaporator capacities.

Multiple effect evaporators, fundamentals of crystallization, nucleation theory, seeding techniques, procedures of evapo-crystallization and crystallization in motion, centrifugation and drying operations. Sugar recovery.

Recent advances in sugar technology: Defecation processes and implementation practices. Packaging and storage of sugar. Utilization of molasses.

Practicals

Analysis of raw sugarcane juice, clarified and filtered juice, Masecuite, molasses, sucrose. Handling of processing equipments: Juice extractors,

clarifiers, filter press, evaporator, crystallizer and centrifugal machines. Visit to sugar factories.

Text Book

1. Chen JCP, 1985. Meade – Chen cane sugar handbook, a manual for cane sugar manufacturers and their chemists. John Wiley and Sons, Inc, New York.

Recommended Books

1. Lionnet, GRE, 1999. Sugar technology for students. Lang Fred, Durban.
2. Chon C C, 2000. Handbook of sugar refining. Anmol for the design and operation of sugar refining facilities. John Willey and Sons Inc New York.

Food Quality Assurance Management

Theory

Qualify assurance: Theoretical and practical considerations, description of different systems: GMP, TQM, HACCP, ISO – 9000 series.

New approaches to quality assurance: Deming's, Juran's and Corsby's.

Local and international approaches to obtain safe foods. Statistical quality control techniques.

Sanitation and hygiene in quality assurance. Good laboratory practices, cost of quality, supplier development.

Practicals

Development of proseedues/manuals/documents as per different standard requirements.

Development of HACCP plans, GMP manual, calculation of quality cost

Development of supplier assurance manual.

Text Book

1. Stevenson K E, 1999. A systematic approach to food safety. National food processors association. Food processor Institute, Washington DC.

Recommended Books

1. Dean JWJ and Evans R R, 1994. Total quality: Management, organization and strategy. Westport Publishing Co, New York.
2. Gould W A and Gould R W, 1993. Total quality assurance for the food industries. CTI Publications Inc, Baltimore.

Food Industrial Waste Management

Theory

Food industrial wastes: Types, sources and characteristics of industrial wastes.

Waste disposal: Physical, chemical and biological treatments. BOD, COD, bio processing in food waste treatment.

Management of waste by products: Sugar, fruits and vegetable. Meat, fish, oil and fat. Dairy and cereals. Recovery of useful materials from effluents by different systems. Utilization of food industry wastes.

Text Book

1. Herzaka A and R G, 1981. Food industry wastes, disposal and recovery. Applied Science Pub, London.

Recommended Books

1. Lawrence K W and Wang MUS, 1992. Handbook of industrial waste treatment, Marcel Dekker, Inc, New York.
2. Lee B H, 1996. Fundamentals of food biotechnology. VCH Publishers, Inc, New York.

Advanced Beverage Technology

Theory

Beverage industry: Overview and recent advances in beverage technology.

Water treatment plants: Comparison selection and requirements.

Bottle washing plants: Operations and inspection, detergents used in bottle washing.

Packaging materials: Glass bottles, pet bottles, metal cans, tetra pack, plastic containers, container closures, aluminium and metal type packaging containers.

Raw material handling and storage: Syrup room operation, pasteurization, sterilization, bodying agents, stabilizers and emulsifiers.

Filling systems: Premix, post-mix, three stage processes. Composition and formulation of carbonated and non-carbonated beverages.

Carbondioxide and carbonation.

Trouble shooting in beverage industry: Spoilage detection and control, physical, chemical and microbiological spoilage.

Plant sanitation: CIP systems for beverage plants, cleaning and disinfection.

Practicals

Laboratory procedures for testing treated water; physical, chemical, sensory and bacteriological examination. Production of still, carbonated and non-

carbonated beverages, beverage analysis, powder mixes, traditional and fermented beverages.

Text Book

1. Hicks D, 1990. Production and packaging of non-carbonated fruit juices and beverages. Blackie, Pub Co, Glasgow.

Recommended Book

1. Mitchell A J, 1990. Formulation and production of carbonated soft drinks. AVI Pub Co, Westport, Connecticut.

Post Harvest Management

Theory

Fruits and vegetables: Structure, composition, physiology, biochemistry, methods of harvesting, losses during harvesting, handling, transportation, packaging and storage. Water losses, respiration activity, mechanical injuries.

Storage methods and types: Controlled atmospheric storage.

Grains and legumes: Harvesting, threshing and grading systems. Deterioration during storage, causes, loss assessment, control, mycotoxins. Commodity treatments and packaging. Storage atmosphere, role of temperature and humidity.

Storage methods: CA storage, MAS, role of temperature and humidity in storage, methods of packaging: types of packaging.

Text Book

1. Yamashita R, 1993. New technology in grain post-harvesting. Farm Machinery Industrial Research Corp. Tokyo.

Recommended Books

1. Jongen W, 2002. Fruits and vegetable processing – improving quality. CRC Press, Boca Raton, Florida.
2. Lee T H, Graham D, McGlasson and Hall E G, 1981. Post-harvest. The AVI publishing Company, Inc, Westport, Connecticut.

Food Packaging

Theory

Food Packaging: Introduction, graphics and designs.

Packing materials: paper and paper board containers, metal, glass containers, plastic containers.

New trends: Retortable packaging, Aseptic packaged foods, Free oxygen scavenging packaging, frozen foods and oven proof trays, Gas exchange packaging, vacuum packaging.

Food Packaging: Fruits, vegetables, fresh meat, meat by products, seafood products, fish & meat by products, dairy products, cake and snack foods.

Text Books

1. Kadoya T. 1994. Food packaging. Academic Press, New York.
2. Paine F A and Paine H Y, 1993. Hand Book of Food Packaging. Kluwa Academic Publisher. Van Nostrand, Reinhold, New York.

Physical Properties of Food

Theory

Relation to other food properties: Optical, thermal, electrical and mechanical.

Physical properties and texture of muscle foods, measurement of physical properties of muscle foods, horticultural products, baked foods.

Rheology of emulsions and dispersions: Behaviour of colloids, evaluation of rheological properties. Rheological properties of cereals, proteins and carbohydrates. Application in cereal industry.

Electron microscopy: Principles, scanning, transition

Colorimetry: Physical properties of colours, physiological basis of colours, tristimulus colorimetry

Practical

Determination of viscosity, specific gravity of different liquid foods, organic solvents and solutions. Determination of conductivities of different foods. Use of colorimeters and spectrophotometers for determination of optical properties of foods. Measurement of food textures and rheological properties.

Recommended Books

1. Faridi H and Faubion J M, 1997. Dough rheology and baked products texture. CBS Publishers and Distributors, New Delhi.
2. Peleg M and Bagely E B, 1983. Physical properties of foods. Avi Pub Co Inc Westport, Connecticut.

Recent Advances in Food Science and Technology

Theory

Functional foods, genetically modified organic foods: Food safety, nutrition, ethics, legislation, emerging technologies: Fats and oils, cereals, dairy, beverage and meat industry. New tools in food analysis: HPLC, capillary electrophoresis, Mass spectrometry. Aseptic processing. Extrusion technology.

Recommended Books

1. Frazier R A, 2000. Cappillary Electrophoresis for Food Analysis. Royal Society of Chemistry, Cambridge.
2. Buttriss J and Saltmarsh S, 2000. Functional Foods II. Royal Society of Chemistry, Cambridge.

Marine Foods

Theory

Fish: Catching fish, on board handling, quality retention with ice, ice chilling water, refrigeration and freezing. Reception and testing, storage of fish.

Fish preparation: Heading, filleting, skinning, smoking, precooking.

Fish freezing and defrosting of frozen fish.

Canning of fish: Cans and lids. Microbiology of fish. Introduction to quality indicators, Authenticity of fish.

Practicals

1. Preparation of fish products.
2. Chemical and sensory evaluation of fish and its products.

Recommended Books

1. Aushurst P R and Dennis M J, 1996. Food authentication. Blackie Academic & Profession, London.
2. Footitt R J and Lewis A S, 1995. The canning of fish and & meat. 1st ed. Blackie Academic & Professional, London.
3. Davies A and Board R, 1998. The microbiology of meat and poultry. Blackie Academic & Professional. London.

RECOMMENDATIONS

1. Food Technology may be recognized as one of the priority area for the uplift of the national economy.
2. In addition to existing B.Sc./B.Sc.(Hons) (Agriculture — Major Food Technology, a separate four-year degree programme in B.Sc.(Hons) Food Science and Technology may be introduced in all the institutions/ universities. A separate meeting of NCRC for development of B.Sc. (Hons) Food Science and Technology may be arranged by HEC.
3. The Departments of Food Science and Technology must be strengthened by adding faculty members, laboratory and library facilities to meet R&D as well as STO requirements.

4. Job opportunities to food technologists may be provided in Provincial and Federal Food Departments. Export Promotion Bureau, Pakistan Agricultural Services and Storage Corporation (PASSCO), Pakistan Standards & Quality Control Authority/Public Analyst and Pakistan National Accreditation Council (PNAC).
5. The Ministry of Industries may ensure employment of the qualified food technologists in food industries.
6. HEC may arrange international and national Teachers Training Programme in different themes of Food Technology.
7. The HEC is urged to approach Ministry of Industries, Ministry of Food and Agriculture and other relevant agencies with a request to direct public and private sector food industries and related research institutions to facilitate the internship of students of Food Technology.
8. Study tour of NCRC to visit academic/research institutes and food industries of India may be sponsored by HEC.
9. Follow up meeting of NCRC may be held every year to review the progress.