



JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR

Faculty of Agriculture and Veterinary Science

Department of Food and Biotechnology

SYLLABUS

DURATION – 3 YEARS/ 6 SEMESTER

**BACHELOR OF SCIENCE -FOOD SCIENCE & TECHNOLOGY
(B. Sc. FST)**

**SYLLABUS FOR:
3 YEARS (1-6 SEM)**



PROGRAM DETAIL

Name of Program	-	Bachelor of Science (B.Sc.)
Program Code	-	B. Sc. FST
Mode of Program	-	Semester
Duration of Program	-	3yrs/ 6Semester
Total Credits of Program	-	154
Curriculum Type and Medium Choice	-	English

Program Outcomes Graduates will gain and apply knowledge of Food technology, Science and Engineering concepts to solve problems related to field of Food technology. Graduates will be able to decide and apply appropriate tools of Food technology for making new food products & technologies

Specific Program Outcomes Apply the knowledge of New emerging Food Technology industry world. Recognize the importance of bioethics, entrepreneurship, Communication and management skills so as to usher next generation of Indian Food Tech industrialists.



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SYLLABUS DETAIL

I Semester

S. No.	Credit	Name of Course
1	4	Food & Nutrition
2	4.5	Fundamentals of Chemistry
3	1.5	Fundamentals of Chemistry Lab
4	3	Basics of Biosciences
5	1	Basics of Biosciences Lab
6	3	Introduction to food technology
7	3	Fundamentals of Biological Chemistry
8	1	Fundamentals of Biological Chemistry Lab
9	3	Biomolecules
10	1	Biomolecules Lab
TOTAL	25	

II Semester

S. No.	Credit	Name of Course
1	3	Fundamentals of microbiology
2	1	Fundamentals of microbiology Lab
3	3	Thermodynamics
4	3	Cell biology
5	1	Cell biology Lab
6	2	Unit operations in Food Industry
7	1	Unit operations in Food Industry Lab
8	3	Analytical Chemistry
9	1	Analytical Chemistry Lab
10	3	Fundamentals of Food Science & Technology
11	1	Fundamentals of Food Science & Technology Lab
12	1	Industrial Visit
TOTAL	23	



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III Semester

S. No.	Credit	Name of Course
1	3	Metabolism and Bioenergetics
2	1	Metabolism and Bioenergetics Lab
3	3	Basic Enzymology
4	1	Basic Enzymology Lab
5	3	Technology of Milk & Milk Products
6	1	Technology of Milk & Milk Products lab
7	3	Principles of Food Preservation
8	1	Principles of Food Preservation lab
9	2	Biostatistics
10	1	Biostatistics lab
11	3	Food Microbiology & Safety
12	1	Food Microbiology & Safety lab
13	10	Industrial Training (60 Days, after II Sem, during Summer vacation)
Total	33	

IV Semester

S. No.	Credit	Name of Course
1	3	Food Packaging Technology
2	1	Food Packaging Technology Lab
3	3	Meat, Fish and Poultry Product Technology
4	3	Dairy Plant Management
5	3	Waste management of Food Industries
6	3	Fruits and Vegetable Processing Technology
7	1	Fruits and Vegetable Processing Technology lab
8	4	Minor Project
9	1	Industrial Visit
Total	22	

V Semester

S. No.	Credit	Name of Course
1	3	Food additives and ingredients
2	1	Food additives and ingredients Lab
3	3	Cereal, Pulse & oilseed Technology
4	1	Cereal, Pulse & oilseed Technology lab
5	2	Basic Food Engineering
6	1	Basic Food Engineering lab
7	2	Food Storage and Transport
8	3	Food Laws. Standards & Regulations
9	3	Modern Baking & Confectionary Technology
10	1	Modern Baking & Confectionary Technology lab
11	10	Industrial Training (60 Days, after IV Sem, during Summer vacation)
Total	30	



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SIXTH SEMESTER

S. No.	Credit	Name of Course
1	3	Food Process Technology
2	1	Food Process Technology Lab
3	3	Sensory Evaluation
4	3	Modeling & simulation of Bioprocess
5	3	Research Methodology
6	3	Food Business Management
7	3	Food Project Planning and Entrepreneurship
8	3	Dairy Engineering
9	1	Dairy Engineering lab
Total	23	

B. Sc. FST1ST YEAR

I Semester

Foods & Nutrition Credits-4

Objective: The objective of this paper is to make students familiar with various principles of food and nutrition.

UNIT – I Relationship of Food, Nutrition & Health Definitions of food, nutrition and health and inter-relationship between them. Description of basic terms and concepts. Functions of Nutrients, Guidelines for Good Health, RDA, Reference Man and Woman, Factors affecting RDA, Methods for Deriving RDA, Uses of RDA, BMR, Factors affecting BMR.
(2 Credit)

UNIT –II Functions of Foods, Nutrient & Source Functions of food. Nutritional aspects of carbohydrates (including glycemic index and load), proteins and fats. Functions of energy and minerals and vitamins and water. Food sources of nutrients. Concept of a balanced diet. Dietary fibre, its sources and importance.
(1.3 Credit)

UNIT – III RDA & Enhancement of Nutritional Quality Overview of human nutrition requirements (RDA) through the life cycle. Factors affecting bio-availability of nutrients example, nutrient interactions, food components like antinutrients etc. Principles of meal planning. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing procedures to reduce cooking losses of nutrients.



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Common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc.
Emerging common degenerated disorders.

(1.4 Credit)

Reference Books:

1. Food Science N N. Potter & J Hotchkiss
2. Food Processing and Preservation G Subbalakshmi
3. Food Packaging Technology Handbook NIIR
4. A practical Guide for Implementation of ISO HACCP Sohrab

Fundamentals of Chemistry

Credits-4.5

Objective: To develop the understanding of basic chemistry and its types. To make students understand about the practical aspects of things. Students will able to identify various matters and equipment used in labs, perform some basic experiments.

UNIT I – Overview of Physical Chemistry Solutions: Concept of homogeneous and heterogeneous solution, Introduction of the terms, Ionization, acidity, basicity, equivalent weight and gram equivalent weight with suitable example. Preparation of solution, Normality, Molarity, and Molality as applied in relation to a solution. Simple numerical problems related to volumetric analysis. Brief concept of gravimetric analysis.

(1.5 Credit)

Practicals: (Credit: 0.5)

S.No.	Name of Practical
1	Preparation of original solution.
2	Correct group detection
3	Cu with change in concentration of electrolytes (CuSO_4)
4	Zn with ZnSO_4
5	using starch solution as indicator (clock reaction).

UNIT II- Overview of Inorganic chemistry Occurrence and principles of extraction of aluminium, copper, zinc and Iron. position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; hydrides-ionic, covalent and interstitial; physical and chemical properties of water, heavy water. Hydrogen peroxide- preparation, properties and structure; hydrogen as a fuel. Uses of hydrogen peroxide.

(1.5 Credit)

Practical: (Credit: 0.5)

S.No.	Name of Practical
1	Systematic detection of ion.
2	Any two confirmatory tests of cation.
3	Physical nature.
4	Flame test.
5	Charcoal cavity test.



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UNIT III Overview Organic Chemistry Stereochemistry of Organic Compounds: Concept of isomerism. Type of isomerism. Optical Isomerism - Elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules and erythrodiastereomers, *, D & L and R & S systems of nomenclature.

Geometric Isomerism: Determination of configuration of geometric isomers. E & Z system of nomenclature.

Conformational isomerism: Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Application of Stereochemistry in biochemistry.

(1.5 Credit)

Practical: (Credit: 0.5)

S.No.	Name of Practical
1	Recrystallization.
2	Melting points and Boiling point and the identification of an unknown and known compound naphthalene, Benzene
3	Molecular modelling.
4	L.S modelling.
5	Distillation, steam distillation.

Recommended text Books:

1. P.W. Atkins, Physical Chemistry (7th Edition), Oxford University Press, 2006.
2. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall of India Pvt. Ltd., 5th Ed, 1990

Reference Books:

1. I. A. Levine, Physical Chemistry, McGrawHill, 2009
2. D.A. McQuarrie and J.D. Simon, Physical Chemistry – a Molecular Approach, Viva Books Pvt. Ltd., 1998.
3. G. Solomons and C. Fryhle, Organic Chemistry, John Wiley & Sons (Asia) Pte Ltd.
4. J.D. Lee, Concise Inorganic Chemistry, (5th Edition), ELBS, 1996.
5. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, Oxford University Press, 2006.

Basics of Biosciences Credits-4.5

UNIT-I Introduction to biology Diversity in biological systems, Cell biology and cell structure, difference between Prokaryotes & Eukaryotes systems, Five-kingdom classification and General characters, Brief account on Ecology, Morphology, Nutrition, osmosis, Locomotion and Reproduction, useful and harmful effects of Bacteria, Viruses, Algae, Fungi and Protozoans.

(1 Credit)



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Practical: (0.4 credit)

Sr. no.	Name of practical	Nature
1	To perform gram staining.	Practical
2	To study different types of Algae by making their slides.	Practical
3	To study different types of Fungi by making their slides.	Practical
4	To study slides of Protozoans.	Practical
5	Study of osmosis by potato osmoscope.	Practical

UNIT-II Classification and physiology of plant Classification of Plant Kingdom. Concepts of Growth, Meristems, Plant growth regulators, Bacterial & Plant photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll as trapper of solar energy, photosynthetic reaction centres, Hill reaction, PS I & PS II, Photophosphorylation - cyclic & non-cyclic; Dark reaction & CO₂ fixation.

(1 Credit)

Practical: (0.4 credit)

Sr. no.	Name of practical	Nature
1	To isolate chloroplast from plants.	Practical
2	Separation of plant pigments through paper chromatography.	Practical
3	Demonstration of O ₂ evolution during photosynthesis.	Practical
4	Study of distribution of stomata in the upper and lower surface of leaves.	Practical

UNIT-III Classification and physiology of animals Classification of Animal Kingdom, Functions, morphology, growth and Reproduction, economic importance. Phylogeny of Invertebrate & Vertebrate Phyla, Concepts of Species & Ecosystem. Introduction of cell cycle, cell division, Electrolytes, Body fluids.

(1 Credit)

Practical:(0.2 credit)

Sr. no.	Name of practical	Nature
1	To study mitosis in onion root tip.	Practical
2	To study meiosis in grasshopper testis	Practical
3	To test the presence of urea in urine.	Practical
4	To detect the presence of sugar in urine/blood sample	Practical
5	To detect the presence of albumin in urine.	Practical



Recommended Text Books:

1. NCERT Textbook for Class 11 Biology
2. NCERT Textbook for Class 12 Biology

Reference Books:

1. Cell and Molecular biology – P.K. Gupta
2. Plant Physiology- H.S. Srivastav
3. Animal Physiology- A.K. Berry

Introduction to Food Technology Credits- 3

Objective: Students would be able to understand the principles of food science, different areas of food science and the historical evolution of food processing. They would be able to understand the basics of plant and animal foods, their types, structure and composition, nutritional value, changes taking place during storage and different processing methods used.

Unit- I Introduction to food composition Introduction , Food composition & Food group, Introduction Introduction to food science and technology, Food composition Food composition – Carbohydrates, protein, fat, vitamins and minerals water, Food groups Composition and nutritive value of Cereals, Pulses, Legumes, Oil seeds, Fruits, Vegetables, Meat, Fish, Poultry and Milk.

(1 Credit)

Unit – II Introduction to food preservation Food preservation -High temperature, low temperature and chemical preservations. Concept of nutrition, Digestion and absorption of nutrients, balanced diet, malnutrition, Packaging-Functions of packaging, types of food packaging materials.

(1 Credit)

Unit III Introduction to role of microbes in food technology Microbiology- Microorganisms important in foods, food contamination, food spoilage, food born diseases, Engineering -Unit operation, principles of heat exchangers, Pasteurizer, refrigerator, freezer and drier.

(1 Credit)

References:

1. Food Science N N. Potter & J Hotchkiss
2. Food Processing and Preservation G Subbalakshmi
3. Food Packaging Technology Handbook NIIR
4. A practical Guide for Implementation of ISO HACCP Sohrab



Fundamentals of Biological Chemistry

Credits- 4

Objective: Students would be able to understand the principles of food science, different areas of food science and the historical evolution of food processing. They would be able to understand the basics of plant and animal foods, their types, structure and composition, nutritional value, changes taking place during storage and different processing methods used.

UNIT-I Origin of life, Origin of amino acids, nucleotides, Urey Miller's expt., Unicellular organism, multicellular organisms. Concept of biomolecules, polymerisation, formation of polymers i.e. proteins, nucleic acids, Molecular interactions, biological functions. Chiral interactions, pH, pK, buffers. Reaction mechanism. Nucleophile, electrophile, Acid base reaction, nucleophilic addition, nucleophilic substitution, electrophilic addition, electrophilic substitution reaction.

(1 Credit)

UNIT-II Carbohydrates: Introduction, biological importance. Definition, Classification, {glyceraldehydes, Simple Aldose, Simple Ketose, D-glucose, Conformation of D glucose}, Monosaccharides other than glucose, glycosidic bond, disaccharides, polysaccharides [starch, glycogen, peptidoglycan, proteoglycan matrix.

(1 Credit)

Practical: (1 credits)

Sr. no.	Name of practical	Nature
1	Test for Carbohydrates	Practical
2	Test for proteins	Practical
3	Test for Lipids	Practical

UNIT-III Lipids: Introduction, Classes, Fatty acids [Physical prop. Chemical prop, Sap value, acid value, iodine number, rancidity. Glycerolipid, Sphingolipid, Lipid derived from isoprene, Behavior of lipid in water, Bile acids, bile salts, plasma lipoproteins, Vesicles, membrane transport.

Recommended Text books:

1. Outlines of Biochemistry: Conn and Stumpf
2. Principles of Biochemistry: Jeffery Zubey

Suggested Readings:

1. Biochemistry: Stryer



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Bio-molecules Credits-4

Unit-I Carbohydrates General account of the chemical nature of living cells. Carbohydrates: Classification (Monosachharides, Di- sachharides and Polysachharides), configurations and conformations, sugar derivatives, structural and storage polysaccharides.

(1 Credit)

Practical:(0.3credit)

Sr. no.	Name of practical	Nature
1	To perform Molish test for the qualitative estimation of carbohydrate. (i) Preparation of Molish reagent (ii) Estimation and observation of carbohydrate	Practical
		Practical
		Practical and practice
2	To perform Benedict test for the qualitative estimation of carbohydrate. (i) Preparation of Benedict's reagent (ii) Estimation and observation of carbohydrate	Practical
		Practical
		Practical and practice
3	To perform Fehling's test for the qualitative estimation of reducing sugar's (i) Preparation of Fehling's reagent (ii) Estimation and observation of carbohydrate	Practical
		Practical
		Practical and practice
4	To perform Barfoed's test for the qualitative estimation of reducing sugar's (i) Preparation of Barfoed's reagent (ii) Estimation and observation of carbohydrate	Practical
		Practical
		Practical and practice
5	To perform Inversion of Sucrose: (i) Preparation of reagents for inversion (ii) Estimation of converted sugar by Fehling's reagent.	Practical
		Practical
		Practical

Unit-II Proteins Amino acids: General properties, peptide bond, essential and non-essential amino acids. Classification, different levels of protein structure, forces stabilizing protein structure, protein folding, protein modification.

(1 Credit)

Practical : (0.3 Credit)

Sr. no.	Name of practical	Nature
1	To perform Ninhydrin test for the qualitative estimation of amino acids. (iii) Preparation of Ninhydrin reagent	Practical
		Practical
		Practical



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	(iv) Estimation and observation of amino acids.	
2	To perform Xanthoproteic test for the qualitative estimation of amino acids. (iii) Preparation of Xanthoproteic reagent (iv) Estimation and observation of amino acids.	Practical
		Practical
		Practical
3	To perform Millon's test for the qualitative estimation of amino acids (Tyrosine, Phenylalanine & Glycine). (iii) Preparation of Millon's reagent (iv) Estimation and observation of amino acids.	Practical
		Practical
		Practical
4	To perform Lead-Sulfide test for the qualitative estimation of Cysteine and Cystine. (iii) Preparation of Lead sulfite reagent (iv) Estimation and observation of amino acids.	Practical
		Practical
		Practical and practice
5	To perform Sakaguchi test for the qualitative estimation of Arginine. (i) Preparation of Sakaguchi reagent (ii) Estimation and observation of amino acids	Practical
		Practical
		Practical

Unit- III Lipids and Vitamin Lipids: Classification, properties of lipid aggregates and biological significance. Vitamins: Water and fat soluble vitamins and their deficiency diseases .

(1 Credit)

Practicals: (0.4 credit)

Sr. no.	Name of practical	Nature
1	To Estimate the Saponification value of oils. (i) Preparation of reagents. (i) Determination of Saponification number.	Practical
		Practical
		Practical
2	To Estimate the acid value of oils. (i) Preparation of reagents. (ii) Determination of acid value by titration	Practical
		Practical
		Practical
3	Determination of Total Lipid Concentration (i) The preparation of a sample for solvent extraction (ii) Extraction of lipids and its determination.	Practical
		Practical
		Practical

Recommended Text Books:

1. Fundamentals of Biochemistry - J.L. Jain , S. Chand publication
2. Fundamentals of Biochemistry - Dr A C Deb

Reference Books:

- Biochemistry- [U. Satyanarayana](#), [U. Chakrapani](#) , BOOKS AND ALLIED (P) LTD. (2008)



II SEMESTER

Fundamentals of Microbiology Credits-4

Unit- I Introduction-aims and scope Introduction-aims and scope, Role of microbes in agriculture, public health, medicine and industry, Organization of prokaryotic and eukaryotic cells: Structure and function of cell organelles and surface structure and cellular reserve materials; Distinguishing features of various groups of microorganisms: actinomycetes, bacteria, molds, yeasts and algae and their broad classification.

(1 Credit)

Practicals: (0.4 credit)

Sr. no.	Name of practical	Nature
1	Purify the given bacterial sample by serial dilution method	practical
	(i) To prepare culture media for microorganisms	Practical
	(ii) Growth study of Microorganisms	practical
2	Perform Gram's staining in given bacterial sample	Practical
	(i) Preparation of staining solutions	Practical
	(ii) Microscopic observation and identification	practical
3	Identify the fungal flora of soil and their microscopic view	Practical
	(i) To prepare culture media for microorganisms	Practical
	(ii) Microscopic examination and identification	practical
4	Preparation of culture media for algae	Practical
	(i) Media preparation and standard stock preparation	Practical
	(ii) Autoclaving and finalization of media for inoculation	practical
5	Perform antagonistic activity of micro organisms n	Practical
	(i) Culture media preparation, inoculation of 2 different organisms	Practical
	(ii) Observation of result	practical

Unit-II Characteristics of micro-organisms Characteristics of selected groups of microorganisms including microorganisms of extreme environment, Microbial nutrition and growth-principles of nutrition, growth measurement techniques, effect of environmental and culture parameters on growth, assimilation of nitrogen and sulphur, Isolation and preservation of cultures.

(1 Credit)



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Practicals: (0.4 credit)

Sr. no.	Name of practical	Nature
1	Isolate the microorganism of extreme environmental condition (i) To prepare culture media for microorganisms (ii) Streaking	practical
		Practical
		practical
2	Study the bacterial growth curve with complete phases (i) Preparation of culture media for microorganisms (ii) Microscopic observation and identification of density of MO	Practical
		Practical
		practical
3	Isolate nitrogen fixating bacteria and their identification (i) To prepare culture media for microorganisms (ii) Staining, Microscopic examination and identification	Practical
		Practical
		practical
4	Effect of environmental conditions on bacterial growth (i) Media preparation and standard stock preparation (ii) Effect of unusual condition on MO	Practical
		Practical
		practical
5	Perform the preservation process for bacterial culture (i) Culture media preparation, inoculation (ii) Observation of result after complete duration	Practical
		Practical
		practical

Unit-III Energy transduction in microbial systems Energy transduction in microbial systems: fermentation, aerobic and anaerobic respiration. Phototrophic microorganisms, Phosphoketolase, Entner-Doudoroff and glyoxalate pathways, Control of microbial growth effect of heat, disinfectants and therapeutic agents, Microbial pathogenicity, Bioassays.

(1 Credit)

Practicals: (0.2 credit)

Sr. no.	Name of practical	Nature
1	Study the batch and fed batch culture condition on bacterial growth (i) To prepare culture media for microorganisms (ii) Observation of different density and growth of MO	practical
		Practical
		practical
2	Isolate the bacterial pigments form cyanobacteria (i) Preparation of culture media for microorganisms (ii) Microscopic observation and identification and isolation of Chl pigment	Practical
		Practical
		practical
3	Chromatographic evaluation of bacterial pigments	Practical



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	(i) To prepare culture media for microorganisms (ii) Chromatographic identification of pigment	Practical practical
4	To determine the ability of Microorganisms to degrade and ferment carbohydrates with the production of acid or acid and gas (i) Media preparation and standard stock preparation (ii) Microbial production	Practical Practical practical
5	To detect the antibiotic sensitivity on the given culture sample (Antibiotic Sensitivity Test) (i) Culture media preparation, inoculation (ii) Observation of result after complete antimicrobial activity	Practical Practical practical

Recommended Text Books:

1. Microbiology – L. M. Prescott
2. A Textbook Of Basic And Applied Microbiology - Aneja K.R.

Recommended Reference Books:

1. Pelczar Microbiology
2. Practical microbiology by Satish Gupte
3. Basic practical microbiology a manual – Cuteri

Thermodynamics Credits- 3

UNIT – I Basic concept of Thermodynamics Basic Concepts: Introduction and scope of Thermodynamics, Thermostatics, Thermodynamic properties, Cycle integral for property and non-property variable, Stored and transit forms of energy, Thermodynamic systems and control volume, Isolated system, Universe, Steady flow system, their characteristics and examples, Types of work, Thermodynamic Processes.

(1 Credit)

UNIT – II Laws of Thermodynamics Laws of Thermodynamics: Zeroth Law, First Law of Thermodynamics, Second Law of Thermodynamics, Carnot Theorem, Steam Engine, Concept of entropy, T-S Diagram, availability and irreversibilities. Pure Substances: Behaviour of pure substances.

(1 Credit)

UNIT – III Heat transfer Rankine vs. Carnot, modified Rankine cycle. Air Standard Cycles: Assumptions, Analysis of Otto, Diesel, Dual and Joule cycles, Calculation of cycle work and state values. Introduction to Heat Transfer, Refrigeration and Air-Conditioning.

(1 Credit)

Recommended text Books:

1. Heat thermodynamics and statistical physics by Brijlal, N. Subrahmanyam, S. Chand publication New Delhi.



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Reference Books:

1. Timoshenko S P and Young D H, "Engineering Mechanics", McGraw Hill (International) 4/e, New Delhi (1984).
2. Beer, Ferdinand; Johnston, Jr., E. Russell, "Vector Mechanics for Engineers: Statics (in SI Units)", 3rd Edition Tata McGraw Hill, 2000.
3. R C Hibbeler, "Engineering Mechanics: Statics (in SI Units)", Pearson Education, India, 2000.

Cell Biology Credits- 4

Unit-I Ultra-structure of Plant and animal cell Cell – Shapes, morphology, Cell theory, Cells , Structure-function relationship including organelles and their Biogenesis (e.g., Endoplasmic reticulum, Mitochondria, Chloroplast, Golgi body, nucleus, lysosomes, vacuoles), Membrane structure , Membrane transport, Cytoskeleton, Extracellular matrix , Cell junctions.

(1 Credit)

Practicals: (0.5 credit)

Sr. no.	Name of practical	Nature
1	Study of Microscopy: - Simple, Compound, & Phase Contrast Microscope (i) Learn about simple microscope (ii) Learn about compound microscope (iii) Learn about phase contrast microscope	Practical
		Practical
		practical
		practical
2	Study of cell organelles by using Models, Charts and Slides. (i) Study of models (ii) Study of charts (iii) Study of slides	Practical
3	To demonstrate osmosis by using potato osmoscope. (i) Setting up of potato osmoscope (ii) Demonstration of osmosis	Practical
		Practical
		practical

Unit-II Brief Idea about cell cycle Cell cycle: different phases of cell cycle (G_1 , S- phase, G_2 and M-phase). Regulation of cell cycle: role of cyclins and CDKs, Check points. Mitosis: phases of mitosis (prophase, metaphase, anaphase, telophase and cytokinesis). Significance of mitosis. Meiosis: phases of meiosis and gametogenesis.

(1 Credit)

Practicals: (0.5 credit)

Sr. no.	Name of practical	Nature
1	Squash preparation of Onion root tip to study Mitosis. (i) Squash preparation (ii) Making slide (iii) Observation of mitosis	Practical
		Practical
		practical
		practical
2	Preparation of polytene chromosome in chironomous larva/fruit fly. (i) Separation of chromosome (ii) Making slide (iii) Observation of chromosomes	Practical
3	Study of meiosis in Grasshopper testis. (i) Separation of testis	Practical
		Practical



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	(ii) Making slide	practical
	(iii) Observation of meiosis	practical
4	Learn about cell cycle and Gametogenesis through charts and models	Practice

Unit- III Cell signaling Signaling: different pathways (G-protein mediated, cAMP mediated and tyrosine kinase mediated), secondary messengers. Cell differentiation, program cell death, techniques in Cell biology (microscopy, chromatography, centrifugation and spectroscopy).

(1 Credit)

Recommended Books:

1. Cell and molecular biology by P.K. Gupta
2. Cell biology by C. B. Panwar, Rastogi publication.

Reference books:

1. Molecular Biology of the Cell- Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff.
2. The Cell: A Molecular Approach, Sixth Edition by Geoffrey M. Cooper and Robert E. Hausman

Unit Operations in food Industry Credits- 3

Objective: Upon successful completion of this course, students should be able to:

1. Explain basic principles of unit operations and also waste treatment in food industry.
2. Explain the methods and effects of preservation and processing on food product quality.
3. Apply numerical solution to solve problems involved in unit operations of food processing.

UNIT – I Flow, Heat Transfer Principles of fluid flow, heat transfer, heat exchanger, EMC & Water activity, Evaporation, Distillation, Drying, Dehydration; Types of dryers, Material handling equipment; Size reduction, Energy requirement in Size Reduction.

(1 Credit)

Practical (1 Credit)

S. No.	Name of practical	Nature
1	Solvent Extraction (Extraction)	Practice
2	Distilled Water Preparation (Distillation)	Practice
3	Study & Demonstration of Spiral & Planetary Mixers (Mixing)	Practice
4	Sieve Analysis (Sieving)	Practice



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5	Study & Demonstration of Ball Mill (Size Reduction)	Practice
6.	Study & Demonstration of Refrigeration System (Refrigeration)	Practice

UNIT – II Separation, Mixing Sieve analysis, Mixing, Kneading, Blending, Homogenization, Size Separation, Sedimentation, Extraction, Leaching, Crystallization, Thermal Processing, Refrigeration principles, Cooling, freezing, thawing of food materials.

(1.5 Credit)

UNIT – III Mechanical Separation, Grading & Emulsification Absorption and adsorption, Mechanical Cleaning, Grading, Sorting, Filtration, Membranic Separation, Emulsification.

(0.5 Credit)

Recommended Books:

1. Albert Ibarz, Gustavo V. Barbosa-Canovas, Unit Operations in Food Engineering, CRC Press 2010
2. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998
3. R.L. Earle and M.D. Earle, Food Engineering, 1978

Analytical Chemistry Credits- 4

Unit- I Separation methods Solvent extraction (liquid-liquid extraction): General principles, relationship between percentage of extraction and distribution coefficient and distribution ratio, multiple extraction, extraction of metal organic complexes and ion association complexes. Chromatographic techniques: Classification, basic principles, theory of chromatography- Ion exchange chromatography - ion exchange process, synthesis and structure of ion-exchange resin and separation of lanthanides. Paper and thin-layer chromatography- stationary and mobile phases, various techniques of development – visualization and evaluation of chromatograms, separation of inorganic and organic compounds.

(1 Credit)

Practicals: (0.5 credit)

Sr. no.	Name of practical	Nature
1	To perform Ion exchange methods- (i) To the preparation of solution. (ii) To separation and estimation of mg (II) and Zn (II).	Practical
		Practical
		practical
2	To perform of Solvent extraction- (iii) To prepare solution. (iv) To separation and estimation of Mg (II) and Fe.	Practical
		Practical
		practical



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3	To the study Green leaves with the help of Thin layer chromatography-	Practical
	(i) To preparation and Identification of organic compound.(Benzene)	Practical
	(ii) Determination of R_f value .	practical
4	To the study of Organic compound with the help of Column chromatography.	Practical
	(i) Separation of fluoresin and methylene blue. (ii) Separation of a mixture of dying using cyclo hexane and ethyl acetate(8.5:1.5).	Practical
		Practical
5	To the study of Paper chromatography-Ascending and circular.	Practical
	(i) Separation of a mixture of Phenylalanine and glycine.	Practical
	(ii) Observation of result.	Practical

Unit- II Spectral methods UV absorption spectroscopy: Beer-Lambert law, molar extinction coefficient, analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophores and auxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shifts, UV spectra of conjugated enes and enones.

(1 Credit)

Practicals: (0.5 credit)

1	Spectral methods –	Practical
	(i) To Determine of Beer -Lambert law.	Practical
	(ii) Calculation of law by U.V	practical
2	Spectroscopy methods-	Practical
	(i)To prepare the solution.	Practical
	(ii) Simultaneous determination of Co (II) and Cr (III) in a mixture of both by spectro - photometric method.	Practical
3	Thermal Methods-	Practical
	(i) To the study of Determine the content of iron in vitamin tablets by colorimetric method.	Practical
	(ii) Calculation by colorimetric methods.	Practical
4	To the study of fluoresin and methylene blue with the help of Column chromatography-	Practical
	(i) Identification of organic compound.	Practical
	(ii) Separation of a mixture of dying using cyclo hexane and ethyl acetate(8.5:1.5).	Practical
5.	To Analysis Solvent extraction methods-	Practical
	(i)To the Preparation of solution.	Practical



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	(ii) Separation and estimation of Mg (II) and Fe metal.	Practical
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Unit-III Thermal methods Theory, instrumentation and applications of Thermogravimetric method of analysis (TGA), (b) Differential thermal methods of analysis (DTA), (c) Differential scanning calorimetry (DSA).

(1 Credit)

Recommended text book:

1. Qualitative analysis ,G.R.Chatwal,

Reference books:

- Vogel's Qualitative analysis ,Svehla,Orient Longman.
- Inorganic synthesis McGrawHell

Fundamentals of Food Science & Technology Credits- 4

Objective:Students would be able to understand Scope of food processing in India and different areas of food processing. They would be able to understand the processing of different food products like meat and meat products, Fruit and vegetable, milk and milk products and marine products.

UNIT – I Food Processing & Packaging and Food Industries Scope of food processing in India; Introduction to food processing, food preservation, food packaging, food drying and dehydration. Important food industries in India; role of Food Science & Technology in national economy.

(1 Credit)

Practical: (0.4Credit)

S. No.	Name of practical	Nature
1	Study of Various Processed foods available in the market	Practical
2	Study of Different Methods of Food Preservation	Practical
3	Study of Different types of Drying Techniques	Practical
4	Study of Different types of Packaging Materials	Practical
5	Study of Different Food Industries in India	Practical

UNIT – II Processing of food products Fruit and vegetable processing, processing of meat and meat products, processing of milk and milk products, processing of marine products.

(1 Credit)

Practical:

0.4 Credit

S. No.	Name of practical	Nature
1	Processing of Fruits	Practical
2	Processing of Vegetables	Practical



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3	Processing of Milk & Milk Products	Practical
4	Processing of Meat Products	Practical
5	Processing of Marine Products	Practical

UNIT – III Unit operations and Food Engineering Unit operations in food industry. Rheology of food. Basic principles of food engineering. Introduction to various food processing equipments.

(1 Credit)

Practical (0.2 Credits)

S. No.	Name of practical	Nature
1	Study of Various Food Processing Equipments	Practical
2	Study of Unit operations in Food Industry	Practical
3	Study of Food Rheology	Practical

Recommended Books:

1. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998
2. Vickie A. Vaclavik, Elizabeth W. Christian, Essentials of Food Science, Springer, 2008
3. B. Srilakshmi, Food Science, New Age International, 2007



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III SEMESTER

Metabolism and Bioenergetics Credits- 4

UNIT – I Bioenergetics and Carbohydrate metabolism Molecular basis of life, proteins, classification, structure, function, dynamics, specificity and techniques; Protein configuration, conformation, conformational analysis, Ramachandran's map and energy calculations; Helix to coil transition of proteins. Carbohydrates and lipids, classification, structure and function, membrane fluidity. Structural proteins, actin, myosin and muscle contraction.

(1 Credit)

Practicals: (0.4 credits)

Sr. no.	Name of practical	Nature
1.	To understand the principle and operation of Spectrophotometer	Practical
2.	Determination of reducing sugars by Nelson- Somogyi's method 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	practical
3.	Determination of starch in plant Tissue 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	Practical
4.	Determination of Glycogen in Liver 1. Preparation of reagents 2. To perform the assay 3. Observation and calculations	Practical

UNIT – II Lipid Metabolism Nucleic acids, nomenclature, properties and techniques, backbone torsional angle and sugar conformation. Enzymes, introduction, classification, kinetics and Catalysis. Metabolism, basic concepts and design.

(1 Credit)

Practical (0.4 credit)

Sr. no.	Name of practical	Nature
1	Extraction and estimation of total lipid content in the given sample of oilseed 1. Preparation of reagents and extraction of total lipids 2. Estimation of total lipids	Practical
2	Separation and identification of various lipids by Column Chromatography 1. Preparation of reagents 2. Separation of Lipids 3. Identification of lipids	Practical
3	Separation of various Components in different lipid fractions by thin layer chromatography 1. Preparation of reagents 2. Separation of various components	Practical
4	Estimation of Cholesterol content by Liebermann- Burchard method 1. Preparation of reagents 2. To perform the assay 3. Observation and Calculations	Practical



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UNIT – III Protein and Nucleic acid metabolism Carbohydrates and lipids, classification, structure and function. Metabolism of carbohydrates, glycolysis, citric acid cycle and oxidative phosphorylation, lipid, amino acid and nucleotide metabolism. Integration of metabolism, coordinated control and regulation. Photosynthesis, chloroplast, dark and light reactions.

(1 Credit)

Practical (0.2 credit)

Sr. no.	Name of practical	Nature
1.	Estimation of protein by Lowry's method 1. Preparation of reagents 2. To Perform the assay 3. Observation and Calculations	Practical
2.	Determination of Protein by Bradford method 1. Preparation of reagents 2. To perform the assay and calculation for the concentration of protein	Practical

Recommended text Books:

1. A.L. Lehninger, D.L. Nelson, M.M. Cox, "Principles of Biochemistry", 3rd Edn., Worth Publishers.

Reference Books:

1. Biochemistry by Voet and Voet
2. Biochemistry by U. Staynarayan
3. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY.
4. G. Zubay, "Biochemistry", 4th Edn., McGrawhill Publishers.

References/Correlation with Ancient Indian Literature:

1. Asvalayana Grhya Sutra II 7

<https://www.australiancouncilofhinduclergy.com/uploads/5/5/4/9/5549439/asvalayana-eng.pdf>

2. Atharveda <http://www.sacred-texts.com/hin/av.htm>

3. Yajurveda <http://vedicheritage.gov.in/science/>

Basic Enzymology Credits- 4

UNIT I Introduction & Classification of enzymes Introduction – Characteristics of Enzymes, Concept of Activation energy, free energy, Difference between enzyme and biocatalyst, IUB enzyme classification (specific examples), enzyme specificity, methods for isolation, purification and characterization of enzymes

(1 Credit)

Practicals: (0.5 credit)

Sr. no.	Name of practical	Nature
1	To examine the effect of pH on activity of alkaline phosphatase 1. Preparation of Reagents 2. To perform the assay 3. Observation and calculations	Practical
2	To determine the temperature optima for alkaline phosphatase	Practical



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	<ol style="list-style-type: none">1. Preparation of Reagents2. To perform the assay3. Observation and calculations	
3	Time course of enzymatic reaction <ol style="list-style-type: none">1. Reagent preparation2. To perform the assay and observe for the results	Practical
4	Specificity of enzyme action. <ol style="list-style-type: none">1. Preparation of Reagents2. To perform the assay and observation	Practical

UNIT II Enzyme kinetics Kinetics of enzyme action –Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of K_m & V_{max} and their physiological significances. Importance of K_{cat}/K_m . Kinetics of zero & first order reactions. Classification of multi-substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms. Use of initial velocity, inhibition and exchange studies to differentiate between multi-substrate reaction mechanisms.

(1 Credit)

Practicals: (0.5 credit)

Sr. no.	Name of practical	Nature
1.	To understand the principle and operation of Spectrophotometer	Practical
2.	Influence of substrate concentration on the rate of enzymatic reaction. <ol style="list-style-type: none">1. Preparation of Reagents2. To perform the assay3. Observation and calculations	Practical
3.	Inhibition of enzyme activity Determination of K_i values <ol style="list-style-type: none">1. Preparation of Reagents2. To perform the assay3. Observation and calculations	Practical
4.	Determination of β-amylase activity in germinating barley seeds <ol style="list-style-type: none">1. Preparation of Reagents2. To perform the assay3. Observations and calculations	Practical

UNIT III Enzyme Inhibition and Mechanism of Enzyme action(2) Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, mixed type inhibitors and their kinetics, determination of K_i and numerical based on these. Suicide inhibitor. Mechanism of Enzyme Action – Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain and distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.

(2 Credit)

Recommended Text Books :

1. N.S. Kulkarni -General Enzymology

Reference Books



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1. Travor and Palmer - Enzymology
2. A.L. Lehninger, D.L. Nelson, M.M. Cox, " Principles of Biochemistry", 3rd Edn., Worth Publishers.

References/Correlation with Ancient Indian Literature:

1. RasRatna Samuchchay <https://www.exoticindiaart.com/book/details/rasa-ratna-samucchaya-NZI038/>
2. RasayanShastra <https://www.pgurus.com/chemistry-ancient-india/>

Technology of Milk & Milk Products Credits- 4

Objective: Students would be able to understand the basics of milk and milk processing. Understand the importance of dairy, the techniques that can be used for preservation and manufacturing of various value added milk products. Understand the processing of various milk products like butter, ghee, flavored milk, yoghurt and shrikhand, ice cream, cheese, channa, paneer, condensed milk and milk powder.

UNIT – I Composition of Milk Milk: Definition, composition, and Present milk industry scenario and its future, Physical and chemical properties, Nutritive value of milk and milk products and its national and international standards. Practices related to procurement and transportation of milk, soy milk manufacturing and processing, Types of Milk- standardized milk, recombined milk, toned milk and double toned milk.

(1 Credit)

Practical (0.4 Credit)

S. No.	Name of practical	Nature
1	To determine the titratable acidity of milk	Practical
2	Determination of Physico- chemical properties of Milk	Practical
3	To test the quality of milk using COB test	Practical

UNIT – II Testing & Microbiology of Milk Testing the authenticity of Milk & Milk Products: Detection of foreign fats, milk of other species, microbiology of milk, Spoilage of Milk, Good Hygeine Practices in Milk Processing: Principal Hazards, cleaning and disinfection agents and processes. Reception, cream separation.

(1 Credit)

Practical (0.4Credit)

S. No.	Name of practical	Nature
1	To conduct the platform test of milk sampling of dairy products	Practical
2	Detection of common adulterants in Milk	Practical
3	Separation and standardization of Milk	Practical



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UNIT – III Processing of Milk & Milk Products Milk Processing: Clarification, Homogenization, Pasteurization, Sterilization of Milk, UHT Milk, Aseptic Packaging and Storage. Technology of Traditional Indian Dairy products, Technology of fat rich dairy products like Cream, Butter, ghee and margarine, Technology of fermented milk and probiotic milk based products, flavored milk.

(1 Credit)

Practical(0.2 Credits)

S. No.	Name of practical	Nature
1	Preparation of Flavored Milk	Practical
2	Preparation of traditional Indian dairy products	Practical
3	Preparation of white and salted butter and ghee	Practical

Recommended Text Books:

1. Many N.S. Shadakshasawamy M, Food Facts and Principles, New Age International, 2004.

Reference Books:

1. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998
2. Vickie A. Vaclavik, Elizabeth W. Christian, Essentials of Food Science, Springer, 2008

References/Correlation with Ancient Indian Literature:

- Prasna Upanishad 1-5 <https://esamskriti.com/Prasnopanishad-TNS-Complete.pdf>
- Brihadaranyaka Upanishad (V.12) <https://www.swami-krishnananda.org/brdup-audio.html>
- Chhandogya Upanishad (VII. 26) https://www.chinfo.org/images/userupload/Reflections/16_Bhumaiva_Sukham_Chand_7.pdf
- Chhandogya Upanishad (VII. 9) https://www.chinfo.org/images/userupload/Reflections/16_Bhumaiva_Sukham_Chand_7.pdf

Principles of Food Preservation Credits- 4

Objective: This course deals with the techniques and principles involved in processing and preserving the various food products. The student will be able to apply the principles and methods involved in the processing of different foods and discuss their processing. They would understand important application of various preservation methods in food industries.

UNIT – I Water Activity & Moisture Removal Principles of food preservation, Asepsis, removal of microorganisms, Maintenance of anaerobic conditions, Methods of food preservation. Water Activity and Food Preservation, Free and Bound water, Effect of water activity on quality of food constituents during storage (proteins, lipids and carbohydrates) Effect on physical and nutritional quality, Water activity and food stability, Effect of packaging material on water activity.

(1 Credit)



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Practical (0.4Credit)

S. No.	Name of practical	Nature
1	Measurement of water activity in Fresh fruits	Practical
2	Measurement of water activity in dehydrated fruits - Raisins, figs (dry), dried vegetable	Practical
3	Measurement of water activity in milk powder/instant coffee powder	Practical
4	Effect of packaging material on water activity	Practical
5	To see Osmosis in Raisins	Practical

UNIT – II Controlled Atmospheric Storage & Freezing (1-0.7) Preservation through temperature reduction, Storage of food at chilling temperature - behaviour, Refrigeration Controlled Atmosphere Storage (CAS), Modified Atmosphere Storage (MAS), Chilling defects Freezing-principles, fundamental aspects of freezing Freezing process-technological aspects Freezing damage-osmotic damage, solute Structural damage Preservation by use of High Temperatures, Concentration of food Evaporation Freeze concentration, Membrane process for concentration.

(1 Credit)

Practical (0.4 Credit)

S. No.	Name of practical	Nature
1	Low Temperature processing (i) Processed food / fruits / vegetables Banana, Sapota, Potato, Leafy Vegetables (ii) Processing of fruits and vegetables and storage at low temperature using various packaging material (after giving appropriate pre-treatment)	Practical
2	Frozen food Processing (i) Fruit pulp processing, packaging and freezing (using various packaging material and methods)	Practical
3	High Temperature processing (i) Experiments on Blanching of vegetables (ii) Experiments on sterilization	Practical
4	Experiments on concentration	Practical
5	Quality analysis of the products during storage, storage studies	Practical

UNIT – III Dehydration of foods & Preservation Techniques Dehydration of food (Food Preservation through water removal), Transport of water in foods, Different methods of dehydration, Cabinet drying, sun / solar drying, Osmo drying, Osmo-vac drying, micro-vac drying, vacuum drying,. Recent advances in dehydration of food. Freeze drying: Introduction, principles, process and preservation. Preservation using high Sugar-Jam, Jellies, Squashes, syrups, marmalades, cordials, concentrate etc. Salting preservation Use of common salt, principle, process Fish salting Pickling Pickle salting (sauerkraut, cucumber, Kim chi) Vegetable salting Acidified - brined pickles (vegetables-onion, garlic).

(1 Credit)

Practical (0.2 Credit)

S. No.	Name of practical	Nature
1	Dehydration : Cereal/Pulse based products (including comparative studies on packaging) Banana powder, Potato and Sweet Potato	Practical



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	powder appropriate pre-treatment)	
2	Sugar based products: Jam making	Practical
3	Sugar based products – Jelly making	Practical
4	Salting: Salting of vegetables, Brining / preservation of vegetables in brine using various containers	Practical
5	Effect of chemical preservatives (Benzoate, So ₂ , salts (KMS, NaMs)	Practical

Recommended Text Books:

1. Giridhari Lal, G.S. Siddappa and G.L. Tondon Preservation of Fruits and Vegetables, CFTRI, ICAR, New Delhi -12.
2. Diane M. Barrett, Laszlo Somogyi, Hoshahalli Ramaswamy Processing Fruits, 2nd edition, Science and Technology, CRC Press

Reference Books:

1. B. Sivasankar, Food Processing & Preservation, PHI Learning Private Limited, 2002
2. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998

References/Correlation with Ancient Indian Literature:

1. Maitrayani Upanishad (VI. 9) <https://www.yousigma.com/religionandphilosophy/maitrayani.html>
2. Arunika Upanishad (Taitt. Up. II. 2) https://archive.org/stream/EssentialsOfUpanishadsKashyapR.L.SAKSI/Essentials%20of%20Upanishads%20%20Kashyap%20R.L.%20SAKSI_djvu.txt
3. (Mahabharatha Anu.65-46) <https://sanskritdocuments.org/mirrors/mahabharata/mbhK/mahabharata-k-01-sa.html>
4. Atharva Veda (2-13-1). <http://www.sacred-texts.com/hin/av/index.htm>

Biostatistics Credits- 3

UNIT-I Classification and Tabulation of Data Classification and tabulation of data ,Frequency distribution Histogram , Frequency polygon and frequency curve ,Cumulative frequency curves, Measures of central tendency: arithmetic mean geometric mean harmonic mean median, mode; Measures of dispersion: range, quartile deviation, mean deviation, variance and standard deviation; Correlation: Karl Pearson's correlation coefficient, Spearman's rank correlation coefficient, Spearman's rank correlation coefficient, Regression: Lines of regression and regression coefficient.

(1 Credit)

Practical (0.5 Credit)

Sr. no.	Name of practical	Nature
1.	To find out Mean	Practical
2.	To find out Median	Practical
3.	To find out Mode	Practical
4.	To draw Bar Graph	Practical
5.	To draw Pie diagram	Practical

UNIT-II Vital Statistics Vital statistics: Concept, importance, Vital index, Birth rates: CBR, GFR, SFR, TFR, Death rates: CDR, SDR, STDR, Life tables: introduction, Description and



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uses, Sampling: concept of population and sample, Sampling distribution and standard error of sample mean and sample proportion, Hypothesis testing, type I & II errors, Level of significance, Critical region, acceptance region, p-values of the statistics, confidence limits.

(0.5 Credit)

Practical (0.5 Credit)

Sr. no.	Name of practical	Nature
1.	To draw Histogram	Practical
2.	To draw line graph	Practical
3.	To find out correlation	Practical
4.	To find out rank correlation	Practical
5.	To draw Histogram	Practical

UNIT-III ANOVA and sampling Large sample tests (normal test): Test for one sample proportion and two sample proportion test, Small sample tests : t-test (test for one and two sample means): F-test, Chi square test (goodness of fit test, test of independence, homogeneity of samples), Analysis of variance (ANOVA); One way and two way analysis of variance, Application of these tests to analyze the biological data.

(0.5 Credit)

Recommended Text Books:

1. Elements of Biostatistics; S. Prasad; Rastogi Publications, Merrut
2. Elements of Mathematical Statistics; S.C.Gupta and V.K. Kapur; Sulatanchand& Sons, New Delhi

Reference books:

1. Statical methods in Biology; T.I. Norman; Bailey, 3rd edition
2. Fundamentals of Mathematics; S.C. Gupta and V.k. kapur; Sultan Chand& sons , New Delhi

References/Correlation with Ancient Indian Literature:

1. Sankhyā: The Indian Journal of Statistics Published by: Indian Statistical Institute
<https://www.springer.com/statistics/journal/13171>
2. The Sulba Sutras http://www-history.mcs.st-and.ac.uk/Projects/Pearce/Chapters/Ch4_2.html
3. "History of Hindu Mathematics, Asia Publishing House, Bombay, 1962"
<https://link.springer.com/article/10.1007/BF02836134>

Food Microbiology & Safety Credits- 4

Objective: Students would be able to acquaint the knowledge of the important genera of microorganisms associated with food and their characteristics. They would be able to explain the role of microbes in fermentation, spoilage and food borne diseases. Gain Knowledge of Food safety and hygiene, types of hazards associated with food and understand the current Food Regulations.



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UNIT – I Introduction to food microbiology & food Borne Diseases

Introduction to Food Microbiology, History of food Microbiology, Scope of Food Microbiology, and Types of organisms associated with food: Bacteria, Fungi, Yeast, and Mold. Growth Kinetics and factors affecting growth of microorganisms. Sources of Microbial contamination on foods, Sources of Microbial contamination in food and its control .Food Microbiology and Public Health- Food Poisoning, Food Poisonings due to pathogens, important features. Bacterial Agents of food borne illness- a brief account of various organisms related with food poisoning. Food Borne Diseases.

(1 Credit)

UNIT – II Role of Microorganisms & Techniques in Microbiology

Beneficial Role of microorganisms in foods.Introduction to Biotics & Probiotics. Screening, Detection and enumeration techniques including rapid detection techniques for food micro flora including pathogens, Requirement of Microbiology laboratory for food analysis, preparation & maintenance of cultures, media, sterilization techniques, disposal of used cultures and media detection and detection techniques of microorganisms in foods: culture, microscopic examinations, physical, chemical and immunological methods of microbial detection.

(1 Credit)

Practical (0.5Credits)

S. No.	Name of practical	Nature
1	Preparation of common laboratory &Special media for cultivation of bacteria, yeast & molds	Practical
2	Staining of bacteria: Gram's Staining, Acid- Fast, Spore, Capsule and Flagellar Staining, Motility of Bacteria	Practical
3	Study of environment around us as sources of transmission of microorganisms in foods- assessment of surface sanitation of food preparation units- swab and rinse techniques	Practical
4	Isolation of Microorganisms- different methods & maintenance of cultures of microorganisms	Practical
5	Bacteriological analysis of foods	Practical
6	Bacteriological Analysis of water: MPN	Practical
7	Bacteriological Analysis of Milk: MBRT	Practical
8	To perform various tests used in Identification of commonly found bacteria in foods: IMVIC, Urease	Practical
9	To perform various tests used in Identification of commonly found bacteria in foods: H ₂ S, Catalase	Practical
10	To perform various tests used in Identification of commonly found bacteria in foods: Coagulase, Gelatin & Fermentation (Acid/ Gas)	Practical

UNIT – III Quality Control & AssuranceQuality Control/Quality Assurance, Legislation for food safety- national & International criteria, sampling Schemes. Records, risk analysis, risk management. CC-Microbial source, code indicators of food safety and quality: Microbiological criteria of foods and their significance. The HACCP system and Food Safety Management Systems used in controlling microbiological hazards.

(1 Credit)

Practical (0.5 Credits)

S. No.	Name of practical	Nature
1	To study the implications of HACCP in relation to a food industry	Practical
2	To study the available rapid methods & diagnostic kits used in	Practical



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	identification of microorganisms or their products.	
3	To study a food processing unit dealing with advanced methods in food microbiology	Practical

Recommended Books:

1. James M.J. (2000) Modern Food Microbiology, 5th edition, CBS Publishers.

Reference Books:

1. Adams M. R. & Moss, M.O (1995) Food Microbiology, New age International Pvt. Ltd Publishers.

References/Correlation with Ancient Indian Literature:

- Gita 14.17 http://en.krishnakosh.org/krishna/Gita_14:17
- Chandogya Upanishad
VI.6.5 https://www.chinfo.org/images/userupload/Reflections/14_Chandogya_Chap_6-Tat_Twam_Asi.pdf
- Taittiriya Upanishad, III.vii.1 <https://www.hinduwebsite.com/taittiriya-upanishad.asp>



IV SEMESTER

Food Packaging Technology Credits- 4

Objective: On successful completion of the course students will be able to:

1. Describe the role and function of packaging materials used for a range of consumer food needs and wants.
2. Relate the properties of food packages to conversion technologies, processing and packaging technologies and user requirements including safety, convenience and environmental issues.
3. Describe the technology involved in the production, shaping and printing of various packaging materials and packages.

UNIT – I Packaging Machineries & Materials Packaging Machineries, Systems and Regulations, Introduction to Food Packaging: History, Definitions, Importance and scope functions of packaging, package components. Packaging Materials and Properties: Manufacturing process, types, properties, advantages and disadvantages. Primary Packaging Materials: Paper and paper based packaging materials, Plastic as packaging materials: Brief history, processing, classification, mechanical, optical and barrier properties like WVTR, GTR, additives in plastics. Aluminum foil, Metal packaging materials: Manufacture of tin plate, TFS, fabrication, corrosion and remedial measures. Glass packaging materials: Composition, structure, properties, manufacture, design and closure.
(1 Credit)

Seminar (0.5Credits): Seminar based on Unit I is recommended

UNIT – II Packaging Requirement of different foods Secondary Packaging Material: Folding carton. Transport packaging materials- corrugated fiber board boxes, properties of corrugated fiber board boxes; drop strength, compression strength and puncture resistance strength, wooden boxes. Ancillary Packaging Materials: Printing inks, varnishes, lacquers and adhesives. Packaging Requirements of Different Types of Foods : fruits and vegetables, meat, fish, poultry, dairy products, edible oils and spice products, bakery products, confectioneries, Instant foods, extruded foods, snack foods, alcoholic and non-alcoholic carbonated beverages.
(1 Credit)

Practical (0.3Credit)

S. No.	Name of practical	Nature
1	Determination of Puncture Resistance Strength of CFB boxes.	Practical
2	Determination of Compression Strength of CFB boxes	Practical
3	Determination of Drop Strength of CFB boxes.	Practical

Group Discussion (0.2 Credits): Group Discussion based on Unit II is recommended

UNIT – III Packaging Machineries, Systems and Regulations Packaging Machineries, Systems and Regulations:- Packaging, Machineries: Bottling, canning, capping, labeling, form- fill sealing,



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strapping, cartonning machineries. Packaging Systems:, Vacuum and gas packaging, aseptic packaging, retort packaging, CAP & MAP, active packaging, shrink packaging, lined cartonning, system. Packaging Standards and Regulations: Laws, regulations, specifications and quality control, recycling of plastic packaging materials: Collection, separation and disposal.

(1 Credit)

Recommended Text Books:

1. Roberston G.L. (2006) Food Packaging: Principles and Practice. 2nd edition, Taylor and Francis Group.
2. Mattsoon B. and Sonesson U. (2000) Environmentally-friendly food processing. Woodhead publishing ltd.

Reference Books:

1. Ahevenainen R. (2003). Noval food packaging techniques. Woodhead publishing ltd.

Meat, Fish and Poultry Product Technology

Credits- 3

Course Outcome-On successful completion of the course students would be able to develop the knowledge in the area of animal product processing and technology. They would be able to appreciate the application of scientific principles in the processing and preservation of these materials.

UNIT – I Introduction to Meat & its microbiology Introduction to meat; Meat production, processing and composition trends and nutritive value; Slaughtering techniques of animal and slaughtering practices; Meat cuts and portions of meat; Meat quality; Inspection and grading of meat; Physicochemical composition of muscle, connective tissue, intramuscular fat; Post-mortem changes in muscle; Conversion of muscle to meat. The eating quality of meat - color, water holding capacity (WHC) and juiciness, texture and tenderness, odor and taste; Meat microbiology and safety.

(1 Credit)

UNIT – II Meat processing & Egg quality Meat processing- comminution, emulsification, curing, smoking, cooking, ageing and tenderization; Meat products - meat emulsion, fermented meats, sausages, ham, bacon and comminuted meat products; Meat analogs; Meat storage and preservation- by temperature control (refrigeration, freezing, thermal processing), by moisture control (dehydration, freeze drying, curing, IMF meat), by microbial inhibition (chemical preservation, ionizing radiation); Meat production, processing and consumption trends. Egg and egg products- Structure, composition and functions of eggs; Changes in eggs due to aging; Abnormalities in eggs; Functions of eggs in food products; Inspection and grading for egg quality.

(1 Credit)

UNIT – III Fish processing & preservation Fish as raw material for processing and its physical properties. Factors affecting the quality of product and post-harvest losses. Chilling and freezing of fish and other aquatic products. Physical, chemical, microbiological and sensory changes during storage. Principles of thermal processing. decimal reduction time, thermal death time, "Z" and "F" values, 12D concept, determination of process time. Canning process for fish/shellfish. Value added and ready to use canned products. Retort pouch processing of fish and fishery products principles and techniques. Nutritional importance of fish meal and quality requirements. Value



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added products of fish: Present market trends, scope and types of value addition, Important value added products.

(1 Credit)

Recommended Text Books:

- Vaclavik V.A. and Christian EW (2003), Essentials of food science, 2nd edition, Springer International.
- Laurie R.A. (1998), Lawrie's meat Science, 6th edition, Woodhead Publishing Ltd..

Reference Books:

1. Stadelman W.J. and Cotterill O.J. (2001), Egg science and technology, CBS Publishers.
2. Pearson A.M. and Gillett T.A. (1996), Processed Meats, CBS Publishers.
3. Stadelman W.J., Olson V.M., Shemwell G.A. and Pasch S. (1988), Egg and poultry meat processing, Elliswood Ltd.
4. Aitken A., Mackie M., Merritt S.H. & Windsor M.L. 1982. Fish Handling and Processing. Ministry of Agriculture, Fisheries and Food, Edinburgh.
5. Balachandran K.K. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.

Dairy Plant Management Credits- 3

Objective: Students would be able to define management, production planning and control. They would learn about energy conservation, auditing, financial and managerial efficiency and will be able to know about safety hazards, prevention and breakdown maintenance.

Unit I Production Management Production Management: Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement method and time study, Plant Operations.

(1 Credit)

Unit II Managerial Efficiency Efficiency factors losses, Financial and Managerial efficiency, Provision for Industrial Legislation in India, Particularly in dairy industry, Personal Management. Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions.

(1 Credit)

Unit III Safety hazards & Prevention Safety hazards, hazards prevention security for plant machinery and the employees, Plant Maintenance. Prevention & Break-down maintenance Spare parts inventory, tools & lubricants etc. Food hygiene, personnel hygiene, plant hygiene, water quality etc. Cleaning and Sanitation – different type of cleaning and sanitizing agents, Effluent treatment: Type, degree and treatment of waste.

(1 Credit)

Recommended Text Books:



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1. Martin 1872- Mortensen, Management of Dairy Plants, Wentworth Press

Reference Books:

1. J David, Contemporary Trends in Dairy Plant Management – 2007, Kitab Mahal Agencies

Waste Management of Food Industries Credits- 3

Objective:- By the end of semester students will be able to understand and analyze different types of food industry wastes their Classification, their special characteristics and management of wastes from different food processing industries. The students will also acquaint knowledge about food industry waste by products.

UNIT – I Classification and characterization of food industrial wastes Introduction: Classification and characterization of food industrial wastes from fruit and vegetable processing industry, beverage industry, fish, meat and poultry industry, sugar industry and dairy industry; Waste disposal methods – physical, chemical and biological; Economical aspects of waste treatment and disposal.

(1 Credit)

UNIT – II Treatment methods for liquid wastes from food process industries Treatment methods for liquid wastes from food process industries; Design of activated sludge process, Rotating biological contactors, Trickling filters, UASB, Biogas plant. Treatment methods of solid wastes: Biological composting, drying and incineration; Design of solid waste management system: Landfill digester, Vermicomposting pit.

(1 Credit)

UNIT – III Biofilters and bioclarifiers Biofilters and bioclarifiers, Ion exchange treatment of waste water, Drinking-water treatment, Recovery of useful materials from effluents by different methods.

(1 Credit)

Recommended Text Books:

1. Food Industry Wastes: Disposal and Recovery; Herzka A & Booth RG; 1981, Applied Science Pub Ltd.
2. Water & Wastewater Engineering; Fair GM, Geyer JC & Okun DA; 1986, John Wiley & Sons, Inc.
3. Wastewater Treatment; Bartlett RE; Applied Science Pub Ltd.
4. Symposium: Processing Agricultural & Municipal Wastes; Inglett GE; 1973, AVI.

Reference Books:

1. Food Processing Waste Management; Green JH & Kramer A; 1979, AVI.
2. Environmental Biotechnology: Principles and Applications; Rittmann BE & McCarty PL; 2001, Mc-Grow-Hill International editions.
3. Environmental Biotechnology; Bhattacharyya B C & Banerjee R; Oxford University Press.

References/Correlation with Ancient Indian Literature:



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- Ganguli, K.M. (1883-1896) "Adi Parva" in The Mahabharata of Krishna-Dwaipayana Vyasa (12 Volumes). Calcutta https://archive.org/stream/TheMahabharataOfKrishna-dwaipayanaVyasa/MahabharataOfVyasa-EnglishTranslationByKMGanguli_djvu.txt
- Dutt, M.N. (1895) The Mahabharata (Volume 1): Adi Parva. Calcutta: Elysium Press https://www.wikizero.com/en/Adi_Parva
- Debroy, B. (2010) The Mahabharata, Volume 1. Gurgaon: Penguin Books India, pp xxiii - xxvi https://www.wikizero.com/en/Anushasana_Parva
- "Book 1: AdiParva: JatugrihaParva". Sacred-texts.com. Retrieved 1 September 2010 <https://wikivisually.com/wiki/Mahabharata>

Fruits & Vegetable Processing Technology Credits- 4

Objective: The course would furnish and acquaint a student with knowledge and understanding of the basic post harvest biological, chemical, physiological and metabolic processes and changes in fruits and vegetables. They would even learn the basic steps, application and operation of selected technologies and principles used to process, preserve and extend shelf life and value addition.

UNIT – I Post Harvest Technology Fruits and vegetables as living products: Current status of production and processing of fruits and vegetables. Chemical composition; pre and post harvest changes, harvesting and maturity standards for storage, and desirable characteristics of fruits and vegetables of processing. Post harvest treatments to enhance shelf-life, conditions for transportation and storage. Pre- cooling.

(1 Credit)

UNIT – II Types of Processing Treatments Cold chain & low temperature preservation: Types of cold preservation; Types of freezers and freeze concentrators, Cooling above freezing point, Cooling below freezing point. Control & modified atmosphere storage. Thermal processing: Canning and bottling, effect of canning and bottling on nutritive value, spoilage of canned foods, detection and control. Dehydration of Fruits & Vegetable: Thermal, Osmotic. Products processing: Juice extraction and preparation of syrups, squashes, cordials, nectars; Jam, jelly, marmalade, preserves and candies; ketchup, pickles, chutneys and sauces; fruit juice concentrates and powders; fortified soft drinks, tomato product, vinegar; cut fruits and vegetable, fruit toffee; fruit flavors and essences.

(1 Credit)

Practical (1 Credit)

S. No.	Name of practical	Nature
1	Estimation of benzoic acid	Practical
2	Estimation of So ₂ in processed fruit products	Practical
3	Pectin determination in fruits and vegetable products	Practical
4	Preparation fruit juices and its concentrate	Practical
5	Preparation of tomato products- ketchup	Practical

UNIT – III Packaging & By- Products Basics of Packaging materials & containers: Tin, glass, plastic and other packaging materials used in fruits and vegetables preservations. Modified atmosphere and active packaging, By-products utilization: Fruit & vegetable processing industry waste treatment, disposal and reuse. Emerging technologies for fruit and vegetable processing.

(1 Credit)



Recommended Books:

1. Fruits and Vegetables. A.K Thompson. Blackwell publishing S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.
2. L. Somogyi, Processing Fruits: Science and Technology, Vol I: Biology Principles and Applications, Woodhead Publishing, 1996.

References/Correlation with Ancient Indian Literature:

- Mantra (4-21-6) of the Atharva veda <http://www.sacred-texts.com/hin/av.htm>
- Atharva Veda's Mantra 18-4-16 <http://dahd.nic.in/hi/related-links/annex-v-ii-2-superiority-cow-milk-paper-sh-ik-narang>
- Rigveda (10-179-3) <http://www.gatewayforindia.com/vedas/rigveda/rigveda10.shtml>

V SEMESTER

Food Additives & Ingredients Credits- 4

Objective: Students would be able to acquire knowledge tools of the most important classes of chemical food additives, their technological use for the adding in certain food preparations and for a sustainable use. In addition students will have notions on food contaminants, their presence or delivery in food approaches to limit and control them.

UNIT – I Additives in Food Processing & Preservation (1.0-0.3) Additives in food processing and preservation - classification and their functions, Safety and quality evaluation of additives and contaminants, acute and chronic studies, NOAEL, ADI, Ld50. Indirect food additives. Various additives such as preservatives, antioxidants, antimicrobials, colors, flavor, emulsifiers, sequesterants, humectants, hydrocolloids, sweeteners, acidulants, anticaking, agents, buffering salts etc. with respect to chemistry, food uses and functions in food formulations Acids, bases and buffers.

(1 Credit)

Practical (0.3 credit)

S. No.	Name of practical	Nature
1	Techniques of quality assessment of fruits & vegetables	Practical
2	Techniques of quality assessment of cereals & pulses	Practical
3	Techniques of quality assessment of dairy products	Practical
4	Identification of food preservatives	Practical
5	Ingredient study of food product label	Practical

UNIT – II Flavor Technology(1-0.3) Flavor Technology: Types of flavors, flavors generated during processing - reaction flavors, flavor composites, stability of flavors during food processing, analysis of



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flavors, extraction techniques of flavors, flavor emulsions, essential oils and oleoresins, authentication of flavors etc.

(1 Credit)

Practical (0.3 Credit)

S. No.	Name of practical	Nature
1	Sensory evaluation of food attributes	Practical
2	Effect of processing on sensory evaluation of food attributes	Practical
3	Identification of various food flavors	Practical
4	Effect of flavor on sensory evaluation of food products	Practical

UNIT – III Food Ingredients (1.0-0.4)Ingredients used in food production e.g. sugar, starches/modified starches, fibres, proteins/protein hydrolysates and fats etc and their technology of production and application. Sugars and Sweeteners: Sugars, syrups, sugar alcohols, potent sweeteners, sugar products, caramelization. Sweetener chemistry related to usage in food Products Food Colors: Food colours - Types and properties, regulatory aspects, safety issues - natural food colours - heme pigments, chlorophylls, carotenoids, anthocyanins and flavonoids, tannins, caramel and others Artificial food colours.

(1 Credit)

Practical (0.4 credit)

S. No.	Name of practical	Nature
1	Collection of various food ingredients	Practical
2	Preparation of caramelized products	Practical
4	Food safety in food ingredients	Practical
5	Effect of artificial color on sensory quality of food	Practical
6	Identification and collection of various food colors	Practical

Recommended Text Books:

1. Branen, A. F. et al (2001). Food Additives, 2nd Edition, Marcel Dekker.
2. George, A. B. (1991). Encyclopedia of food and color additives, Vol III, CRC Press.

Reference Books:

1. Nakai, S. and Modler, H. W (2000). Food proteins. Processing Applications, Wiley
2. Food Quality Assurance-Principles and Practices - Intez Ali, CHIPS, Texas.



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Cereal, Pulse & Oilseed Technology Credits- 4

Objective - Students would be able to understand basic composition & structure of food grain and understand the basics of milling operations. They would learn processing of food grains into value added products and how to manage production, distribution & storage of grains and even understand the principle of alcoholic beverage preparation.

UNIT – I Cereals ProcessingWheat Processing: Wheat classification, wheat grain structure quality and milling Functionality of wheat flour components and bakery ingredients. Rice Processing: Classification, paddy Processing and treatment for quality improvement, Milling and sorting, By product utilization e.g. Bran: Novel product development – Instant Rice, puffed products etc. Coarse Cereals Products: Maize, sorghum, pearl millet and small millets processing and value addition.

(1 Credit)

Practicals (0.4 credit)

Sr No.	Name of practical	Nature
1	Milling of wheat with emphasis on quality and recovery.	Practical
2	Milling of rice with emphasis on quality and recovery.	Practical
3	Milling of sorghum with emphasis on quality and recovery.	Practical
4	Milling of maize with emphasis on quality and recovery.	Practical
5	Milling of pearl millet with emphasis on quality and recovery.	Practical

UNIT – II Pulse ProcessingPulses: Pretreatment of pulses for milling, Methods of pulse milling, milling of major pulses. Methods to improve recovery. Oil seeds Processing: Groundnut, Mustard, Soybean, Sunflower, Safflower, Sesame and other oil bearing materials, By products of oil milling.

(1 Credit)

Practicals(0.4 credits)

Sr No.	Name of practical	Nature
1	Pulses: Milling characteristics and effect of treatments on recovery.	Practical
2	Determination of triglyceride composition of oils	Practical
3	Milling of oilseeds	Practical
4	Pretreatment of pulses for milling	Practical

UNIT – III Soyabean& Extrusion TechnologySpecial Topics: Processing & Utilization of Soya bean for value added products, Innovative products from cereals, pulses and oilseeds. Extrusion technology for cereals.

(1 Credit)

Practicals(0.2 credit)

Sr No.	Name of practical	Nature
1	Preparation of Soy-Milk	Practical
2	Preparation of tofu	Practical
4	Preparation of soy-snacks	Practical
5	Preparation of Soy-Milk based products	Practical
6	Development of Bakery and other products	Practical



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Recommended Text Books:

1. Wheat Chemistry and Technology by Y. Pomeranz

Reference Books:

1. Post Harvest Technology of Cereals by Chakraborty AC

References/Correlation with Ancient Indian Literature:

1. Arthasastra https://sanskritdocuments.org/doc_z_misc_sociology_astrology/artha.html?lang=sa
2. Manusmrti <https://sanskritdocuments.org/sanskrit/samajashastra/>
3. Kasyapasamhita <https://sanskritdocuments.org/sanskrit/vedanta/>

Basic Food Engineering Credits- 3

Objective: Student would learn to Emphasis the various properties of the raw material used in food processing, different processing technologies required in transforming them into quality food products and material handling equipment involved in food processing operations.

UNIT – I Materials Handling Material Handling- Theory, Classification of various material handling equipments- conveyors (gravity & powered conveyors), elevators (bucket & screw type elevators), trucks) high lift & pallet trucks), cranes and hoists. Cleaning- types of contaminants found on raw foods, aims of cleaning, methods of cleaning- dry, wet and combination methods, Dry cleaning methods: screening, aspiration, magnetic cleaning and abrasive cleaning, Wet cleaning methods: soaking, spray washing, floatation washing and ultrasonic washing.

(0.5 Credit)

UNIT – II Sorting & Grading Sorting & Grading- Advantages of sorting & grading, grading factors, methods of sorting and grading, Size Reduction: reasons/ Benefits of size reduction, nature of forces used in size reduction, criteria of size reduction, equipment selection (hardness of feed, mechanical structure of feed, moisture content and temperature sensitivity of feed), mode of operation of size reduction equipment – open circuit and closed circuit grinding, free crushing, choke feeding and wet milling.

(0.5 Credit)

Practical (0.5 Credit)

S. No.	Name of practical	Nature
1	Sieve Analysis of mean particle diameter	Practical
2	Sorting & Grading of foods	Practical
3	Energy Requirement for size reduction using different mills	Practical

UNIT – III Mixing & Conveying Mixing Terminology (agitating, kneading, blending, and homogenizing), Mixing equipments- mixers for blending and homogenizing). Mixing Equipments- mixers for liquids of low or moderate viscosity (Paddle agitators, turbine agitators and propeller agitators), mixers for high viscosity pastes (Pan mixers, horizontal mixer and dough mixer), mixers for dry solids (tumbler mixer & vertical screw mixer), effects of mixing on foods.

(1 Credit)

Practical (0.5 Credit)

S. No.	Name of practical	Nature
1	Mixing indices for mixing solids	Practical
2	Power consumption for mixing of liquids using different impellers	Practical

Recommended Books:



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1. Earle, R. L. (1983) Unit Operations in Food Processing, 2nd edition, Pergamon Press, Oxford, U.K

Reference Books:

1. Introduction to Food Engineering (Food Science and Technology), by R Paul Singh, Dennis R. Heldman, 2013

References/Correlation with Ancient Indian Literature:

- Raghuvamsa, https://sanskritdocuments.org/sanskrit/major_works/
- Kumarasambhava https://sanskritdocuments.org/sanskrit/major_works/
- Malavikagnimitra <https://archive.org/stream/cu31924022967578#page/n9/mode/2up>

Food Storage & Transport Engineering Credits- 2

Objective: The course would help students in acquiring and applying basic knowledge of Food storage and transport technologies. Course will emphasize on the characteristics of fresh produce, important environmental factors affecting produce quality, optimum storage conditions and harvesting.

UNIT – I Food Science & Transport of Foods Food science and the transport of food: Composition of food, Chemical reactions in foods, Physical changes in foods: crystallization phenomena, Microbiology and food transportation. Food Transport: Controlled Atmosphere: The Biology of Controlled Atmospheres, Techniques in Controlled Atmosphere Storage, Modified Atmosphere Packaging. Food Storage, Handling & Transportation: Bulk storage system: Metallic bins, silos.
(0.5 Credit)

UNIT – II Modes of Transport of Foods Transport of food stuffs by sea: Cooling of cargo in transit, Conventional refrigerated ships, Container ships, Need for refrigeration. Air transport of perishables: Cargo space, Unit load, devices: containers and pallets, Transport of fruit and vegetables : Post-harvest behavior of fruit and vegetables, Pre-cooling and the cold chain, Product requirements during transport, Storage temperature management. Product deterioration, Land transport, Shipping, Air freight Insurance.
(1 Credit)

UNIT – III Legislation & Hygiene Hygiene in food transport : Basic hygiene requirements, Shipping container loading, Inspection of incoming carriers, Quality systems in food transportation, Quality and safety in food transportation, History of quality management in food transportation, Standards for quality systems, Benefits of implementing a quality management system, Clauses of ISO9002, HACCP: A food safety management system.
(0.5 Credit)

Recommended Books:

1. IGNOU-2006 Food Processing and Engineering -II, Practical Manual, www.ignou.ac.in.
2. Norman N. Potter, Joseph H. Hotchkiss. Food Science, Springer, 1998

Reference Books:

1. Marcus Karel, Owen R. Fernnema Physical principles Food Science, Part I and II Marcel Dekker Inc

References/Correlation with Ancient Indian Literature:



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- Matsyapurana <https://sanskritdocuments.org/sanskrit/purana/>
- Markandeypurana <https://sanskritdocuments.org/sanskrit/purana/>
- Agnipurana <https://sanskritdocuments.org/sanskrit/purana/>

Food Laws Standards & Regulations Credits- 3

Objective: Students would be able to understand the concept of food safety, types of hazards and their control measures. They would be able to identify and prevent potential sources of food contamination. Understand the need of hygiene and sanitation for ensuring food safety, knowledge of Food Safety Management tools and understand National and International Food Safety Laws and Regulations.

UNIT – I Food Hazards & Contamination and their prevention Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution /chemicals) and physical factors. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of microbiological and chemical hazards. Food safety aspects of novel methods of food processing such as PEF, high pressure processing, thermal and non thermal processing, irradiation of foods.

(1 Credit)

UNIT – II Different Acts of Food Safety Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

(1 Credit)

UNIT – III Quality Marks & Standards Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labeling, Health claims Voluntary Quality Standards and Certification: GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

(1 Credit)

Recommended Text Books:

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, 3. London. Winton AL (1999). Techniques of food analysis, Allied Science Publications New Delhi.

Reference Books:

1. Pomeranze Y (2004). Food analysis - Theory and Practice CBS, Publications, New Delhi.

References/Correlation with Ancient Indian Literature:

- Maitrayaniasamhita <https://sanskritdocuments.org/sanskrit/purana/>
- Rasa-Jala-Nidhi or Ocean of Indian chemistry and alchemy/vol.v IEd.1984/AvaniPrakashan,Ahmedabad,India;CharakSamhita http://www.carakasamhiatonline.com/mediawiki-1.28.2/index.php?title=Main_Page



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- AvS'5/23/5; Medicine in the Veda Ikenneth Zysk <http://www.new.dli.ernet.in/handle/2015/201547>

Modern Baking & Confectionary Technology Credits- 3

Objective: Upon successful completion of the course, the student will be able to identify and explain baking terms, ingredients, equipment and tools and employ safe food handling practices using contemporary guidelines. They would acquire the knowledge of the technologies behind bakery products and understand trends in bakery industry.

Unit-I Traditional Bakery Products Introduction: Status of bakery and confectionery industries in India- Raw materials for bakery and confectionery products-Essential and optional. PFA Specification of raw materials. Bakery products technology: Dough rheology – Bread making- methods process-specification for various types of breads- Biscuit manufacturing process-Cookies- Crackers- Cakes- Buns- Petties preservation of bakery products.

(1 Credit)

Practical (0.4 Credit)

S. No.	Name of practical	Nature
1	Production of bread in pilot plant.	Practical
2	Production of biscuits in pilot plant.	Practical
3	Production of cookies in pilot plant	Practical
4	Production of cake in pilot plant	Practical
5	Production of petties in pilot plant	Practical

Unit – II Bakery Machinery & Equipment Bakery machinery and equipment: Weighing Equipment- Manual scale, Automatic weigh, liquid measuring. Mixing- blenders, Horizontal and vertical planetary, continuous. Make up equipment-Divider, Rounder, Proofer, Moulder. Baking equipment – different oven, slicer.

(1 Credit)

Practical (0.4 Credit)

S. No.	Name of practical	Nature
1	Visit & Study of Bakery pilot plant of the University.	Practical

Unit – III Confectionary products Confectionery products: chocolate, fondant, caramels, fudge and toffee. Equipment and process. Safety and sanitation: Health and safety- safety rules- safe practices in the work places- sanitation duties of the sanitation equipments- Code for hygiene condition in bakery and biscuit manufacturing unit.

(1 Credit)

Practical (0.2 Credit)

S. No.	Name of practical	Nature
1	Production of toffee.	Practical
2	Production of chocolate.	Practical

Recommended text books

1. Textbook of Bakery and Confectionery, by Ashokkumar Y Prentice Hall India Learning Private Limited; 2 edition (2012)



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Reference Books:

1. Theory of Cookery, Oxford University Press, 1st Ed, by Parvinder S. Bali 2017
2. A Professional Text To Bakery And Confectionary, John Kingslee, New Age International, 2006

References/Correlation with Ancient Indian Literature:

1. Atharvaveda <http://www.sacred-texts.com/hin/sbe42/index.htm>
2. Taittiriya samhita <http://www.sacred-texts.com/hin/#other>
3. Vjjasaneyi samhita <http://www.sacred-texts.com/hin/#other>
4. Maitrayaniya samhita <http://www.sacred-texts.com/hin/#other>

IV SEMESTER

Food Process Technology Credits- 4

Objective: Students will understand the basic concepts in food science and will get knowledge of the different food preparation methods. They will understand the requirement of food with respect to energy, food and consumer safety, nutrients and their impact on health. They will get the knowledge of nutritive value of cereals, pulses, nuts, fruits and vegetables, and nutritional factors, germination of pulses, factors affecting cooking.

Unit I Processing of Cereals & Millets (1.0-0.5) Storage of cereals, Infestation control; Drying of grains, Processing of rice and rice products. Milling of wheat and production of wheat products, including flour and semolina. Milling of corn, barley, oat, coarse grains including sorghum, ragi and millets; Processing of tea, coffee and cocoa.
(1 Credit)

Practical (0.5 Credit)

S. No.	Name of practical	Nature
1	Preparation of orange squash.	Practical
2	Preparation of mango jam.	Practical
3	Preparation of guava jelly	Practical
4	Preparation of sponge cake	Practical
5	Preparation of sponge bread.	Practical

Unit II Processing of Fruits and Vegetables (1-0.5) Storage and handling of fresh fruits and vegetables, Preservation of fruits and vegetable by heat treatment. Production and preservation of fruits and vegetable juices, preservation of fruit juice by hurdle technology.
(1 Credit)

Practical (0.5 Credit)

S. No.	Name of practical	Nature
1	Preparation of dry onion, chilli & garlic.	Practical
2	Manufacture of potato powder.	Practical
3	Manufacture of ice cream.	Practical
4	Manufacture of candid fruits.	Practical



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Unit III Food Laws & Quality Control (1-0-0) Non-alcoholic beverages; Food Laws, food rules and standards, Statistical Quality Control ; Various types of packaging.
(1 Credit)

Recommended Books:

1. Fruits and Vegetables. A.K Thompson. Blackwell publishing S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.

Suggested Readings:

- L. Somogyi, Processing Fruits: Science and Technology, Vol I: Biology Principles and Applications, Woodhead Publishing, 1996.

SENSORY EVALUATION Credits- 3

Objective -Students would be able to have an insight of 4 basic tastes and derived tastes in food, basic understanding of flavors, colors and texture in foods and concept of sensory panels and various instruments used in assessing the quality parameters of food.

UNIT – I Packaging and Labelling Packaging and Labelling of the product, Packaging design, graphics and labeling nutritional evaluation (estimation of relevant parameters), Shelf life testing of the product (testing for appropriate quality parameters- chemical, microbiological and nutrient content, acceptability studies).
(1 Credit)

UNIT – II Overview of Sensory evaluation Subjective & Objective evaluation, Overview of sensory principles and practices: General consideration in sensory testing, flowcharts of sensory evaluation. Psychological methods Selection and screening of panel: Types of panel (Trained panel, discriminative and communicative panel).
(1 Credit)

UNIT – III Methodology for sensory evaluation Methodology for sensory evaluation: Discriminative test - difference test: paired comparison, Duo-trio, triangle, ranking, Sensitivity Test, Descriptive test - category scaling, ratio scaling, flavor profile analysis, texture profile analysis, quantitative descriptive analysis
Effective Tests: paired performance test, ranking test, rating scale: hedonic rating, food action scale rating. Maintaining suitable environmental conditions: laboratory setup and equipments.
(1 Credit)

Recommended Text Books:

1. Lyon, D.H.; Francombe, M.A.; Hasdell, T.A.; Lawson, K. (eds) (1992): Guidelines for Sensory Analysis in Food Product Development and Quality Control. Chapman and Hall, London.
2. Amerine, M.A.; Pangborn, R.M.; Roessler, E.B. (1965): Principles of Sensory Evaluation. Academic Press, New York.

Reference Books:

1. Kapsalis, J.G. (1987): Objective Methods in Food Quality Assessment. CRC Press, Florida.



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- Martens, M.; Dalen, G.A.; Russwurm, H. (eds) (1987): Flavour Science and Technology. John Wiley and Sons, Chichester

References/Correlation with Ancient Indian Literature:

- Rasa-Jala-Nidhi or Ocean of Indian chemistry and alchemy/vol.vIEd.1984/AvaniPrakashan,Ahmedabad,India;CharakSamhitahttp://www.carakasamhitaonline.com/mediawiki-1.28.2/index.php?title=Main_Page
- Rigveda1/191/9<http://www.sacred-texts.com/hin/rigveda/index.htm>
- Atharva Veda. X. 3<http://www.sacred-texts.com/hin/sbe42/index.htm>

MODELLING AND SIMULATION OF BIOPROCESSES Credits- 3

Objective: Students will be able to understand about general approach of modeling, modeling fundamentals, chemical kinetics, microbial growth kinetics. Students will also learn about heat transfer, energy balance conversion and selectivity of energy, numerical techniques in modeling, simulation tools and software and modeling of batch, fed-batch and continuous culture reactors.

Unit-I General approach of Modelling Modelling Fundamentals, General Aspects of the Modelling Approach, General Modelling Procedure, Material Balance Equations, Chemical Kinetics, Rate of Chemical Reaction, Reaction Rate Constant, Chemical Equilibrium and Temperature, Microbial Growth Kinetics.

(1 Credit)

Unit-II Mass Transfer Theory Mass Transfer Theory, Heat Transfer, Total Material Balance Equation, Energy Balance Equation, Momentum Balances, Yield, Conversion and Selectivity, Time Constants.

(1 Credit)

Unit-III Parameters Numerical Integration techniques, trapezoidal rule, Parameter estimation, Least square method, Simulation Tools, Simulation Software, Modelling of batch, fed-batch and Continuous Stirred-Tank Reactor.

(1 Credit)

Recommended Text Book:

- Biological reaction engineering: dynamic modelling fundamentals By Irving J. Dunn

References/Correlation with Ancient Indian Literature:

- Vijasaneyisamhita<http://www.sacred-texts.com/hin/#other>
- Vishnu Purana<https://sanskritdocuments.org/sanskrit/purana/>
- Shabdhalpadruma<http://www.sacred-texts.com/hin/#other>

RESEARCH METHODOLOGY Credits- 3

Objective: Students will be able to understand the basic concepts of research methodology including meaning and objectives of research, types of research, various research criteria, research problem, research design, measurement and scaling techniques in research, various scaling techniques in research, methods of data collection in research and report writing of research.

UNIT – I Introduction & Types of research Research methodology: Introduction & meaning of research, Objectives of research, motivation in research. Types of research & research approaches. Research methods vs. methodology, Criteria for good research.



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Research problem: Statement of research problem, Statement of purpose and objectives of research problem, Necessity of defining the problem.

(1 Credit)

UNIT – II Research design Research design: Meaning of research design, Need for research design, Features for good design, Different research designs, Basic principles of research design. Measurement & scaling techniques: Measurement in research- Measurement scales, sources of error in measurement, Technique of developing measurement tools, Meaning of scaling, its classification, important scaling techniques.

(1 Credit)

UNIT – III Methods of data collection Methods of data collection: collection of primary data, collection data through questionnaires & schedules, Difference between questionnaires & schedules. Report Writing.

(1 Credit)

Recommended Text Books:

1. Kothari CR (2004). Research Methodology: Methods and Techniques, New Age International.
2. Bhattacharya DK (2009). Research Methodology, Excel Books.

Reference Text

1. Annals of Food Science & Technology
2. Journal of Nutrition
3. Journal of Food Science & Technology

References/Correlation with Ancient Indian Literature:

- Vjjasaneyisamhita <http://www.sacred-texts.com/hin/#other>
- Vishnu Purana <https://sanskritdocuments.org/sanskrit/purana/>
- 3.Shabdhakalpadruma <http://www.sacred-texts.com/hin/#other>

Food Business Management

Credits- 3

Objective: Students would be able to introduction, theories and functions of Business Management, food industry management; marketing management and human resource development, personal management.

UNIT – I Business Management Business management; introduction, theories and functions, food industry management; marketing management and human resource development, personal management. Sectors in food industry and scale of operations in India. Human Resource Management Study the basics about HR and related policies and capacity mapping approaches for better management. Consumer Behavior towards Food Consumption, Consumer Surveys by various Institutes and Agencies, Various Journals on Consumer Behavior and Market Research, Internet based data search.

(1 Credit)

UNIT – II International trade International trade; basics, classical theory, theory of absolute advantage. theory of comparative, modern theory, free trade- protection, methods of protection, quotas, bounties, exchange control, devaluation, commercial treaties, terms of trade, balance of payments, EXIM policy, foreign exchange, mechanics of foreign exchange, GATT, WTO, role of WTO, International Trade in



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agriculture. World trade agreements related with food business, export trends and prospects of food products in India.

(1 Credit)

UNIT – III World consumption of food World consumption of food; patterns and types of food consumption across the globe. Ethnic food habits of different regions. Govt. institutions related to international ad trade; APEDA, Tea board, spice board, wine board, MOFPI etc. management of export import organization, registration, documentation, export import logistics, case studies. Export and import policies relevant to horticultural sector.

Project: Consumer Survey on one identified product -both qualitative and quantitative analysis (say, Consumer behavior towards Pickles and Chutneys).

(1 Credit)

Recommended Text Books:

1. Principles of Agri Business Management - D. David and S Erickson 1987. Mc Graw Hill Book Co., New Delhi.
2. Agricultural Marketing in India - Acharya S S and Agarwal N L 1987. Oxford & ISH Publishing Co., New Delhi.

Reference Books:

1. Marketing in the International Environment - Cundiff Higler 1993, Prentice Hall of India, New Delhi.
2. GAD implications of Denkel proposals - G S Batra & Narindevkumar (1994) Azmol Publications Pvt., New Delhi.
3. Marketing Management - Phill Kottler. 1994. Prentice Hall of India, New Delhi

References/Correlation with Ancient Indian Literature:

- Atharvaveda <http://www.sacred-texts.com/hin/sbe42/index.htm>
- Vjjasaneyisamhita <http://www.sacred-texts.com/hin/#other>
- Vishnu Purana <https://sanskritdocuments.org/sanskrit/purana/>

FOOD PROJECT PLANNING AND ENTREPRENEURSHIP Credits- 3

Objective: Students would be able to develop an insight of Entrepreneurs and Entrepreneurship development and understand the basics of Business project report and SWOT analysis. Develop insight for different types of Fund raising. Understand the different support system for business development.

UNIT – I Indian Economy Indian Economy and contribution of various sub-sectors in the economy. Structural base of Indian economic Life. Contribution of MSME sectors in the national economy. Impact of globalization and liberalization on MSME sectors. Agricultural sector and food processing industry-problems and opportunity. Self employment need and various mode open in Food Processing and Agri-sector.

(1 Credit)

UNIT – II Fundamentals of marketing principles and marketing Fundamentals of marketing principles and marketing mix, Sales and distribution management, Costing and cost management, pricing methods, fundamentals of operations and supply chain management, organization structure and human resource management , capital structure and methods of raising fund. Opportunity identification and feasibility studies, financial analysis, technical entrepreneurship. Project sizing, fund management and enterprise management issues.

Problem solving, decision making processes and tools, conflict and change management in a new industrial enterprise, Systems approach and consideration in an entrepreneurial venture. Management reporting and



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information system for monitoring and control of the new enterprise, managing Innovation. Marketing challenges and approaches for new products and services. Sustaining in a competitive environment

(1 Credit)

UNIT – III Entrepreneurship Development Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by Individual entrepreneurs. Globalization and the emerging business/entrepreneurial environment. Concept of entrepreneurship: entrepreneurial and managerial characteristics managing an enterprise; motivation and entrepreneurship development; importance of planning, Budgeting monitoring, evaluation and follow up; managing competition. Entrepreneurship Development Programs (EDP). SWOT analysis; Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and Medium Enterprises (SMEs)/ Small Scale industries (SSIs). Export and Import Policies relevant to Food Processing Sector. Venture capital, contract farming and joint ventures. Public-private partnership (PPP). Over view of Food Process Industry. Characteristics of Indian Food Processing Industry. Social Responsibility of Food Processing Business.

(1 Credit)

Recommended Text Books:

1. Entrepreneurship - Thomas W Zimmer and Norman M Scarborough 1996. Prentice Hall, New Jersey, USA.
2. Entrepreneurship Strategies and Resources - Mark J Dollinger 1999. Prentice hall, Upper Saddal River, New Jersey, USA.

Reference Books:

1. Entrepreneurial Development - Khanks SS 1999. S. Chand and company New Delhi.

References/Correlation with Ancient Indian Literature:

- Atharvaveda <http://www.sacred-texts.com/hin/sbe42/index.htm>
- Taittiriya samhita <https://sanskritdocuments.org/sanskrit/purana/>
- Vjjasaneyi samhita <https://sanskritdocuments.org/sanskrit/purana/>

Dairy Engineering Credits- 4

Course Outcome- Students would be able to describe the engineering principles used in dairy processes responsible for evaporation, drying and refrigeration and other related processes. They would be able to evaluate the integration of engineering concepts required for the optimized processing of milk streams.

UNIT I (Market milk) Market Milk- definition, composition. Physio- chemical properties of milk and other dairy products. Milk reception and storage. Processing of milk- pasteurization, sterilization, homogenization, standardization. Fortification of milk and milk products.

(1 Credit)

Practical (0.4 credit)

Sr.	Name of practical	Nature
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no.		
1	Moisture & ash estimation of milk and milk products	Practical
2	Sensory evaluation of milk	Practical
3	Acidity estimation in milk	Practical
4.	Rapid platform tests	Practical

UNIT II (Production & preservation of milk products) Production and preservation of cream butter, ghee, butter oil, condensed & powdered milk, ice-cream. Technology of yogurt, paneer, cheese spread. (1 Credit)

Practical (0.4 credit)

Sr. no.	Name of practical	Nature
1	Preparation of ghee	Practical
2	Preparation of shrikhand	Practical
3	Preparation of fruit yoghurt	Practical
4.	Preparation of cheese product	Practical
5	Preparation of khoya product	Practical

UNIT-III Packaging & distribution of milk & its products Packaging and distribution of milk and milk product. Utilization of milk industry by- products. Milk & milk product standards. Process flow chart for product manufacture, Batch & Continuous drying systems, Freezing and Low Temperature Preservation of Food. (1 Credit)

Practical (0.2 credit)

Sr. no.	Name of practical	Nature
1	Study of packaging material of milk and milk products	Practical
2	Preparation of whey based products	Practical

Recommended text books

1. Dairy Engineering: Advanced Technologies and Their Applications
2. 1st Edition by Murlidhar Meghwal, Megh R. Goyal, Rupesh S. Chavan, Apple Academic Press, 2017

Reference Books:

1. Dairy Science and Technology, 2nd Edition, by P. Walstra, Pieter Walstra, Jan T. M. Wouters, Tom J. Geurtsm, Apple Academic Press, 2005
2. Handbook of Farm, Dairy and Food Machinery by Kutz & Myer, 2007, Springer Netherlands

References/Correlation with Ancient Indian Literature:

- Matsyapurana <https://sanskritdocuments.org/sanskrit/purana/>
- Markandeyapurana <https://sanskritdocuments.org/sanskrit/purana/>
- Agnipurana <https://sanskritdocuments.org/sanskrit/purana/>



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