

**DEPARTMENT OF FOOD SCIENCE AND NUTRITION UNIV. OF  
MYSORE, MANASAGANGOTRI, MYSORE**

**1. M.Sc. Degree in FOOD SCIENCE AND NUTRITION**

**2. M.Sc. Degree in FOOD SCIENCE AND NUTRITION [with specialization in  
CLINICAL NUTRITION & DIETETICS ]**

**Preamble**

Department of Food Science and Nutrition is offering M.Sc. Degree in Food Science and Nutrition since inception with modifications in scheme and syllabus from time to time as needed to keep abreast with latest knowledge in the field. Since the subject has grown tremendously, there is a need to specialize within the subject and train students specifically for the job market. Clinical Nutrition is one such branch of nutrition which is in great demand because of job opportunities in hospitals, clinics, and health clubs. In view of this, it was found necessary to introduce a specialization in the existing course of Food Science and Nutrition in Clinical Nutrition. Students opting for this stream can branch out in the II semester into a second stream offering this specialization. In I semester all courses will be same for both streams. There are some common papers in II and III semesters also. It is also planned to give an internship exclusively for students of clinical nutrition for better and practical training and preparation in IV semester.

The eligibility criteria is revised as students opting for clinical nutrition are required to have a stronger background of nutrition.

**ELIGIBILITY CRITERIA**

1. B.Sc., Cognate subjects: Home Science/any one of the following subjects as one option at B.Sc - Food Science and Nutrition/Human Nutrition and Dietetics/Clinical Nutrition and Dietetics/Food Science & Quality Control and from Medical and Para-medical courses (MBBS, B.Sc - Nursing, B.Sc - Yoga & Naturopathy) are eligible to apply.
2. Candidates from Non-cognate subjects viz., Biochemistry as major are also eligible to apply.
3. Preference at every stage of seat allocation will be given to students who have studied COGNATE subjects. If seats fall vacant applicants from Non-cognate subjects shall be considered.
4. Candidates with cognate subjects are eligible to opt for specialization in CND from II semester onwards in the program, while others will continue with Food Science and Nutrition.

### Choice-Based Credit System Syllabi of M.Sc in Food Science and Nutrition w.e.f 2019-20

No	Paper Code	Title of course	HC/SC/open elective	No. of credits			
				L	T	P	Total
I Semester							
1.		Food Science and Food Processing- I	Hard core [16 credits]	3	0	2	5
2.		Nutritional Biochemistry		2	1	2	5
3.		Human Nutrition		2	1	0	3
4.		Life cycle Nutrition		2	1	0	3
5.		Food Microbiology	Soft core [to choose 4 credits]	2	0	0	2
6.		Public health nutrition		2	0	0	2
7		Assessment of Nutritional status		1	1	0	2
STREAM 1. FOOD SCIENCE AND NUTRITION							
II Semester							
1.*		Food Science and Food Processing- II	Hard core [14 credits]	3	0	2	5
2.*		Vitamins in Nutrition		1	1	2	4
3.*		Minerals in Nutrition		1	1	0	2
4.		Food laws and food safety		2	1	0	3
5*		Nutritional Epidemiology	Soft core [to choose 4 credits]	2	0	0	2
6.*		Nutraceuticals and Functional foods		2	0	0	2
7.		Food additives		1	1	-	2
8		Healthy lifestyle and nutrition	Open elective	4	-	-	4
III Semester							
1.		Food Preservation	Hard core [14 credits]	3	0	2	5
2.		Functional properties of foods		2	2	0	4
3.		Principles of Clinical Nutrition		2	1	0	3
4*		Biostatistics & its applications		1	1	0	2
5.		Food fortification	Soft core [to choose 6 credits]	1	1	0	2
6		Food packaging technology		2	0	0	2
7*		Nutrition transition in India		2	0	0	2
8.		Project work – Part I **		0	4	0	4
9.		Culinary Science- Principles & Techniques	Open elective	2	2	0	4
IV Semester							
1.		Product Development & entrepreneurship	Hard core [8 credits]	2	2	0	4
2.		Advances in Nutritional Sciences		1	1	0	2
3.		Diet in diseases		1	1	0	2
4.		Project work- Part II	Soft core [to choose 6 credits]	0	6	0	6
5.		Nutrition and Physical fitness		2	0	0	2
6.		Storage and handling of fresh produce		1	1	0	2
7.		Food Biotechnology		2	0	0	2
8.		Foods in Indian Tradition	Open elective	2	-	-	2

**Open elective papers are for students of other courses.**

**M.Sc. Program in Food Science and Nutrition [Specialization in Clinical Nutrition & Dietetics]**

No	Pape r	Title of course	HC/SC/open Elective	No. of credits			
				L	T	P	Total
STREAM 2. SPECIALIZATION IN CLINICAL NUTRITION AND DIETETICS							
II Semester							
1.*		Food Science and Food Processing- II	Hard core [14 credits]	3	0	2	5
2.*		Vitamins in nutrition		1	1	0	2
3.*		Minerals in nutrition		1	1	0	2
4.		Human Physiology		2	1	2	5
5.*		Nutritional epidemiology	Soft core [to choose 4 credits]	2	0	0	2
6.*		Nutraceuticals and functional foods		2	0	0	2
7.		Sports nutrition		2	0	0	2
III Semester							
1.		Principles of Diet therapy	Hard core [12 credits]	2	1	-	3
2.		Clinical nutrition & dietetics-I		2	1	2	5
3.		Food service management		1	1	0	2
4*		Biostatistics & its applications		1	1	0	2
5		Nutrition in extreme environments	Soft core [to choose 6 credits]	2	0	0	2
6.		Drug and nutrient interactions		2	0	0	2
7.		Research methods in clinical nutrition		2	0	0	2
8.		Pediatric & Geriatric nutrition		2	0	0	2
IV Semester							
1.		Clinical nutrition & dietetics-II	Hard core [10 credits]	1	1	2	4
2.		Internship ***		0	6	0	6
3.		Nutrition counseling	Soft core [to choose 6 credits]	1	1	0	2
4.		Nutrition in critical care		1	1	0	2
5.		Inborn errors in metabolism		2	0	0	2
6.		Nutrition and health issues of women		2	0	0	2

\* Papers common for both the streams.

\*\* To be assessed as Internal Assessment only. For all others, distribution of IA and Exam marks are 50% each. Total credits needed for M.Sc. 76, [I year: 40, II year 36] Min credit 4 and maximum of 8 credits to be chosen from other courses during II, III, and IV Semesters.

\*\*\*Internship in Hospitals / Foods service institutions + hospital / clinics.

Certificate to be issued by the Department.

**Important Note for Stream 2: Specialization in Clinical Nutrition and Dietetics:**

During the first half of IV semester all the hard core and soft core papers, which are taught in the department will be completed. The second half will be devoted to Internship, for which students need to go outside the department for three/five days a week. Accordingly, C1 and C2 component marks will be submitted at the end of IV semester.

## I SEMESTER

### 1. Hard core:      **FOOD SCIENCE AND FOOD PROCESSING- I \***      **[3+0+2=5 ]**

#### 1. **Processing of foods:**

**A.** Brief history of food processing, Types of processing- Primary, secondary and tertiary. Traditional technologies used in food processing.

**B.** Effects of processing on physical properties (density, specific gravity, viscosity, emulsions), sensory characteristics and nutritive value of foods.

#### 2. **Processing of wheat:** Structure, composition, primary processing, functionality in food system, role of gluten, study of preparation/ manufacture of common unleavened and leavened products like chapathi, bread, cake etc.

#### 3. **A. Rice:** Structure, composition, primary and secondary processing, effect of processing and cooking on nutrient content, processed products.

**B. Millets:** Types, composition, malting, other food uses.

#### 4. **A. Legume:-**Types, composition, milling, germination, cooking & processed products.

**B. Oilseeds:** Use of oilseeds and oilseed meals, soya bean and groundnut— composition, processing and food uses.

**C. Fruits and vegetables:** Composition, pectins, plant acids, types of pigments, Physico-chemical changes during harvesting, post-harvesting, ripening, cooking and Storage.

## PRACTICAL SESSIONS

**Study of preparation variables and quality factors of products from the following food commodities**

1. Wheat
2. Rice and millets
3. Legumes
4. Vegetables

## 2. Hard Core:

## NUTRITIONAL BIOCHEMISTRY \*

[2+1+2=5]

1. **Cell Structure and Function:** Components, cell membrane composition and functions, membrane receptors, mechanism of membrane transport, fundamentals of signal transduction.
2. **Enzymes:** Classification, nomenclature, general properties, mechanisms of enzyme action, regulation of enzyme activity. Role of Coenzymes and cofactors in enzyme activity. Factors affecting enzyme activity Enzyme inhibition, Iso-enzymes, immobilized enzymes, clinical significance of enzyme assays.
3. **Hormones:** Classification, Second messengers, mechanism of action, neuro-endocrine control of metabolism.
4. **Metabolic pathways of macronutrients**
  - a. **Carbohydrates-** classification, physico-chemical properties. Aerobic and anaerobic degradation, Glycogenesis, Glycogenolysis, Gluconeogenesis, HMP shunt pathway. Alcoholic fermentation. Hormonal regulations of blood glucose.
  - b. **Proteins and amino acids** - Classification and structure, physico-chemical properties. Protein degradation, metabolism of aromatic, sulfur containing, BCAA, amino acid pool, fate of nitrogen (urea cycle). Glutamine and alanine cycle, protein biosynthesis.
  - c. **Lipids:** Classification, chemical structure, and properties of fatty acids. Metabolic pathways of triacylglycerol, fatty acids, cholesterol and lipoproteins. Biosynthesis of fatty acids and ketone bodies.
  - d. **Nucleic acids:** Classification, metabolism of nucleic acid components, biosynthesis of nucleotides.
  - e. **Iron and Heme Metabolism:** Iron metabolism, iron containing proteins, intestinal absorption of iron, heme biosynthesis.
5. **Integration and regulation of metabolism:** Interrelationship of carbohydrate, protein and lipid metabolism, role of liver, muscle and adipose tissues.
6. **Bioenergetics:** Principles, Endergonic and exergonic processes, High-energy compounds and their role in energy capture and transfer. Structure of mitochondria, Electron transport chain and oxidative phosphorylation.

## PRACTICAL SESSIONS

### Techniques used in biochemical analysis:

1. **Determination of pH:** in acids, alkalis and buffers using pH meter and indicators.
2. **Colorimeters:** Use of colorimeter in UV and visual range, Flame Photometer, fluorimeter (principle to be explained and demonstrated with one example for each).
3. **Separation techniques:** Chromatography- paper and column. Centrifugation, Electrophoresis and Dialysis. (One example for each may be demonstrated).
4. **Enzyme Assays:** Amylase, protease, lipase or alkaline phosphatase using suitable substrates, Effect of pH, temperature & substrate concentration on any one enzyme activity may be included

**3. Hard Core:****HUMAN NUTRITION \*****[2+1+0=3]**

1. **Basis for computing nutrient requirements**, latest concepts in dietary recommendations, RDA- ICMR and WHO: their uses and limitations.
2. **Body fluids and water balance**: Body water compartments. Regulation of water balance, disorders of water imbalance
3. **Body composition**: Body compartment models, Compositional changes during life cycle, Methods of studying body composition- underwater weighing, air displacement technique, DXA (dual X-ray absorptiometry), anthropometry, bio-electrical impedance. Significance of Body composition analysis.
4. **Energy metabolism**: Basal and resting metabolism- influencing factors. Methods to determine energy requirements & expenditure. Thermo genesis, adaptation to altered energy intake, latest concepts in energy requirements and recommendations for different age groups.
5. **Carbohydrates**: Occurrence and physiological functions, Glycemic index and glycemic load of foods and their uses, intrinsic and extrinsic factors affecting glycemic index. Dietary fiber-types, sources, effect on intestinal physiology and its role in health and disease. Alternate sweeteners – Synthetic and natural. Role of carbohydrates in oral health and Dental caries.
6. **Lipids**: Occurrence, types (visible and invisible fats, EFA, SFA, MUFA, PUFA), sources and physiological functions. Lipoproteins – Types and functions. Role of lipoproteins, cholesterol & triglycerides in health and disease.
7. **Proteins and Amino Acids**: Nutritional classification, Types, sources and physiological functions. Concepts of Biological value of proteins, essential and non-essential amino acids - their role in growth and development. Protein quality (PER, PDCAAS), digestibility, improving protein quality, Nitrogen balance.
8. **Regulation of food intake**: Hunger , Appetite and satiety – neural centers for regulation of food intake

**4. Hard core:****LIFE CYCLE NUTRITION \*****[2+1+0=3]****1. Nutrition during life span-**

- a. **Pregnancy**: Physiological adjustments, Nutritional requirements, Nutritional status of Indian pregnant women. Effect of malnutrition on outcome of pregnancy.
- b. **Lactation**: physiology of lactation, Factors affecting lactation, nutritional requirements. Effect of lactation on maternal malnutrition and fertility.
- c. **Infancy**; Growth and development, nutritional requirement in the first 1000 days (*in*

*utero* and post natal), advantages of breast feeding, compositional differences between human milk and milk substitutes and their suitability for infant feeding. Preterm babies, weaning practices, weaning and supplementary foods. Human milk bank - Benefits (Pre-term babies, NICU), Donor Breast milk – considerations, milk banking process, pasteurization of human breast milk. Human milk banks in India.

- d. Preschool age: Growth and Development, nutrient requirements, factors influencing food intake, special care in feeding preschoolers, nutritional concerns.
- e. School age and adolescent children: Growth and Development- physiologic and psychological changes, nutrient requirements, food choices and health habits, nutritional problems.
- f. Young adults: Nutrient requirements, food choices and health habits, Nutritional status of Indian adult population, c o m m o n nutritional problems.
- g. Elderly: Physiologic changes, Nutrient requirements, Special needs, Nutritional problems.

**Soft Core:**

**FOOD MICROBIOLOGY \***

**[2+0+0=2]**

**1. Microorganisms of importance in food-**

- a. Food and microorganisms- bacteria, yeast, molds, fungi and viruses- general characteristics, classification and identification
- b. Factors affecting the growth of microorganisms in food- intrinsic and extrinsic parameters that affect microbial growth
- c. Microorganisms and their importance in food microbiology (fermentation, health foods and enzymes)

**2. Contamination and spoilage of foods- sources of contamination, principles underlying spoilage- chemical changes caused by microorganisms in :**

- a. Cereals, pulses and their products
- b. Vegetables and fruits
- c. Flesh foods, eggs and poultry
- d. Milk and milk products

**3. Methods for the Microbiological examination and Microbial Quality of foods**

- a. Identification of microorganisms
- b. Culture and enumeration techniques
- c. Rapid methods and detecting spoilage specific microorganisms
- d. Quality control using microbiological criteria
- e. Codes of GMP, HACCP concept and quality system

#### **4. Food hazards of microbial origin**

- a. Food Borne Diseases-Types, Food Borne Intoxications-Staphylococcal poisoning, Bacillus cereus poisoning, Botulism.
- b. Food Borne Infections- Salmonellosis, Shigellosis, Vibrio gastroenteritis, E.Coli, Hepatitis A and Shellfish poisoning, Food Borne Toxic infections-Clostridium perfringens, E.coli gastroenteritis, Cholera, Listeriosis, Yersinia, Campylobacter, Mycotoxins- Aflatoxicosis, Ergotism
- c. Naturally occurring toxicants-Lathyrism, epidemic dropsy and veno occlusive disease

#### **SOFT CORE:**

#### **PUBLIC HEALTH NUTRITION**

**[2+0+0=2]**

1. Concept of public health nutrition- relationship between health and nutrition, role of public health nutritionists in the health care delivery.
2. Food and nutrition security- food production, distribution, access, availability and consumption. Socio cultural aspects and dietary patterns: their implication for nutrition and health.
3. Health care facility- primary health care of the community, health care delivery system.
4. Determinants of nutrition and health status- socio cultural, biologic, environmental and economic factor, indicators of health and malnutrition.
5. Link between nutrition and demographic changes, Health and nutrition transitions, Economical and public health implications of micro nutrient deficiencies, impact on productivity and national development.
6. Approaches and strategies for improving nutritional status and health:
  - a) National nutrition policy: need for nutrition policy, policy strategies and their implementation
  - b) Nutrition programs: National anemia prophylaxis program, Prevention of night blindness, Vitamin A prophylaxis program, National iodine prophylaxis program, Goiter control program ICDS
  - c) National nutrition surveillance system (NNMB). Food for work etc.
  - d) NGO in community development operations
7. **Nutrition Education-** Importance of Nutrition Education In Public health Nutrition.



**Soft Core:**

**ASSESSMENT OF NUTRITIONAL STATUS \***

**[1+1+0=2]**

1. **Indirect methods** - Demography, population dynamics and vital events and their health implications, indicators of health and nutrition (IMR, TMR, MMR).
2. **Direct methods** - Anthropometry, Biochemical, Clinical, Dietary and Functional indices of assessments
  - a) **Anthropometry** – methods, reference standards in children and adults, scales of comparison (percentiles, Z score), classification and interpretation of somatic data, somatic indicators of PEM
  - b) **Biochemical** - use of specimen types, indicators of protein-energy status, anemia, immune function, CVD risk, oxidative stress. Urine and stool analyses.
  - c) **Dietary**- methods, nutrient intake analysis, dietary assessment in special populations and specific situations, Dietary reference intakes
  - d) **Clinical**- components of clinical assessment, associations with nutrient deficiencies and biochemical status
3. **Assessing food and nutrition security** – Definition and assessment schedules, National and household food security. Factors affecting food security system. National and International systems to improve food security

## II SEMESTER

### 1. Hard Core:      **FOOD SCIENCE AND FOOD PROCESSING- II \***      **[3+0+2=5]**

1. **Fats and oils:** Properties, manufacture, uses in food systems (as cooking media and shortening). Changes while cooking, Rancidity- types, mechanism and prevention. Use of fat replacers/ substitutes in processed foods.
2. **A. Milk and milk products :** Composition, functionality in food system, processing of different products like ghee, butter, milk powders, khoa, paneer, cheese, milk products and ice-cream.  
**B. Eggs:** Structure and composition, changes on cooking, functional properties and products, Quality grading.
3. **A. Flesh foods:** Types, composition, structure of muscle, conversion of muscle to meat (rigor mortis, ageing, tenderizing), physico -chemical changes, cooking and processing.  
**B. Marine foods:** Types, composition, cooking and processing, spoilage.
4. **A. Sugar and jaggery:** Principles of sugar crystallization, stages of cookery and role in Indian traditional sweet preparations, manufacturing of candies and sweets  
**B. Manufacturing process (in brief) of coffee, tea, cocoa, alcoholic beverages (fruit wines).** Ready to serve beverages

### PRACTICAL SESSIONS

**Study of preparation variables and quality factors of products from the following food commodities**

1. **Fats and oils**
  - a. Determination of smoking point
  - b. Determination of ideal temperature for frying
  - c. Determining frying quality of different oils
  - d. Analysis of fresh and used oils
  - e. Measuring oil uptake in deep fried foods
2. **Milk and egg**
  - a. preparation of chana and khoa
  - b. preparation of cream of tomato soup, followed by variations
  - c. studying the taste profile and consistency of vermicelli payasam prepared with various ingredients
  - d. studying the textural characteristics of curds using different milk sources
3. **Flesh foods**
  - e. Determining the storage stability of eggs stored at – room temperature, refrigerated temperature and fresh eggs
  - f. Factors affecting ferrous sulphide formation in boiled eggs
  - g. Preparation of products to determine the functionality of egg in cookery
  - h. Study of foaming properties and factors affecting it.

#### 4. Sugar and jaggery

- Demonstrate stages of sugar and jaggery cookery
- Determine the effect of adding other ingredients on the stages of sugar and jaggery cookery
- Preparation of fondants
- Preparation of sugar and jaggery based Indian sweets

#### 5. Flesh foods

Demonstrate the different methods of cooking (frying, boiling, grilling and baking) on the quality of chicken, fish and meat

### 2. Hard Core:

### VITAMINS IN NUTRITION \*

[1+1+2=4]

1. **Introduction-** History, Definition of terms- requirements, RNI, UTNI, protective nutrient intake, food based approaches to meet the need for vitamins, physico-chemical properties, general functions, analytical methods and compositional data sources, ADME concept, bioavailability, factors affecting variations/losses of vitamins in food.
2. **Classification-** Fat soluble vitamins and Water soluble vitamins
  - i. **Water soluble vitamins**

Vitamin C, thiamin, riboflavin, niacin, pantothenic acid, biotin, folic acid.(Physicochemical properties, stability, biochemical indicators, factors affecting requirements).
  - ii. **Fat soluble vitamins**

Vitamin A- stability and modes of degradation, role in visual cycle, functions of carotenoids

Vitamin D- Formation in the skin, photochemical regulation and factors affecting synthesis of vitamin D3 in human body, supplements.

Vitamin E – Vitamin E as a part of endogenous antioxidant system

Vitamin K – Role in blood clotting process, anti-platelet aggregation, anti-clotting drugs (vitamin K- agonists and antagonists)

**Note:** All nutrients to be dealt in the following sub headings apart from the topics mentioned above with respect to each vitamin.

History, forms of vitamins, tissue distribution, physiological functions, metabolism (ADME), units of expression, assessment of vitamin status and interpretation of values, RDA, deficiency and toxicity, dietary sources, factors affecting bioavailability, deficiency and toxicity, interactions with nutrients and drugs.

### PRACTICAL - FOOD ANALYSIS

- A) Determination of moisture, Ash - total, acid soluble and insoluble.
- B) Determination of Protein in foods.
- C) Determination of Fat – Crude fat.
- D) Carbohydrates – Free sugars, Starch (Total & available), Dietary fiber.
- E) Mineral estimation – Dry and wet ashing, calcium, iron, phosphorous.
- F) Vitamin estimation – Ascorbic acid, thiamine, riboflavin and  $\beta$  carotene.

### 3. Hard Core:

### MINERALS IN NUTRITION \*

[1+1+0=2]

**1. Introduction** – Characteristics of minerals, bioavailability, mineral-mineral interaction, mineral composition of the body, food based approaches to meet the demand, physic- chemical properties, general functions, analytical methods and source of data, ADME concept, factors affecting variations/ losses in food, distribution in fluid compartments

**2. Classification** – Macro minerals and micro minerals.

**i. Macro minerals – Calcium, Phosphorus, Magnesium, Sodium, Potassium, Sulphur and Chloride**

**Calcium**- determinants of calcium balance, disorders associated with calcium deficiency and toxicity, nutritional factors affecting calcium requirement, osteoporosis- factors determining peak bone mass and loss of bone.

**Magnesium** – role in blood pressure control

**Sodium** – sodium balance, sodium intakes among Indians, role in blood pressure control

**Potassium** –potassium balance, role in acid-base balance, disorders associated with acid base imbalance, role in blood pressure control

**ii. Micro minerals – Iron, Zinc, copper, manganese, iodine, selenium, chromium, fluoride and molybdenum**

**Iron** –iron requirements – basal losses, growth, and menstrual losses. Dietary iron absorption (haem and non- haem), factors influencing non- haem iron absorption, deficiency- causes, symptoms, prevalence and prevention, iron overload

**Zinc** –maternal zinc deficiency, RNA/ DNA synthesis, reproductive health, toxicity.

**Copper** – Wilson's disease

**Selenium** – Immune function, role in antioxidant defense system, selenium and thyroid function

**Chromium** – role in glucose utilization and insulin action

**Iodine** - Iodine deficiency disorders

**Fluoride** – Fluoridation of water, Fluoride belt and fluorosis

**iii. Ultra trace minerals** – significance in Human nutrition

**Note:** All nutrients to be dealt in the following sub headings apart from the topics mentioned above with respect to each mineral.

Occurrence and distribution, physical properties, tissue distribution and physiological functions, metabolism (ADME) and body homeostasis, dietary sources, factors promoting and impairing absorption bioavailability, interactions with other nutrients, assessment of requirement and intake, assessment of status- biological indicators, risk factors, causes, symptoms and prevention of deficiency/toxicity

**4. Hard Core:                      FOOD LAWS AND FOOD SAFETY                      [2+1+0=3]**

1. Concept and meaning of Food quality and Food Safety, Total Quality Management, Food quality Factors -appearance, texture flavor, Food adulteration, food related hazards- biological, chemical, physical and trace elements. Microbial considerations in food safety.
2. Natural toxins in food- An overview, Regulatory concerns.
3. Food laws and regulations – concepts and trends in Food Legislation. International and Federal standards – WHO, FAO, Codex, ISO series. Food laws in India, Governing bodies- Bureau of India standards (BIS), HACCP, Food Safety and Standards Act, 2006 (FSSAI), Food policies, Food certification, Nutritional labeling
4. Exposure, estimation, toxicological requirements and risk assessment.
5. Safety aspects of water and beverages such as soft drinks, tea, coffee, cocoa.
6. Safety assessment of food contaminants and pesticide residues.
7. Safety evaluation of processed foods (RTC, RTE, RTD, ETR) and related processing techniques

**Soft core:                                      NUTRITIONAL EPIDEMIOLOGY                                      [2+0+0=2]**

1. **Epidemiology**- Historical aspects, Definition, Aims and uses, Principles and application of epidemiology. Measurement of morbidity and mortality, incidence, prevalence, age-adjustment and survival analysis, life expectancy, years of potential life lost, disability-adjusted life years (DALYs). Health-adjusted life expectancy (HALE), use of morbidity and mortality statistics.
2. **Nutrition epidemiology**- Definition, Determinants of disease, Link between eating behavior and chronic diseases. Importance of nutritional epidemiology in developing countries Diet-assessment methods used in epidemiologic research- Observation, diet history, 24 hour recall, Food frequency questionnaire, physical activity. Processing and analysis of dietary data.
3. **Field based study designs** – Observational studies, Cross-sectional, case-controlled, cohort studies. Methods of sampling, sample size.
4. **Classic Nutritional epidemiology studies**- Study design and methodology of selected studies - NNMB, National Family Health survey (NHFS), Framingham heart study, Dietary Approaches to stop Hypertension (DASH), Chennai urban rural epidemiological studies (CURES II).

**Soft Core: NEUTRACEUTICALS AND FUNCTIONAL FOODS \***

**[2+0+0=2]**

**1. Nutraceuticals:**

- a) Use of nutraceuticals in traditional health sciences. Their role in prevention and control of diseases.
- b) Definition, Classification, food and non food sources, mechanism of action. Role Of omega-3, fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinates; organosulphur compounds as nutraceuticals.

**2. Prebiotics, probiotics and synbiotics:** definition, characteristics, types, sources, their effects on gut microbes. Role in health promotion and in chronic diseases. Production, application in health foods and safety issues.

**3. Functional foods** Definition, development of functional foods, benefits and sources of functional foods in Indian diet. Effects of processing conditions and storage; Development of biomarkers to indicate efficacy of functional ingredients; Research frontiers in functional foods.

**4. Development of nutraceutical and functional foods** – Standards for health claims. Process of developing, preclinical & clinical studies, Marketing and Regulatory issues, Regulatory bodies in India.

**Soft Core:**

**FOOD ADDITIVES**

**[1+1+0=2]**

- 1. Food additives- Definition, history, classification, role of additives in processed foods, e-numbers, role of codex commission, safety evaluation of food additives, setting ADI for food additives.
- 2. Chemical, technological and toxicological aspects of acid, base buffer systems, salts and chelating/sequestering agents, leavening agents, antioxidants, emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents, flour bleaching agents and bread improvers.
- 3. a. Sweetening agents- History, properties and food applications of various artificial sweeteners, ADI, food applications, advantages and disadvantages, safety evaluation.  
b. Natural and synthetic colors- history, need for food coloring, classification, basic properties, benefits of natural colors, types, health hazards associated with synthetic food colors, permissible levels, safety evaluation, food applications.
- 4. Food flavors- classification spices and flavoring constituents, methods of extracting flavoring compounds, factors affecting flavor perception, application of flavor in food industries.
- 5. Sweetening agents: Artificial sweeteners, composition, uses.

**OPEN ELECTIVE FOR OTHER STUDENTS**  
**HEALTHY LIFESTYLES AND NUTRITION**

**[4+0+0=4]**

- 1. Factors affecting food habits, choices and dietary patterns** – Definition of Food, Nutrition, Health, Fitness. Interrelationship between nutrition and health, concept of a desirable diet for optimum nutrition, health and fitness.
- 2. A brief review of nutrients in general**
  - a. Energy and macronutrients – Carbohydrates, Protein, Fat - functions, sources deficiency disorders and recommended intakes.
  - b. Micronutrients: Minerals – calcium, Iron, Iodine, and other elements. Vitamins – A, D, E, K, B-complex, Vitamin C.
- 3. Basic principles of planning diet** – Nutritional assessment, RDA for Indians, Food groups, Dietary guides and balanced diets.
- 4. Basics of Body composition and changes during life span.**
- 5. Nutrition and physical fitness:**

Exercise and Fitness- Definition, benefits, components and indicators of fitness.  
Nutritional requirements of exercise – fluids, vitamins and minerals, energy, Macronutrient needs and distribution, body adaptation.  
Approaches to the management of fitness and health in weight management.
- 6. Alternative systems for health and fitness** – Ayurveda, yoga and meditation and other methods.

### III SEMESTER

#### 1.Hard Core:

#### FOOD PRESERVATION

[3+0+2=5]

1. **A. Classification of food in relation to shelf life**-Spoilage in food and its control: spoilage caused by microorganism (bacteria, fungi and virus), enzymes, pests and rodents.  
**B. Food dehydration and concentration:** methods of drying and concentration, types of dryers, factors affecting drying process.
2. **Heat processing** : Mechanism of action, methods of application to foods (Equipments), effect on food and micro-organisms
  - a. sterilization,
  - b. pasteurization,
  - c. blanching,
  - d. canning.
3. **Cold preservation** ; Mechanism of action, methods of application to foods (Equipments), effect on food and micro-organisms
  - a. refrigeration,
  - b. freezing,
  - c. freeze drying,
  - d. refrigerated gas storage.
4. **A. Food irradiation:** technology, application and safety assessments, effects on food and microorganisms  
**B. Chemicals in food preservation, safety of preserved foods.**

#### PRACTICAL SESSIONS

Food preservation techniques (use of different techniques in product formulation and analysis of product for quality standards).

1. Sun drying and dehydration-cereals, legumes, vegetable based.
2. Preservation with sugar-jams, jelly, preserves, etc.
3. Preservation - salt, oil, vinegar-pickling.
4. Preservation of foods using chemicals –tomato ketchup, squash.

#### 2.Hard Core:

#### FUNCTIONAL PROPERTIES OF FOODS

[2+2+0=4]

1. **Physico-chemical properties of foods**- Organic food components, colloids, osmotic pressure, food dispersions (sols, gels, emulsion, foam), Hydrogen ion concentration
2. **Role of water in foods**-
  - a. Functions of water in food system, free and bound water, importance of water activity in food quality, sorption characteristics of foods, factors influencing moisture uptake



b. Intermediate moisture foods- definition, steps in manufacturing, additives used, manufacturing of IMF based on – fruits, vegetables, meat and fish.

**3. Functional properties of proteins-**

a. General functional properties, need for modification, techniques of modification, effect of modification on functional properties.

b. Food applications of modified proteins- Textured vegetable proteins and meat analogues- characteristics, manufacturing process and their application in food sector.

**4. A. Carbohydrates:** Starch, cellulose, hemicelluloses, hydrocolloids and gums: occurrence, functions in food systems, properties, gelatinization, retrogradation and modified starches.

**B. Browning in foods :** Enzymatic and non enzymatic- mechanism, method of prevention, relationship to health.

**PRACTICAL TUTORIAL SESSIONS**

1. Water activity – water sorption isotherms of different foods.
2. Functional properties of proteins – Water and fat absorption, emulsion and foaming properties, protein gels, (application in food products)
3. Starch Gelatinization and retrogradation – factors affecting and measurement of viscosity of starch gels, use of hydrocolloids/gums.
4. Browning reactions in foods.

**3.Hard Core:**

**PRINCIPLES OF CLINICAL NUTRITION**

**[2+1+0=3]**

**1. Introduction to Clinical Nutrition and Dietetics-** Definition and history of dietetics. Concepts of a desirable diet for optimum health. Interrelationship between food, nutrition and health. Factors affecting food choices, Physiologic factors regulating food intake- role of neurotransmitters and nutrients in hunger and satiety.

**2. Role and responsibilities of dieticians** - specific functions, team approach in patient care, psychological consideration, interpersonal relationship with patients. Nutrition and medical ethics. Hospital dietary- scope and importance, types of food service, quality management.

**3. Nutrition screening and assessment in clinical settings :** Nutrition screening and assessment methods ( MNA, SGA, PG-SGA, MUST, disease specific tools ). Nutrition care process- Assessment, Diagnosis, Interpretation, Monitoring, and Evaluation (ADIME). Usage of International Dietetic terminologies.

#### **4. Principles and Objectives of Medical nutrition therapy-**

- a) Characteristics of a Regular diet, rationale for modifications in terms of energy and other nutrients, texture, consistency. Translation of diet orders into menu: defining nutrient needs, desirable dietary pattern, menu plan, use of exchange list, types of menu. Monitoring food intake.
- b) Enteral and Parenteral feeding: indications, types (commercial and kitchen-based feeds), methods of administration, monitoring and associated complications.

#### **5. Dietary principles and management of special conditions-**

- a) Protein and energy malnutrition (hospital and domiciliary treatment)
- b) Febrile diseases-classification of fevers, metabolism, general dietary considerations, diet in acute and chronic fevers (typhoid and tuberculosis)
- c) Surgical conditions, Burns and organ transplants

**6. Nutrition in adverse reactions to food:** pathogenesis, food allergens, symptoms, tests for diagnosis, food allergies - pollen food allergy syndrome, latex –fruit syndrome, food dependant, exercise- induced anaphylaxis, food induced anaphylaxis , food –protein induced enterocolitis syndrome, cow’s milk protein allergy (CMPA). Food intolerances- lactose , fructose intolerance. Management - restricted diets, elimination diets and hypo- sensitization.

#### **4. Hard core: BIO-STATISTICS AND ITS APPLICATIONS**

**[1+1+0=2]**

1. Introduction to Statistics - Conceptual understanding of statistical measures, Sampling Design and Different types of sampling techniques – Probability sampling and Non-probability sampling, Classification and Tabulation of data.
2. Measurement of Central tendency, Measures of Variation, Graphical methods of data presentation.
3. Binomial distribution; nature and properties of Normal distribution; Meaning of parametric and nonparametric tests.
4. Hypothesis testing: Z test; Unpaired and Paired t test; Chi-square test.
5. Analysis of Variance: One way ANOVA; Post Hoc tests; Factorial, ANOVA; ANCOVA; Introduction to Multivariate analysis: MANOVA, MANCOVA, Factor Analysis, Discriminant analysis.
6. Correlation and Regression: Meaning; Regression; Methods of Correlation – Biserial, Point biserial, Tetrachoric, Phi coefficient, Kendal’s Tau.
7. Use of Computers in Statistical Analysis – The computer system and technology, Important characteristics of computer applications in research using SPSS Package, usage of statistical calculators available in web.
8. Practical Exercises under Tutorials - Introduction to Computer application in Statistics – Data entry, spread sheets – data analysis and statistical interpretation using statistical software like SPSS and MINITAB – reporting.

**1. Food fortification**

- a. Needs, objectives, principles and rationale, selection and basis of fortificants, selection and use of specific food vehicles, ongoing programs, food laws for fortification, types of fortification.
- b. Characteristics of nutrients used in fortification of food- types and levels of nutrients added (vitamin A, vitamin D, iodine, zinc, B-vitamins, calcium, selenium, fluorine and other nutrients)

**2. Technology of fortifying cereal products.**

- i. Characteristics of nutrients used in cereal fortification, Types and levels micronutrients to be added.
- ii. Fortification methods – commercial and industrial fortification (Encapsulation, spray drying, freeze drying and nanotechnology - in brief), Bio- fortification, domestic fortification.
- iii. Fortification premixes , Design and composition of premixes and quality control Fortification of bread, pasta, noodles, biscuits, and breakfast cereals.

**3. Technology of fortifying beverages, candies, snack products**

- a) Technology of fortifying beverages - Importance of beverage fortification, Health benefits of fortification, Bioavailability, Organic Vs inorganic salts.
- b) Technology of fortifying candies - Product formulation, Nutrient bioavailability, Packaging, storage, shelf life and cost.
- c) Snack products - Rationale for micronutrient fortification of snack products, Choice of products and selection of micronutrients, Challenges in fortifying snack products, Nutrient interaction and bioavailability.

**4. Other special fortified products** - salt, sugar, oil, Nutri-bars, Granola bars, health foods-technology, stability of nutrients, challenges in fortification, safety issues, packaging and cost.

**Soft Core:****FOOD PACKAGING TECHNOLOGY****[2+0+0=2]**

1. **Food packaging** - Need and role in extending shelf life of foods. Design and testing of package materials, package performance. Principles in the development of safe and protective packing, safety assessment of food packaging materials.
2. **Food packaging systems, product characteristics and package requirements:** Different forms of packaging such as rigid, semi-rigid, flexible forms and different packaging system for:  
(a) dehydrated foods (b) frozen foods (c) dairy products (d) fresh fruits and vegetables (e) meat, poultry and sea foods.
3. **Types of packaging materials** (metals, glass, paper and plastics), their characteristics and uses. Paper: pulping, fibrillation and beating, types of papers and their testing methods.  
Glass: composition, properties, types of closures, methods of bottle making;  
Metals: Tinplate containers, tinning process, components of tinplate, tin free steel (TFS), types of cans, aluminum containers, lacquers;  
Plastics: types of plastic films, laminated plastic materials, co-extrusion.
4. **A. Package accessories and advances in packaging technology** (active packaging, modified atmosphere packaging, aseptic packaging, and packages for microwave ovens, biodegradable plastics, edible gums and coatings).  
**B. Packaging equipment and machinery:** Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; retort pouches, bottling machines; carton making machines, package printing.

**Soft core****NUTRITION TRANSITION IN INDIA****[2+0+0=2]**

1. **Transitions in India-** Socio-economic, Demographic, Health and Nutrition transitions. Demographic transitions in major Indian states, impact of urbanization , link between fetal malnutrition to emergence of chronic disease .
2. **Nutrition Transition-** definition, causative factors, dietary profiles (urban-rural differences), Double burden of Malnutrition, Dietary and lifestyle changes- changing trends in consumer prefer
3. **Nutrition related non-communicable diseases-** Prevalence and Risk factors for NCD's - Diabetes, Hypertension, Cancer, Osteoporosis, Cardiovascular diseases, Obesity, Childhood obesity. Urban - rural differences in NCD risk. Prevention of NCDs - National and International initiatives.
4. **Classic studies on Nutrition transitions in India-** Objectives and study design-
  - a. Chennai Urban Rural Epidemiologic Study (CURES)
  - b. Prospective Urban Rural Epidemiology (PURE)
  - c. Jaipur Heart watch study (JHW)

The candidate will select a topic under the guidance of a faculty, develops a research plan in Food science, Community nutrition, Clinical or Experimental nutrition. The formative research plan comprising of topic selected, related review of literature, objectives and study design shall be presented for approval. At the end of the semester, this proposal shall be submitted for evaluation.

Note: It is mandatory that students opting for this soft core in III semester will continue with the Part II in IV semester. Allotment of candidates is subject to availability of faculty.

### **OPEN ELECTIVE PAPER FOR OTHER STUDENTS**

#### **CULINARY SCIENCE- PRINCIPLES AND TECHNIQUES [2+2+0=4]**

- 1.Introduction to cookery**, Culinary history, aims and objectives of cooking
- 2. Food ingredients and their nutritional value** – Bulk/staple foods, (cereals, legumes, fruits and vegetables, eggs, fish and marine foods, milk and milk products) fats and oils, spices, flavoring agents, additives, beverages.
- 3. Methods of cooking** – Pre-processing of foods, cooking, roasting, frying, grilling, baking, boiling, microwaving, solar, infra-red cooking.
- 4. Principles of cooking and role of food components** – using specific examples for different types of foods such as Cereal and legume based dishes. Preparation of gravies and curries, Spices and flavoring ingredients, Baked products, Egg cookery, meat and fish Indian sweets and snacks ,Preserved products.

#### **PRACTICAL TUTORIAL SESSIONS**

##### **Demonstration and preparation of common recipes**

1. Cereal based products  
Wheat products – Chapathi, poori, upma. Rice dishes and fermented foods
2. Food Accompaniments  
Cooking of legumes, dhals, and vegetables Preparation of gravies and curries.
3. Appetizers, sweets and snacks Soups and puddings, Indian sweets and snacks Baked products
4. Animal foods and preserved products, Egg cookery, Cooking of meat and fish Preparation of preserved products.

## IV SEMESTER

### 1. Hard Core: **PRODUCT DEVELOPMENT AND ENTRPREUNERSHIP** [2+2+0=4]

#### 1. Sensory evaluation of foods

- a. Importance, need and application for product formulation
- b. Basic tastes, threshold tests for basic tastes,
- c. Sensory panel, type, selection and training,
- d. Types of sensory tests- Subjective and objective sensory evaluation,
- e. Instrumental tests for sensory attributes – color, texture and odor.

#### 2. Product Development

- a. Designing new product – types and drawing forces
- b. Need for product development
- c. Stages of product development
- d. Consumer research
- e. Role of sensory evaluation in consumer product acceptance

#### 3. Entrepreneurship - Starting and managing an enterprise - Steps in preparing a business plan, Components of management, Developing managerial skills, Managing a food industry. Qualities of an entrepreneur

#### 4. Consumer Behavior & Marketing: Factors influencing food purchases, product acceptance, purchasing trends. Changing food trends.

#### 5. Special food processing technologies and novel food ingredients – Membrane technology (reverse osmosis and ultra filtration), agglomeration, agitation, air classification, extrusion, automation in food industries.

### PRACTICAL TUTORIAL SESSIONS

1. Sensory analysis: Different types of sensory tests for basic tastes and sensory attributes of products.
2. Project on different sensory techniques and responses utilizing prepared food products, analysis and presentation of sensory data.
3. Stepwise development of a new food product, standardization, acceptability studies and submission of project report.
4. Survey on types of convenience foods / consumer behavior / analysis of food labeling.

- 1. Preclinical and clinical research methods in Nutrition** – Preclinical research (*in vitro*, *ex vivo* and animal studies). Clinical - Cross sectional Longitudinal, Retrospective, Prospective, cohort studies etc.
- 2. Nutrition and brain development** – critical periods of brain and cognitive development, maternal status and brain development, role of macronutrients in general and specific nutrients – Long chain PUFA, omega 3 fatty acids, antioxidants, nutrient interactions, nutrient supplementation.
- 3. Nutrition and work performance** – Relationship between nutrition, physical fitness and work capacity. (Anaerobic and aerobic capacity) Energy expenditure and Nutrient demands
- 4. Nutrition for Space, Mines, Underwater** – Introduction - Environmental challenges - Changes in body composition – Changes in nutritional intake – Nutritional requirements – Special diets – Designer foods
- 5. Nutrition and Infection** – Introduction – patho-physiology of immune response to infection - nutritional modulation of immune function – malnutrition and immunocompetence - nutrients of importance – metabolic consequences of infection – altered nutritional requirements – nutrient recommendations – Immuno-nutrition for the critically ill
- 6. Recent concepts in Human Nutrition:–**
  - i. Nutrigenomics- Definition (nutrigenomics, metabolomics, proteomics, pharmacogenomics and transcriptomics), nutrient-gene interactions, nutrigenomics and non-communicable diseases, impact of nutrigenomics – nutrition research, nutrition therapy, food industry and nutrition policy
  - ii. Fetal origins of adult disease – nutritional basis and genetic link – intrauterine nutrition- birth weight, maternal nutrition, Barker's hypothesis.

### 3. Hard Core:

#### DIET IN DISEASES

[1+1+0=2]

1. **Overweight & Obesity**- classification, causative factors (behavioral risk factors), overview of approaches to treatments and interventions.
2. **Cardiovascular disease** --etiology, incidence, symptoms, long-term and short-term treatment in coronary disease (myocardial & cerebral infarction), congestive heart failure and hypertension.
3. **Diabetes**- Etiology, symptoms, classification, Metabolism, nutrition therapy (OHA and Insulin), prevention, monitoring criteria. Short term and long term complications and management.
4. **Diseases of Liver, Gall bladder & Pancreas**-Hepatitis, (A, B, and C), Cirrhosis, alcoholic liver disease, Gall stones, pancreatitis, pancreatic surgery- Causes, Prevention and dietary management.
5. **Renal disease** - Nephrotic syndrome, Acute and Chronic renal failure- diagnostic procedures and principles of dietary management. Dialysis, medical nutrition therapy.
6. **Gastrointestinal diseases/disorders** –Gastro-oesophageal reflux and esophagitis, Gastritis and Peptic ulcer. Characteristics of and comparison of the stomach and duodenal ulcers. Diagnostic tests for mal-absorption, sprue and tropical sprue, diarrhoea, constipation, diverticular disease, IBD and IBS.
7. **Cancer, HIV/AIDS**: Diagnosis, role of dietary factors in cancer incidence, metabolic effects of cancer, Nutritional implications of cancer therapy, Nutritional management. Stages of HIV infection, Medical and nutritional therapy, Nutrition impact symptoms – diarrhea, mal-absorption, disorders of oral cavity.
8. **Case studies** – Select any two conditions and collect patient's details and feeding care offered in hospital.

### Soft Core:

#### PROJECT WORK- Part II

[0+6+0 =6]

The work planned in III semester will be undertaken by student under the guidance of an advisor. The research should be submitted at the end of semester in the form of a thesis. The project work can be undertaken at University departments, affiliated research institutions, quality control laboratories, food industries or other institutions with prior approval.



**Soft core****NUTRITION AND PHYSICAL FITNESS****[2+0+0=2]**

Definition and benefits of fitness, components of fitness, cardio respiratory fitness, Factors influencing health and wellbeing.

1. Overview of factors influencing-
  - a. Food intake : Food habits, food fads and fallacies, their influence on health and wellbeing
  - b. Health issues in athletes - sports anemia, bone density, micronutrient deficiencies
2. Approaches to the management of fitness and health.
  - a. Diet and exercise - Effect of specific nutrients on work performance and physical fitness.
  - b. Fuel and other nutrients that support physical activity (metabolic pathways) Mobilization of fuel stores during exercise. Importance of carbohydrate loading.
  - c. Fluid and electrolyte balance- fluid requirements, losses, heat stroke, fluid/electrolyte replacement
3. Ergogenic aids - dietary supplements, use of permissible supplements, Sports drinks, beverage choices. Regulatory aspects ( FSSAI)

**Soft core:****STORAGE AND HANDLING OF FRESH PRODUCE****[1+1+0=2]****1.Storage and handling of food grains.**

- a. Food grains and their characteristics, Commercial importance of grains, and standards for food grains.
- b. Marketing and handling of grains, cleaning, grading, weighment, conveying equipment, and mechanical conveyers. Grain sampling, segregation, moisture migration. Moisture determination – drying and aeration.
- c. Insects and mites of food gains - types, and control measures [storage facility, warehousing practices, physical, chemical, biological, and other methods of insect control]
- d. Storage structures of grains.

**2. Storage and handling of fruits and vegetables - Vegetables as living products- Respiration and heat production.**

- a. Harvesting practice and equipment, Preparation for market, Shipping containers and Consumer package
- b. Commodity requirements – leafy vegetables, unripe fruits, ripe fruits, underground structures

- c. Treatment prior to shipment and storage, Ventilated storage, refrigerated storage  
Transportation by Rail, Highway, Air and Sea
- d. Market disorders, physical injuries and diseases of fruits and vegetables  
Protection during wholesale and retail distribution.

### **3. Storage and handling of milk and milk products**

- a. Milk – sources, contamination, chemical composition, keeping quality, grading of milk, microbiology of milk and its products.
- b. Milk products – Butter, cheese, curds, fermented dairy products. Spoilage and preservation of dairy products.
- c. Microbial changes and types of spoilage – souring, gas formation, proteolysis, ropiness, alkali production, changes in butter fat, flavor changes, colour changes.
- d. Preservation techniques – pasteurization, UHT, cooling, chilling and freezing, use of preservatives – added and developed.

### **4. Storage and handling of flesh and marine foods.**

- a. Meat – Classes of meat, spoilage of fresh and cured meats, types of spoilage, aerobic and anaerobic. Sources of contamination, control measures – hygiene, biological control, use of antibiotics, ionizing radiations. Packaging of meat.
- b. Fish – Characteristics – appearance, chemical composition, spoilage, enzymic, microbial and chemical action. Transportation – by sea, rail, railroad container, mechanical refrigerators, cars, packing fresh fish and frozen fish. Refrigeration and freezing of fish and other shell fish.

**Soft core-**

**FOOD BIOTECHNOLOGY**

**[2+0+0=2]**

1. Historical perspective of biotechnology and fermentation technology, Branches of biotechnology, Global scenario, use of biotechnology in food processing, agriculture and pharmaceutical field. Types and mechanism of fermentation, effect on nutritional value, health benefits. Single cell protein- production, importance and its application
2. Genetically modified foods - Need for GM foods – The food challenges, DNA recombinant technology, cell and tissue culture (plant and animal), Potential benefits in agriculture, Crop engineered for input and output traits, nutritional improvement, animal foods, issues of concern , tests for detecting GM foods, safety of GM foods.
3. Technology for production of alcoholic beverages- Manufacturing of wine, beer, whisky, brandy, neutral spirits etc- Raw materials, processing, storage and packaging.
4. Microbial fermentation of Indian Traditional foods -
  - a) Cereal and legume based products, traditional and yeast leavened products-role of leavening, manufacturing of bread, sour dough, rye bread, kulcha, naan, bhatura.

- b) Vegetables and fruits – lactic acid fermentation – principles, difference processes of lactic acid fermentation, factors affecting lactic acid fermentation, products based on lactic acid fermentation.
- c) Milk products – yoghurt, butter- milk, cheese: general requirements for fermented milk product production and factors affecting the quality of product.
- d) Meat and fish- fermentation and drying procedures, starter cultures, processing steps, sensory quality and physical properties.

## **OPEN ELECTIVE PAPER FOR STUDENTS OF OTHER DISCIPLINE**

### **FOODS IN INDIAN TRADITION**

**[2+0+0=2]**

1. History of Indian foods - Ancestral legacies, Food and culture, Indian food ethos.
2. Traditional Indian Dietary patterns and Indian ethnic cuisines
3. Nutritional/medicinal quality of traditional foods - Traditional food beliefs, foods in Ayurveda.
4. Traditional food processing technologies.

## STREAM 2. SPECIALIZATION IN CLINICAL NUTRITION AND DIETETICS II SEMESTER

**1.Hard Core:            FOOD SCIENCE AND FOOD PROCESSING- II \***            **[3+0+2=5]**  
[Common paper]

**2.Hard Core:                            VITAMINS IN NUTRITION \***            **[1+1+0=2]**  
[Common paper]

**3.Hard Core:                            MINERALS IN NUTRITION \***            **[1+1+0=2]**  
[Common paper]

**1. Hard Core:                            HUMAN PHYSIOLOGY                            [2+1+2=5]**

1. **Cell physiology-** structure and function of cell and its components, review of cell membrane transport systems. Structure and function of bone, cartilage and connective tissue. Types of muscles, structure and function.
2. **Digestive system:** structure and function of organs of GI tract, digestion and absorption of food. Role of enzymes and hormones on digestion and absorption.
3. **Circulatory and cardiovascular system:** Blood and its composition, function, blood coagulation and blood groups, use of blood indices for diagnosis. Structure, function of heart and blood vessels, regulation of cardiac output and blood pressure. Pulmonary and systemic circulation.
4. **Respiratory system:** review of structure and function, role of lungs in exchange of gases, transport of O<sub>2</sub> and Co<sub>2</sub>, role of hemoglobin and buffer systems.
5. **Nervous system:** Peripheral and autonomic nervous system, structure and function of neuron, conduction of nerve impulse, synapse
6. **Renal system:** organs in the urinary system, formation of urine, Role of kidney in maintenance of pH of blood, acid-base and fluid balance.
7. **Endocrine system:** endocrine glands ( pituitary, thyroid, parathyroid, islets of Langerhans, adrenals, ovary and testis,) functions, regulation of hormone secretion, symptoms of deficiency and excess secretion
8. **Immune system:** cell mediated and humoral immunity, immune response. Role in inflammation and defence.

## **PRACTICAL – BLOOD AND URINE ANALYSIS**

- a) Collection and storage of biological samples for clinical use. Commonly used tests for diagnosis of various diseases (CVD, diabetes, renal failure, hypo and hyper thyroidism, TB, typhoid, HIV and cancer) and their interpretation (Indices will have to be calculated using analyzed values of each student for interpretation)
- b) **Blood and urine analysis:** i. Total blood count including ESR, ii. Total serum proteins and their fractions. iii. Blood glucose (GTT), (Fasting and post-prandial), iv. Serum lipid fraction – Cholesterol, triglyceride, LDL and HDL, v. Blood urea, vi. Serum calcium. (GTT to be conducted at any clinic/ hospital)
- c) **Urine:** Creatinine, Glucose and protein (albumin).

**Soft core                      NUTRITIONAL EPIDEMIOLOGY                      [2+0+0=2]**  
**[Common Paper]**

**Soft core    NEUTRACEUTICALS AND FUNCTIONAL FOODS    [2+0+0=2]**  
**[Common Paper]**

**Soft core                                      SPORTS NUTRITION                                      [2+0+0/wk]**

- 1. **Approaches to the management of fitness and health:** Nutrition, exercise, physical fitness and health- their inter relationship. Significance of physical fitness and nutrition in prevention and management of weight control regimes. Nutrition guidelines for maintenance of health and fitness.
- 2. **Nutritional requirements of exercise:** Effect of specific nutrients on work performance and physical fitness. Nutrients that support physical activity, Mobilization of fuel stores during exercise. Fluid requirements.
- 3. **Nutrition in sports:** Sports specific requirements- Importance of carbohydrate loading, pre game and post game meals, Diets for persons with high energy requirements, stress, fracture and injury
- 4. **Dietary supplements and Ergogenic aids:** Definitions, Use of different nutrigenic / ergogenic aids and commercial supplements, Sports drinks, sports bars etc

**1. Hard Core:****PRINCIPLES OF DIET THERAPY****[2+1+0=3]**

- 1. Introduction to Clinical Nutrition and Dietetics-** Definition and history of dietetics. Concepts of a desirable diet for optimum health. Interrelationship between food, nutrition and health. Factors affecting food choices, Physiologic factors regulating food intake- role of neurotransmitters and nutrients in hunger and satiety.
- 2. Role and responsibilities of dieticians** - specific functions, team approach in patient care, psychological consideration, interpersonal relationship with patients. Nutrition and medical ethics. Hospital dietary- scope and importance, types of food service, quality management.
- 3. Nutrition screening and assessment in clinical settings :** Nutrition screening and assessment methods ( MNA, SGA, PG-SGA, MUST, disease specific tools ). Nutrition care process- Assessment, Diagnosis, Interpretation, Monitoring, and Evaluation (ADIME). Usage of International Dietetic terminologies.
- 4. Principles and Objectives of Medical nutrition therapy-**
  - a) Characteristics of a Regular diet, rationale for modifications in terms of energy and other nutrients, texture, consistency. Translation of diet orders into menu: defining nutrient needs, desirable dietary pattern (DDP)
  - b) Enteral and Parenteral feeding: indications, types (commercial and kitchen-based feeds), methods of administration, monitoring and associated complications.
- 5. Dietary principles and management of special conditions-**
  - a) Protein and energy malnutrition (hospital and domiciliary treatment)
  - b) Febrile diseases-classification of fevers, metabolism, general dietary considerations, diet in acute and chronic fevers (typhoid and tuberculosis)
  - c) Surgical conditions, Burns and organ transplants
- 6. Nutrition in adverse reactions to food:** pathogenesis, food allergens, symptoms, tests for diagnosis, food allergies - pollen food allergy syndrome, latex –fruit syndrome, food dependant, exercise- induced anaphylaxis, food induced anaphylaxis , food –protein induced enterocolitis syndrome, cow’s milk protein allergy (CMPA). Food intolerances- lactose , fructose intolerance. Management - restricted diets, elimination diets and hypo- sensitization.

**2. Hard Core:****CLINICAL NUTRITION AND DIETETICS- I****[2+1+2=5]**

- 1. Medical nutrition therapy for Upper and Lower gastrointestinal disorders:**
  - a) **Disorders of the Esophagus,** Gastroesophageal reflex and esophagitis (GERD)
  - b) **Disorders of stomach-** indigestion, dyspepsia, gastritis, Peptic ulcer, gastroparesis.
  - c) **Disorders of small and large intestine:** malabsorption syndrome (sprue, ulcerative colitis, Crohn’s disease, inflammatory bowel disease, irritable bowel syndrome, Sprue, Diarrhea, Constipation, Diverticulosis and Diverticulitis, Hernia, Hemorrhoids, short bowel syndrome, Fistula, Intestinal ostomies.

2. **Medical nutrition therapy in pulmonary diseases:** acute (pulmonary aspirations pneumonia, pulmonary failure, acute respiratory distress syndrome) and Chronic pulmonary disorders, (Bronchopulmonary dysplasia, cystic fibrosis, tuberculosis; Bronchial asthma , chronic obstructive pulmonary disease (COPD), effect of lung diseases on nutritional status.
3. **Medical nutrition therapy in Rheumatic disorders:** Osteo arthritis, rheumatic arthritis, scleroderma, systemic lupus erythematosus Gout-: Treatment, prevention
4. **Medical nutrition therapy in Hepatobiliary and pancreatic disorders:**
  - a) Liver function tests, Hepatitis (A,B,C, Fulminant,) alcoholic liver disease and cirrhosis, non-alcoholic steatohepatitis, cholestatic liver disease, End stage liver disease and complications, inherited disorders (Wilson's disease, alpha-antitrypsin, hameochromatosis).
  - b) Cholecystitis, Cholelithiasis, cholangitis.
  - c) Acute and chronic pancreatitis, functional tests and dietary management.
5. **Medical nutrition therapy in Neurologic disorders:** [Epilepsy, Migraine, Alzheimer's, Parkinson's, hemorrhagic stroke, Myasthenia gravis], pathogenesis, causes of malnutrition, Feeding issues and strategies.
6. **Nutrition in thyroid and adrenal disorders:** Thyroid physiology, assessment of thyroid disorders, dietary management in hypo and hyperthyroidism, Cushing syndrome, Addison's disease, adrenal fatigue.

**Note:** Pathology, etiology, symptoms and management of each disease to be covered

## **PRACTICALS**

[4 hrs/wk]

1. Menu planning, food selection, planning and preparation of related dietary modification
2. Medical terminology and interpretation
3. Prepare counseling aids.
4. Visit to the hospitals-learn to use medical record to obtain required information.
5. Development of NCP for specific disease \*
6. Food exchange list and application
7. Introduction to case studies

**Description of the task** – Apply the components of nutrition care process - includes interpretation of an individual's anthropometric measures, biochemical data, history, and dietary intake followed by writing a nutrition diagnosis, identifying nutritional goals of management and formulation of nutritional intervention and monitoring strategies.

**4. Hard Core:****FOOD SERVICE MANAGEMENT****[1+1+0=2]**

1. **Food service Institutions-** Definition and importance, various types of food service institutions like hospitals, school meals, hostels, industrial canteens, commercial hotel/ canteens etc. Institutions catering to different types of handicapped personnel.
2. **Theories about approaches to food service management -**
3. **Developing objectives and goals-** Definition and importance, types of goals Policies, procedures and rules.
4. **Principles and procedures of management-** Managerial roles and responsibilities, the manager and leadership quality. Tools of management – organization chart, types, structure, function; work improvement techniques.
5. **Human resource management** – recruitment, training, placement, promotion, personnel records, work appraisals.
6. **Material management** – Principles of quantity food purchase- selection, buying and accounting of different foods. Inventory management- assessing requirements, receiving and release of stocks. Record maintenance.
7. **Quantity food preparation and service-** Factors in menu planning for large groups, systems for maintaining quality in food preparation and service. Menu planning, Selection, purchasing, receiving, storage and waste management. Maintenance of food supply records.
8. **Financial management** – Budgeting, costing and cost control, accounting.
9. **Hazards and safety standards in food service units**
  - a) Sanitation measures for Food, Personnel and Unit Hygiene, Training techniques for food service personnel in Sanitation.
  - b) Safety- causes of accidents, types and sources of contamination, 3 Es of Safety
  - c) Food laws - FPO, ISI, AGMARK, PFA, New Food Bill 2018
  - d) Quality standards-HACCP, ISO, NABH, licensing by FSSAI

**PRACTICAL SESSION\*Report submission (internal valuation)**

1. Standardization of recipes- costing of recipes.
2. Survey of hostels and cafeteria to assess various aspects of food service management. Submit a report.

**4. Hard core:****BIO-STATISTICS AND ITS APPLICATIONS****[1+1+0=2]****[Common Paper]**



**Soft Core:**

**NUTRITION IN EXTREME ENVIRONMENTS**

**[2+0+0=2]**

1. **General Adaptive Mechanisms to Environmental Extremes:** Role of nutrition in successful acclimatization (physiological changes, nutrient requirement), cascade effect of environmental extremes, adverse metabolic consequences of adaptations, risk of various diseases due to adaptation (obesity, dehydration, and musculoskeletal disorders).
2. **Nutritional requirements in cold and high altitude:** Metabolic adaptations to heat, cold and high altitude. Changes in body composition, Circadian rhythm, management of IBW, nutrient needs (macro and micronutrients, fluid and electrolytes). Prevention of hypoxia through nutrition, nutrient -dense foods, Food choices.
3. **Nutritional requirements for space missions:** Physiological changes, assessment of nutritional status, exercise and bone loss during space missions. Space food system-selection of food and beverages, nutrients of importance, designer foods, Food safety issues.
4. **Nutritional requirements in marine conditions:** Physiological changes, food storage and preparation facilities, sea sickness, Ready-to-eat rations, prevention of nutrient deficiencies, food supply for Indian navy.

**Soft core:**

**DRUG -NUTRIENT INTERACTIONS**

**[2+0+0=2]**

1. **Drugs and pharmaceutical compounds-** natural and synthetic, use of excipient. Characteristics of drug action - Pharmacodynamics, pharmacokinetics, pharmacogenomics. Drug abuse and drug resistance.
2. **Mechanisms of interactions** – effect of drugs on ingestion, digestion, absorption, metabolism of nutrients and excretion. Effect on nutritional status, effect on organ function. Host and Drug / Nutrient factors – Host factors (age, body size, composition, genetics, lifestyle, underlying medical condition), Drug/Nutrient factors (dose, route and time of administration )
3. **Effects of Specific Foods and Dietary Components on Drug Metabolism** - effects of dietary composition, interactions between medication and milk, grape fruit and other fruit juices, antacids, anticoagulants, dietary supplements (eg., garlic, ginger, caffeine ). To discuss evidence
4. **Interactions in Patients Receiving Enteral & Parenteral Nutrition** – factors contributing to interactions – enteral feeding site ( gastric, duodenal, jejunal), drug form. Parenteral - Co-infusion compatibility and stability, influence of PN on drug action related to glucose homeostasis.

**Soft Core: RESEARCH METHODS IN CLINICAL NUTRITION [2+0+0=2]**

- 1. Principles of research** – Introduction to research and evidence-based practice, scientific literature and peer-review process. Research problem: Definition, selection of research problem, Justification and Limitations. Hypothesis : Definition, sources, characteristics, importance, formation of hypothesis. Research terminologies - Subjects: control and experimental group. Placebo, placebo effect. Variables, correlation and validity. Formulation of research proposal.
- 2. Research methods** –
  - a. Descriptive: correlation, case-control, cross-sectional surveys,
  - b. Experimental : clinical/intervention trials, randomized controlled, single- blind and double blind,
  - c. Analytical studies : observational, case-control, cohort studies-retrospective and prospective. Sampling methods and sample size.
- 3. Nutrition Intervention studies** – pilot study, randomized controlled trial , nutritional biomarkers.
- 4. Regulations and guidelines-** Indian Good Clinical Practice guideline (GCP), Clinical Trials Registry of India (CTRI). Ethical guidelines of ICMR (risks and benefits, informed consent). Best practices for Food clinical trials.

**Soft Core: PEDIATRIC AND GERIATRIC NUTRITION [2+0+0=2]**

- 1. Nutritional assessment of paediatric patients:** Growth and anthropometric measurements, obesity assessment, assessment for malnutrition, nutrition requirements of infants, Nutritional management in growth failure and developmental disabilities. Preterm infants, Growth parameters and related complications. Nutrition needs and feeding of high risk infants. New born screening ( NBS) for genetic disorders, Nutrition support for inborn errors of metabolism (phenylketonuria, galactosemia, maple syrup disease, homocysteinuria).
- 2. Nutritional management of preterm and low birth weight infants:** Parenteral and Enteral feeding protocol for high risk/preterm infants. Guidelines for Paediatric formula preparation. Factors affecting protein and energy requirement in critically ill, re-feeding syndrome. Nutritional management of Food hypersensitivities (Milk, egg, soybean, fish and wheat).
- 3. Health status of the elderly:** Physiological changes in aging (CVD, endocrine, GIT, musculoskeletal, nervous, renal, respiratory, hepatic,), chronic health concerns and disease prevention, age related pharmacokinetic changes. Eating disorders, PEM, immune deficiencies. Health related Quality of life, specific exercises for general health
- 4. Nutritional considerations of the elderly:** Food choices, Smell, taste and somato sensation, oral health, Swallowing problems and management, food safety, feeding strategies, indications for nutrition support, oral supplements ( dietary and commercial), Energy and nutrient intake, Enteral and Parenteral nutrition, home nutrition support.

## IV Semester

### 1. Hard Core: CLINICAL NUTRITION and DIETETICS- II [1+1+2=4]

- 1. Medical nutrition therapy of renal disease:** functions of kidney, Diseases of the kidney- Nephritis, Nephrotic syndrome, Acute and chronic renal failure, stages of chronic kidney disease, Nutritional requirements in hemodialysis, transplant. Malnutrition in renal disease Nephrolithiasis (calculi) – types, dietary principles and prevention
- 2. Medical nutrition therapy of Cardiovascular diseases:** Role of specific nutrients in cardiac efficiency, CVD bio markers and interpretation. Metabolic syndrome, long-term and short-term treatment in Coronary disease. Myocardial infarction, cerebral infarction (atherosclerosis as one of the causative factor). **Other acute and chronic conditions:** congestive heart failure, hypertension, stroke, dyslipidemia (genetic hyperlipidemia).
- 3. Medical nutrition therapy in Obesity:** Interrelationships of NCD, Role of genetics, Regulation of body weight, –hunger, satiety, role of neurotransmitters. Hormones Weight management in adults - common problems, diet and physical activity, Childhood obesity and management, Prevention programs. Nutrition in Eating disorders.
- 4. Medical Nutrition therapy in Diabetes mellitus:** classification, therapy, diagnostic/monitoring criteria, long term and short-term management. Drugs in diabetes, calorie counting. Ketoacidosis, Hypoglycemia of non-diabetic origin.
- 5. Medical nutrition therapy in Cancer :** stages of cancer, Nutrition impact symptoms of cancer therapy. Management of Cancer cachexia. Palliative care.
- 6. Medical nutrition therapy in HIV:** classification, manifestations and stages of HIV. Opportunistic infections and complications, relationship between malnutrition and AIDS, Lipodystrophy syndrome. Dietary supplements and palliative care.

**NOTE:** Patho-physiology , incidence, symptoms of each disease condition to be covered in brief .

### PRACTICAL SESSION-

- 1. Identifying a specialty care unit:** diabetic clinic/ weight management center/health clubs/hospitals/nursinghomes-select atleast 3-4 patients
- 2. Case studies:**
  - a. Obtaining Development of tools for assessment of in- patients and out patients. Screening of patients and interpretation of medical history.
  - b. NCP, dietary prescription and counseling of patients with following conditions (a minimum of 2 to 3 cases to be taken up by each student). Obesity, diabetes mellitus (NIDDM and IDDM), hepatitis and cirrhosis, myocardial/cerebral infarction, renal failure, calculi and nephritic syndrome, fever- chronic and acute.

3. Preparation of enteral feeds and demonstration of different types of tube feeding
4. Demonstration of an equipment to measure body composition.

## **2. Hard Core:**

## **INTERNSHIP**

**[0+6+0=6]**

1. Internship in hospitals or Food Service Institutions & Hospitals /Clinics
2. Submission of project work/report on case studies on a minimum of 10 patients in any disease condition
3. Report on internship will be evaluated as stated under project work regulations.

## **Soft Core:**

## **NUTRITION COUNSELING**

**[1+1+0=2]**

1. **Foundation of Nutrition Counseling and education:** Definition, concept, history of nutrition counseling, Fundamentals of food behavior, Effective counseling relationship – characteristics of nutrition counselors, Understanding the client, the counseling environment
2. **Theories of nutrition counseling:** Theories influencing clients – Attitudes and beliefs about the counseling, self image, nutrition and health in general. Theories influencing counselors – Health belief model, Trans theoretical model (motivational stages), family therapy, social-cognitive theory and theory of planned behavior.
3. **Communication skills:** A. Essential skills – Active listening, Responding and making helpful interventions, B. Model of communication – interpersonal communication model, verbal and non verbal communication, listening, action, sharing and teaching responses.
4. **Systems approach to nutritional counseling:** (A) Components of the system – Assessment Diagnosis, Intervention, Monitoring and Evaluation. (B) Nutrition counseling model (C) General approach to counseling – Five A's approach (D) Factors to be considered while counseling- Nutritional & health conditions, personal hygiene, psychological conditions, food allergies, aging and gender related problems.
5. **The counseling Interview:** Assessment of client's readiness for change, The stages of change. Phases of a counseling interview-Involving, Exploration, Education, Resolving .Self evaluation of the counselor.
6. **Nutrition counseling in the management of diseases/disorders:** Obesity, Diabetes mellitus, Renal diseases, Hypertension, Cardiovascular diseases, Liver disease and Cancer.
7. **Hands on experience:** Preparation of counseling aids for any two disease conditions and conduct counseling session.

**Soft Core:****NUTRITION IN CRITICAL CARE****[1+1+0=2]**

1. **Nutritional care of hospitalized patients**-Hospital malnutrition, impetus for improved Nutritional care of patients, nutritional screening, assessment of the critically ill. Preparation of nutritional care plan.
2. **Nutritional support systems:** and other life saving measures for the critically ill- Monitoring nutrient intake and providing nutrition support service, role of immuno enhancers, conditionally essential nutrients, immuno suppressants and special diets.
3. **Planning, monitoring and management of Enteral and parenteral feeding:** Designer feeds, commercial feeds, techniques, applications and complications.
4. **Management of high risk conditions:** including patho-physiological, clinical and metabolic aspects in the following conditions: Burns, CV complications, surgery, cancer, AIDS, multiple organ failure, chronic renal failure (CRF), dialysis, transplant, trauma and sepsis, Dumping syndrome.
5. **Home care for critically ill and requiring long term nutrition support**
6. **Complications of nutritional support systems:** including re-feeding syndrome, palliative care, rehabilitation diets (stages).

**ASSIGNMENT:**

Visits to hospitals (special units- ICU)/ emergency relief camps and health oriented camps and presenting as seminar/ report.

**SOFT CORE:****INBORN ERRORS OF METABOLISM****[ 2+0+0=2]**

1. **Introduction-** definition, occurrence, types, causes, detection techniques - newborn screening (NBM), goals of nutrition therapy, role of nutritionist. Prevention strategies – genetic counseling.
2. **Carbohydrate metabolism** – G6PD deficiency, galactosemia, fructose intolerance, glycogen storage disease, pentosuria – prevalence, clinical and biochemical features, dietary management.
3. **Amino acid metabolism** – Phenylketonuria, tyrosinemia, homocystinuria, BCAA Maple syrup urine disease argininemia- prevalence, clinical and biochemical features, dietary management
4. **Lipid metabolism** – disorders of fatty acid oxidation medium-chain acyl CoA (MCAD) long-chain acyl CoA deficiency (LCAD). - prevalence, clinical and biochemical features, dietary management.
5. **Other disorders** – hypothyroidism, sickle cell anemia, cystic fibrosis, lysosomal storage disease (Tay-Sachs, Gaucher's) and gout - prevalence, clinical and biochemical features, dietary management

1. **Women and Nutrition in India:** socio-economic and cultural influences on women's nutritional status. Food consumption determinants and dietary patterns (NNMB data). Significance of preventive nutrition throughout the life cycle.
2. **Health Concerns in Pre menopausal phase:** menstrual cycle, hygiene during menstrual cycle, effect of menstrual cycle on food intake and nutrient requirement, role of diet on sex steroid hormones. Diet and premenstrual syndrome. Oral contraceptives and nutrition. Effect of under and over nutrition on fertility.
3. **Health Concerns in Post menopausal phase:** Menopause, body composition transition in menopause, dietary supplements for menopausal issues, Adequacy of nutritional intake, hysterectomy, hormone replacement therapy, Non-communicable diseases (obesity, CVD, Osteoporosis, Diabetes and cancer).
4. **Nutrition concerns in female athletes** ideal body fat, guidelines for fat loss, Menstrual dysfunctions, Nutrient needs, competition diets, carbohydrate loading diet, Fluid and food intake, Female athlete triad

## REFERENCES

### STREAM 1

1. Amihud Kramer and Bernard A. Twigg. (2017). Quality control for food industry fundamentals and application, Medtech Scientific International Pvt Limited (Vol 1 & 2).
2. Arun Bhadra Khanal. (2016). Methods in biostatistics for medical students and research workers, Jaypee Brother Medical Publisher.
3. Bamji, M. S., Krishnaswamy, K., & Brahman, G. N. V. (Eds.). (2013). Textbook of human nutrition. Oxford & IBH.
4. Byang. H Lee (2014), Fundamentals of Food Biotechnology, John Wiley and sons
5. Caballero, B. (2012). Encyclopedia of human nutrition. L. H. Allen, & A. Prentice (Eds.). Academic press.
6. Coles, L. (Ed.). (2013). Functional foods: The connection between nutrition, health, and food science. Apple Academic Press.
7. CR Kothari. (1990). Research methodology –Methods and techniques, 2 nd Edition, New age International.
8. Damodaran, S., Parkin, K. L., & Fennema, O. R. (Eds.). (2007). Fennema's food chemistry. CRC press.

9. Earle, R., & Anderson, A. (Eds.). (2001). Food Product Development: Maximizing Success. CRC Press.
10. Fellows PJ(2009).Food processing technology, principle and practices. Wood head publishing India Pvt Ltd, New Delhi 3<sup>rd</sup> edition.
11. Fuller, G. W. (2016). New food product development: from concept to marketplace. CRC Press.
12. Gordon W Fuller., (2004) New Food Product Development: from Concept to Market place,
13. HalMacfie, (2007) Consumer- led food product development, CRC.
14. Isobel R.Contentto.(2007),Nutrition education, library of congress cataloging, Jones and Bartlett publisher
15. James, C. S. (Ed.). (2013). Analytical chemistry of foods. Springer Science & Business Media.
16. Khan and Khanum (2012).Fundamentals of Biostatistics, Ukaaz publications 3<sup>rd</sup> edition
17. Lindsay Allen and Bruno De Benoist (2006). Guidelines for food fortification with micronutrients WHO-FAO library of congress cataloging
18. Lloyd Ryall A and Pentzer WT (2017). Handling transportation and storage of fruits and vegetables, Medtech scientific international pvt limited (Vol 1 & 2)
19. MacFie, H. (Ed.). (2007). Consumer-led food product development. Elsevier.
20. Manay, N. S. O. (2001). Food: facts and principles. New Age International.
21. Mann, J., & Truswell, S. (2012). Essentials of human nutrition. Oxford University Press.
22. Mary Earle &Richard Earle., Food Product Development: Maximizing Success., CRC, Woodhead Publishing Ltd.,2001
23. Mary Kay Mitchell.(2015). Nutrition across the life span. MEDTECH, Scientific international Pvt ltd.
24. NIN (2017), Indian food composition tables
25. Nnakwe, N. (2012). Community nutrition: planning health promotion and disease prevention. Jones & Bartlett Publishers.
26. Nutrition and the Developing Brain, edited by Victoria Hall Moran, Nicola M. Lowe, CRC Press
27. Paul Insel, Don Ross et al.,(2013). Discovery nutrition, Library of congress cataloging. Jones and Bratlett Publisher
28. Potter, N. N., & Hotchkiss, J. H. (2012). Food science. Springer Science & Business Media.
29. Rahman, M. S. (Ed.). (2009). Food properties handbook. CRC press.
30. Rajinith kumar(2016). Research Methodology step by step guide for beginners. Pearson India Education
31. Rhee S.R Lee J & Lee C (2011). Importance of lactic acid bacteria in Asian fermented foods, Microbial cell factors.10 (suppl) :89-101.

32. Rita Singh (2004), Food Biotechnology, Vol 1 and 2 Global Vista Publishing house.
33. Robert D.Lee and David CN.(2010) Nutritional assessment 5<sup>th</sup> edition McGraw Hill Higher education
34. Robertson, G. L. (2016). Food packaging: principles and practice. CRC press.
35. Ruth M DeBusk , Nutrigenomics : The foundation for individualized nutrition, 168-171
36. Sari Edelstein and Judith Sharlin (2009). Essential of life cycle nutrition evidence based approach Jones and Bratlett Publisher.
37. Srilakshmi, B. (2007). Dietetics. New Age International.
38. [www.fssai.gov.in/home/fss-legislation/fss-registration.html](http://www.fssai.gov.in/home/fss-legislation/fss-registration.html)
39. Yoshinori Mine, Kazuo Miyashita, Fereidoon Shahidi.(2009). Nutrigenomics and proteomics in health and disease, Food factors and Gene Interactions,Wiley-Blackwell.
40. Zimmermann, M. (2001). Burgerstein's Handbook of nutrition: micronutrients in the prevention and therapy of disease.

## **STREAM. 2**

1. Advancing Dietetics and clinical nutrition Anne Payne, Helen Barker Churchill Livingstone publishers
2. Bao, Y., & Fenwick, R. (Eds.). (2004). Phytochemicals in health and disease. CRC Press.
3. Bemadette. M. Marriott and Sydne J Carlson, Nutritional needs in cold and high altitude environments
4. Berning, J. R., & Steen, S. N. (2005). Nutrition for sport and exercise. Jones & Bartlett Learning.
5. Boullata, J. I., & Armenti, V. T. (Eds.). (2004). Handbook of Drug' Nutrient Interactions. Springer Science & Business Media.
6. Campbell, B. I. (2013). Sports nutrition: enhancing athletic performance. CRC Press.
7. Cresci, P. D. (Ed.). (2015). Nutrition support for the critically ill patient: A guide to practice. CRC Press.
8. Debra AK and Penny NK.(1996). Nutrition in women's health
9. Eldon W Askew, Cold weather and high altitude nutrition- overview of the issues
10. Escott-Stump, S. (2008). Nutrition and diagnosis-related care. Lippincott Williams & Wilkins.
11. Fink, H. H., Fink, W. S. L. H. H., & Mikesky, A. E. (2013). Practical applications in sports nutrition. Jones & Bartlett Publishers.
12. Food-Drug interactions (chapter 16) Z.M Pronskey and Sr Jeanne, P CroweJournals- Amer J Clin Nutr, Pharmacology, J Amer Dietetic association
13. Gable, J., & Herrmann, T. (2015). *Counselling skills for Dietitians*. John Wiley & Sons.



14. Gopalan C and Shetty P.(1998). Diet nutrition and chronic disease – An Asian perspective Smith-Gordon-Nishimura.
  15. Guyton. Human physiology and mechanism of disease. W.B.SaundersCompany
  16. IDA.(2018).Clinical dietetics manual 2<sup>nd</sup> edition ELITE publishing house, New Delhi.
  17. KE Elizabeth (2015). Nutrition and child development. 5<sup>th</sup> Paras Medical Publisher
  18. Mahan, L. K., & Raymond, J. L. (2016). Krause's food & the nutrition care process. Elsevier Health Sciences.
  19. Manual, A. (2011). Dietary guidelines for Indians. Nat Inst Nutrition, 2, 89-117.
  20. Mark L and Tony W (2008). Public health nutrition from principles to practice, Library of congress cataloging, First south Asian edition.
  21. Mohini Sethi (2016). Institutional food management 2<sup>nd</sup> edition, New Age international Pvt Limited.
  22. Nelms, M., & Sucher, K. (2015). Nutrition therapy and pathophysiology. Nelson Education.
  23. Nutrition counseling and education skill development, By Kathleen Bauer and Liou, 3<sup>rd</sup> edition, Cengage Learning
  24. Nutrition counseling skills for the Nutrition care process. By Linda Snetselaar, 4<sup>th</sup> edn, Jones and Bartlett Publishers
  25. Patricia Queen S, Kathy King H, Carol EL .(1999). Handbook of Pediatric nutrition 2<sup>nd</sup> edition Jones and Bartlett Publisher
  26. Puckett, R. P. (2004). Food service manual for health care institutions . John Wiley & Sons.
  27. Robinson, Lawler: Normal & Therapeutic Nutrition (17th ed.) Macmillan Publishing Co.
  28. Robinson. HC et al., (1986) Normal and therapeutic nutrition (17th edition), Macmillan publishing company.
  29. Ronni Chernoff. (2006).Geriatric Nutrition. Ealth professionals handbook,3<sup>rd</sup> edition, Jones and Bartlett Publisher
  30. Sethi, M. (2008). Institutional food management. New Age International.
  31. Sheila Chander Vir (2011).Public health nutrition in developing countries (Part I &II). Wood head publishing, India ltd.
  32. Shills and Young. Modern Nutrition in Health and Disease
  33. Sigal Sofer et.al, Nutrition targeting by food timing: time related dietary approaches to combat obesity and metabolic syndromes
  34. Ssgt Doug kechinjan, Optimizing nutrition for performance at altitude- A literature review
  35. Thibodeau, G. A., & Patton, K. T. (2010). Human body in health & disease. Mosby/Elsevier.
  36. Waugh, A., & Grant, A. (2010). Ross & Wilson anatomy and physiology in health and illness. Elsevier Health Sciences.
  37. Whitney, E. N., Cataldo, C. B., & Rolfes, S. R. (1998). Understanding normal and clinical nutrition . Wadsworth Publishing Company, Inc.
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