

UNIVERSITY OF MUMBAI



Syllabus
SEMESTER I & SEMESTER II
Program: M.Sc.
Course: Home Science
Branch IA: Foods Nutrition and Dietetics

(Credit Based Semester and Grading System with
effect from the academic year 2012–2013)

Preamble

The M.Sc. (Home Science) Program consisting of four semesters under the Credit Based Semester and Grading System was recommended by the Ad-hoc Board of Studies in Home Science and was resolved by the Academic Council University of Mumbai that was introduced in the year 2012-2013. Under Home Science there are five areas of Specializations namely Branch IA: Foods Nutrition and Dietetics, Branch IB: Food Processing and Preservation, Branch IC: Sports Nutrition, Branch II: Human Development, Branch III: Textile and Fashion Technology, Branch IV: Community Resource Management. M.Sc. (Home Science) Branch IA: Foods Nutrition and Dietetics Semester I and Semester II comprises of five theory and three practical courses with a total of 24 credits. The courses offered equip the learners with advanced knowledge and skills required to be a home scientist with a specialization in Foods Nutrition and Dietetics. It provides an education that is life-, community-, and career- oriented, nurtures, grooms and builds their personal and professional personality. The specific objectives for each course have been listed in the detailed syllabus.

There is a simple rearrangement of subtopics in the Semester II for Course USHSI202 as Clinical Nutrition and Therapeutic Dietetics that has been amended in the given document.

SEMESTER I

Course Code	Title	Credits	Periods	Marks
PSHSIA101	Research Methods and Statistics	4	4	100
PSHSIA102	Nutritional Biochemistry	3	3	75
PSHSIA103	Clinical Nutrition and Therapeutic Dietetics	3	3	75
PSHSIA104	Food Science and Processing	3	3	75
PSHSIA105	Nutrition through Life Cycle	3	3	75
PSHSPIA101	Practicum in Research Methods	2	3	50
PSHSPIA102	Food Science	2	2	50
PSHSPIA103	Biochemistry and Food Analysis	4	5	100
	Total:	24	26	600

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA101	Research Methods and Statistics	4	100	4

RESEARCH METHODS AND STATISTICS

No. of Credits: 4

Objectives

1. To build in students appreciation for high quality research in each of their specialisations.
2. To introduce students to the skills needed in conducting a research in their specialisation.
3. To introduce students to principles of good scientific writing.
4. To enable in students the skills in selecting, computing, interpreting and reporting statistics.

Course Content	Lectures
UNIT I 1.A. Introduction and Overview (a) What is a research? (b) Objectivity and subjectivity in scientific inquiry: Premodernism, modernism, and postmodernism (c) Steps in the research process (d) Importance of research in general, and in each discipline (e) Illustration of research in each of the three specialisations: Foods, Nutrition, and Dietetics; Human Development; and, Textile and Fashion Technology (f) Qualitative versus quantitative research 1.B. The beginning steps in the research process (a) Identifying broad areas of research in a discipline (b) Identifying interest areas; using multiple search strategies (c) Prioritising topics; specifying a topic; feasibility (d) Review of literature/scholarly argument in support of study (e) Specifying research objectives/hypotheses/questions	15
UNIT II 2.A. Variables (a) Definition (b) Characteristics (c) Types (d) Levels of measurement 2.B. Measurement (a) Conceptual definitions and operational definitions (b) Types of validity and reliability in quantitative research 2.C. Data entry in quantitative research (a) Codebook and mastersheet (b) Creating data files and data management	15
UNIT III 3. A. Introduction and overview to statistics (a) Role of statistics in (quantitative) research (b) Definition/changing conceptions (c) Prerequisite concepts in mathematics (e.g., properties of the summation sign, basic algebra) 3 B. Descriptive Statistics for summarizing ratio level variables (a) Frequencies and percentages (b) Computing an average/measure of a central tendency Mean, median, mode(s) Contrasting the mean vs. median Computing an average when there are outliers or extreme values in the data set Robust measures of the center (5% trimmed mean; M estimators) Quartiles and percentiles	15

	<ul style="list-style-type: none"> (d) Computing a measure of variability or dispersion <ul style="list-style-type: none"> Why? (inadequacy of the mean) Minimum value and maximum value Range Interquartile range Variance and standard deviation (e) Discrete and continuous variables (f) Histograms and line graphs 	
UNIT IV	<p>4 A. Descriptive Statistics for summarizing nominal, ordinal and interval level variables</p> <p>4 B. Demonstration of computer software such as the Statistical Package for the Social Sciences (SPSS)</p> <ul style="list-style-type: none"> (a) Data entry (b) Data Management (c) Descriptive Statistics <p>4. C. Probability: Foundation of Advanced/Inferential Statistics</p> <ul style="list-style-type: none"> (a) Definition (b) Role of probability in research and statistics (c) Elementary concepts in probability <ul style="list-style-type: none"> Sample space, experiment, event/outcome/element of the sample space Equally likely outcomes and the uniform probability model Stabilization of the relative frequency 	15

References:

- Bhattacharyya, G.K. & Johnson, R. A. (1977). *Statistical concepts and methods*. NY: John Wiley.
- Dwiwedi, R. S. (1997). *Research methods in behavioral sciences*. Delhi: Macmillan India.
- Gravetter, F. J. & Waillnau, L. B. (2000). *Statistics for the behavioral sciences*. Belmont, CA: Wadsworth/Thomson Learning.
- Kerlinger, F. N. & Lee, H. B. (2000). *Foundations of behavioral research*. Orlando, Florida: Harcourt.
- Leong, F.T.L. & Austin, J. T. (Eds.) (1996). *The psychology research handbook*. New Delhi: Sage.

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA102	Nutritional Biochemistry	3	75	3

NUTRITIONAL BIOCHEMISTRY

No. of Credits: 3

Objectives

At the completion of this course the student should be able to:

1. Describe structure, functions and metabolism of macronutrients.
2. Describe hormonal and enzymatic modulators to the metabolism of macronutrients.
3. Describe the biochemistry and metabolism of the macronutrients during different physiological states.
4. List important micronutrients needed as cofactors involved in macronutrient metabolism.
5. Explain the metabolic inter-relationship between macronutrients.
6. Have knowledge of current research on nutrition and metabolism.

Course Content	Lectures
UNIT I Basic Chemistry and Classification of Macromolecules w.r.t <ol style="list-style-type: none"> Carbohydrates Proteins Lipids Interrelationship of Vit A – ZN, Vit E – Se, Vit C – Fe, Vit D – Ca, P, B-Complex Mn, Mg, Co. Digestion and absorption of macromolecules w.r.t. enzyme action and Biochemical mechanism. 	15
UNIT II Metabolism of macronutrients <ol style="list-style-type: none"> Carbohydrates: EMP, TCA, Gluconeogenesis, HMP, Glycogen metabolism, Uronic acid pathway Metabolism of Fructose, Galactose. Proteins: General reactions of amino acids, Urea cycle, Glucose-Alanine Cycle, NH₃ transport. Biosynthesis of Glutathione, Creatinine, Carnitine, heme, Neurotransmitters. 	15
UNIT III Metabolism of macronutrients <ol style="list-style-type: none"> Lipid- Oxidation and biosynthesis of even C fatty acid Cholesterol biosynthesis. Measurement of energy, Laws of Thermodynamics Redox reactions, Electron Transport Chain, ATP, Mechanism of Oxidative Phosphorylation, Phosphocreatine. Inborn errors of metabolism w.r.t. Carbohydrates, Lipid, Proteins, Nucleic Acid 	15

References

- Berg, J. M., Tynocrko, J. L. et al. (2002). *Biochemistry*, 5th Ed. New York: W.H. Freeman and Co.
- Brody T. (2004) *Nutritional Biochemistry* 2nd Ed. New Delhi: Elsevier/Reed Elsevier India Pvt. Ltd.
- Chatterjee, M. N., Shinde and Rana, (2005). *Textbook of Medical Biochemistry* 6th Ed. New Delhi Jaypee Brothers Medical Publishers.
- Montgomery, Rex and others (1977). *Biochemistry A case oriented Approach* St. Louis The C.V. Mosby Co.
- Murray, R. K. and others. (). *Harper's Biochemistry* 25th Ed. Connecticut: Appleton and Large Publications.
- Nelson D.L. and Cox. M.M. Lehminnges, (2000). *Principles of Biochemistry* 3rd Ed. New York: Worth Publishers Macmullan Press.
- Puri, D. (2002). *Textbook of Biochemistry- A Clinically Oriented Approach*, New Delhi: B.I. Churchill Livingstone Pvt. Ltd.
- Thomas, D. M (Ed) (1997). *Textbook of Biochemistry with Chm, Corr.* New York: John Wiley and Sons Inc.

Course Code	Title	Lectures/ week	Marks	Credits
PSHSIA103	Clinical Nutrition and Therapeutic Dietetics	3	75	3

CLINICAL NUTRITION AND THERAPEUTIC DIETETICS

No. of Credits: 3

Objectives

1. To provide an overview of the physiology and functions of different organ systems, nutritional care process, the role of a nutritionist and the methods employed in nutrition provision and intervention.
2. To impart in-depth knowledge regarding prevalence, etiology, diagnosis, pathophysiology, drug nutrient interactions, gene – nutrient interactions and medical, nutritional and lifestyle management in different disease conditions.
3. To enable students to focus on advancements in clinical nutrition, emerging modes of therapy and intervention and ongoing research in the field
4. To emphasize the importance of nutrition in the prevention of chronic disease.

Course Content		Lectures
UNIT I	Nutritional care process <ol style="list-style-type: none"> i. The nutritional care process a detailed study. ii. Role, Skills of a Nutritionist and a Dietitian iii. Counselling theories and strategies iv. Normal Hospital diet plan v. A review of recommended Dietary Allowances for the normal population vi. Modification of the hospital diet based on texture and calories Nutritional Support: Enteral and Parenteral Nutrition <ol style="list-style-type: none"> i. Access ii. Physical Characteristics iii. Nutrient composition iv. Types of formulae v. Nutrients of current interest vi. Complications and its management vii. Drug – nutrient interaction 	15
UNIT II	Nutrition and the immune system Nutrition & Immunity <ol style="list-style-type: none"> i. Physiology and functions of the immune system. ii. Nutrients affecting the immune system at the physiological, cellular and genetic level. iii. Drug-Nutrient interactions affecting immune status. iv. Nutrients involved in the Inflammatory response. v. Nutritional status and management of Infection- HIV, TB, Helicobacter pylori, Malaria, Dengue vi. Food borne Infections. 	15
UNIT III	Nutritional management in allergies <ol style="list-style-type: none"> i. Diagnosis ii. Management iii. Prevention – with special reference to GM foods Nutrition and respiratory health <ol style="list-style-type: none"> i. Physiology and functions of the respiratory system ii. Nutritional management of Asthma iii. Chronic obstructive pulmonary disease iv. Cystic Fibrosis 	15

References

- Barrer. K. (2007) *Basic Nutrition Counselling Skill Development* Wadsworth Pub. Co.
- Bendich. A. (1997) *Preventive Nutrition* Humana Press
- Blackwell Scientific Publication. (1994). *Manual Of Dietetic Practice*.2nd ed.
- British Nutrition Foundation. (1999). *Obesity*. Blackwell Science Pub.
- Brown. J. (2002). *Nutrition Through The Lifecycle*. Wadsworth Pub Co.
- Gable. J. (1997) *Counselling skills for Dietitians*, Blackwell Publishing House
- Garrow .J.S (1993). *Human Nutrition and Dietetics*, 9th ed., Churchill Livingstone Pub.
- Gibney, J. M. (2005). *Clinical Nutrition*. Blackwell Publishing House.
- Gopalan .C.(2000). *Nutritive Value of Indian Foods*. NIN ICMR Pub.
- ICMR Pub. (2000). *Nutrient Requirement and Recommended Dietary Allowances for Indians*
- Jamison .J. (2003). *Clinical Guide To Nutrition and Dietary Supplements in Disease Management*, Churchill – Livingstone Pub.
- Jeejeebhoy et al. (1988). *Nutrition and Metabolism in Patient Care* W.B.Saunders CO.
- King K. (2003). *Nutrition Therapy* 2nd Ed. Texas: Helm Publishing.
- Lee. R.D. (2003). *Nutritional Assessment* 3rd ed. M c Graw Hill Pub.
- Mahan .K.L. (2008). *Krause's Food and Nutrition Therapy* Saunders Pub.
- McCormic .D. (1999). *Annual Review of Nutrition* vol 19 &20. Annual Reviews , California.
- Peckenpaugh.N. (2003) *Nutrition Essentials and Diet Therapy*. 9th ed. Saunders Pub Co.
- Sauberlich .H (1999). *Laboratory Tests for the Assessment of Nutritional Status* 2nd ed. CRC Press
- Scott .A.S. (1997). *Nutrition Support –Theory and Therapeutics*. Chapman and Hall
- Shills. M. (2006). *Modern Nutrition in Health and Disease*.10th ed.Lippincot William and Wilkins.
- Whitney .C. (2006). *Understanding Normal and Clinical Nutrition*. Wadsworth publication
- Zaloga G. (1994). *Nutrition in Critical Care*. Mosby Pub.

Journals

- American Journal of Clinical Nutrition
- Journal of American Dietetic Association.
- Nutrition Reviews

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA104	Food Science and Processing	3	75	3

FOOD SCIENCE AND PROCESSING

No. of Credits: 3

Objectives

1. To enable understanding of the chemistry of food components, the chemical and biochemical reactions in foods.
2. To impart a systematic knowledge of basic and applied aspects of food processing and technology
3. To enable students to become familiar with the quality and safety of food.

Course Content		Lectures
UNIT I	a) Water: States of water, water activity, water in food preparation. b) Physical aspects of food preparation: energy and food energy transfer, mass transfer, state of matter, dispersions, emulsions, gels, foams. c) Carbohydrates: overview, Sugars-properties of sugars, chemical reactions – Hydrolysis, caramelization, maillard reaction. Food Applications : crystalline candies, crystallization, ripening, syrup, sauces, jams and jellies, sweeteners - types, merits and demerits, safety aspects of sweeteners. d) Starch: structure, functional properties, Gelatinization, pasting, Gelations, syneresis, retrogradation, dextrinization. Factors affecting gelatinization and gelation. Modified starch, resistant starch, Gums – Functions, sources, applications. Pectic substances, pectin gels	15
UNIT II	a) Proteins – Overview, hydrolysis, denaturation, Coagulation, Gluten complex development, Gelatin gel, modified meat products, soy proteins, texturised vegetable proteins, non-conventional sources of protein. b) Lipids Overview, crystallinity of solid fats. chemical degradation, oxidative and hydrolytic rancidity, effect of heat, chemical modifications of fats, Hydrogenation, trans fats, functional roles of fats, fat replacements.	15
UNIT III	a) Enzymes – Enzyme inactivation and control, food modifications using microbial & non microbial enzymes, enzyme browning, enzyme utilization in the food. b) Food colours – Pigments in animal and plant foods, effects of processing ,pH and storage on food colours, food colourants- permitted and non permitted c) Flavouring principles in different foods – flavours of spices, vegetables and fruits, fats and oils, flesh food, milk Artificial flavours.	15

References

- Borvers, J. (1992). *Food Theory and Application* (2ndEd), New York: Maxwell MacMillan International Edition.
- Manay, N. S. and Sharaswamy, S. M. (1997). *Foods: Facts and Principles* New Delhi: New Age International Publishers.
- McWilliams, M (2007). *Foods: Experimental Perspectives* 5th Ed, New Jersey: Macmillan Publishing Co.
- Potter, N. N. and Hutchkiss, J. H. (1997). *Food Science*, 5th Ed, New Delhi: CBS Publishers and Distributors.
- Rick Parker (2003) *Introduction to Food Science*, New York: Delmar Thomson Learning.
- Scottsmith and Hui Y.H (Editors) (2004) *Food Processing – Principles and Applications* London Blackwell Publishing.
- Subbulakshmi, G and Udipti, S. A. (2001). *Foods Processing and Preservation*, New Delhi: New Age International (P) Ltd. Publishing.
- Swaminathan, M. (1995). *Food Science Chemistry and Experimental Food*. The Bangalore Printing and Publishing Co. Ltd.
- Vacklavick, V. and Christian, E. (2003). *Essentials of Food Science*. New York: Kluwer Academic/ Plenum Publisher.

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA105	Nutrition Through the Life Cycle	3	75	3

NUTRITION THROUGH THE LIFE CYCLE

No. of Credits: 3

Objectives

1. To understand the changes in human body composition during different stages of life.
2. To study the influence of nutrition on man during the different stages of life cycle.
3. To be aware of, and update the knowledge in the field of nutrition as applied during the life cycle.

Course Content	Lectures
UNIT I Basics of Nutrition Brief overview of functions, sources and deficiency of Macro and Micronutrients Balanced Diet Nutrition during Pregnancy <ol style="list-style-type: none"> a) Reproductive Physiology (Male and Female) b) Nutrition related disruptions in fertility (under and over nutrition) c) Physiology of pregnancy d) Effect of Nutritional Status on pregnancy outcome. e) Nutritional requirements and dietary guidelines f) Nutrition related complications g) Complications of pregnancy h) HIV/AIDS during pregnancy – Dietary concerns i) Role of Exercise & Fitness j) Adolescent Pregnancy 	15
UNIT II Nutrition during lactation <ol style="list-style-type: none"> a) Physiology of Lactation b) Human milk composition c) Nutritional requirements & dietary guidelines d) Benefits of Breast Feeding e) Galactogouges f) Lactation Management in Normal & Special conditions Nutrition in infancy <ol style="list-style-type: none"> a) Physiological development, Motor, Cognitive development. b) Energy and nutrient needs. c) Feeding in early and late infancy d) Development of infant feeding skills e) Common nutrition problems f) Feeding Preterm and low birth weight infants 	15
UNIT III Nutrition in Toddlerhood and Preschool, Childhood & Preadolescent <ol style="list-style-type: none"> a) Growth and development b) Nutritional requirements c) Nutrition for children with special health care needs d) Feeding problems e) Nutritional concerns and prevention of nutrition related disorders <ol style="list-style-type: none"> i. Obesity – underweight ii. Deficiency condition iii. Allergies, eating disorders 	15

References

- Bennion, H. (1979) *Clinical Nutrition*, New York Harper and Raw Publishers
- Brown, J. E. (1998). *Nutrition Now*, West/Wadsworth: International Thomson Pub. Co.
- Brown, J. E., Sugarman, I. J. (2002). *Nutrition through the Life Cycle*, Wadsworth Thomson Learning.
- Donald, B., MCOLMICK, Bier, D. M. (1997). *Annual Review of Nutrition* (vol. 19)

Goodhart, R. S. S. and Shils, M. E. (1998). *Modern Nutrition in Health and Disease*. Philadelphia: Lea and Febiger.

Groff, J. L and Gropper, S. S. (1999). *Advanced Nutrition and Human Metabolism*, Belmont CA: Wadsworth/Thomson Learning.

Jackson, M. S., Rees, Jane, M., Golden, Neville, H.; Irwin Charles, E. (ed) (1997). *Adolescent Nutritional Disorders*. New York: The New York Academy of Science.

Lee, R. S. and Marcus, C. (1990) *Omega – 3 Fatty Acids in Health and Disease*. – Marcel Dekker Inc.

Mahan L. K. & Stump S.E. (11th ed.) (2004) *Krause's Food Nutrition and Diet Therapy* – Saunders USA: Elsevier.

Wardlaw, G. M. Insel, P. M. and Seyler M. F. (1994). *Contemporary Nutrition; Issues and Insights* St. Louis: Mosby.

Warthington, R., Vermeersch J. and Williams, S. (1985). *Nutrition in Pregnancy and Lactation* St. Louis: Times Mirror/Mosby College Publishing.

Ziegler, E. E. and Filer L. J. (1996). *Present Knowledge in Nutrition*, Washington D.C.: International Life Science Institute.

Journals

Journal of American Dietetic Association USA – The American Dietetics Association.

Nutrition Reviews, New York: Springer-Verlag

The American – Journal of Clinical Nutrition – USA Official Journal of the American Society for Clinical Nutrition Inc

The Indian Journal of Nutrition and Dietetics

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA101	Practicum in Research Methods	3	50	2

PRACTICUM IN RESEARCH METHODS

No. of Credits: 2

Objectives

To provide students with opportunities for hands-on exercises with regard to many steps of the research process, such that they have met the prerequisites for research work.

Course Content		Periods
UNIT I	Preliminary steps in the research process: using multiple search strategies (Part I) a) Identifying broad areas of research in one's specialization (identifying leading scholarly journals, reading the tables of contents, articles in which areas are solicited in each such journal, scanning dissertation topics, identifying focus areas with regard to dissertation topics, changes in dissertation topics over the years, interviewing academicians/researchers/ practitioners, Net search)	15
UNIT II	Preliminary steps in the research process: using multiple search strategies (Part II) a) Visits to research centers in Mumbai (relevant to one's specialization) b) Identifying priority areas of research in one's specialization c) Identifying areas of personal interest (selecting any one dissertation, summarizing this dissertation, justifying the selection of this dissertation; selecting any one research article from a reputed scholarly journal, summarizing this research, justifying the selection of this research article; interviewing one local expert; communicating with one national or international expert in one's area of interest using e-mail)	15
UNIT III	Preliminary steps in the research process: the review of literature and statement of purpose a) studying the review of literature in various dissertations and research articles and identifying key features of the content of literature reviews b) studying the manner in which the purpose is stated in dissertations and research articles c) developing skills in paraphrasing (i.e., rewriting ideas in own words) and avoiding plagiarism (due acknowledgement to original source) d) developing skills in formulating research objectives, questions and hypotheses e) developing skills in writing and orally communicating a literature review and statement of research purpose	15

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA102	Food Science	2	50	2

FOOD SCIENCE

No. of Credits: 2

Objectives

1. To guide the students in their quest for the scientific principles involved in the attainment of food quality.
2. To observe and identify physical and chemical changes underlying the preparation diverse of foods.

Course Content		Periods
UNIT I	Sensory evaluation of foods <ol style="list-style-type: none"> i. Threshold concentrations of primary tastes. ii. Effect of Temperature on taste. iii. Identification of samples through Difference, Descriptive and Affective testing Solutions and Ice crystallization: Effect of formula and procedure on crystal size of frozen deserts Sugar cookery <ol style="list-style-type: none"> i. Tests for stages of sugar cookery ii. Effect of dry heat on sucrose. iii. Crystalline and Non crystalline candies 	15
UNIT II	<ol style="list-style-type: none"> a) Cereals and Flours <ol style="list-style-type: none"> i. Gelatinisation of Starch ii. Comparison of different cereals for water absorption and consistency iii. Comparison of - different methods of cooking rice, different varieties of rice iv. Starches as thickening agents a) Temporary and Permanent emulsions in Salad Dressings, Effect of Stabilizers and Emulsifiers in salad dressings. b) Comparisons of low fat and high fat French dressing: Preparation and Comparison of Mayonnaise with variations c) Principles that maintain high quality fried foods <ol style="list-style-type: none"> i. Smoke point of different fats and oils ii. Effect of Temperature on fat absorption iii. Effect of Formulation on fat absorption iv. Effect of Breading on fat absorption Comparison of Texture, flavor and mouth-feel of food products using fat substitutes (if available) 	15

References

- Jameson K. (1998). *Food Science – A Laboratory Manual*, New Jersey:Prentice Hall Inc.
- Lawless, H. and Heymann, H. (1998). *Sensory Evaluation of Food – Principles and Practices*, Kluwer Academic/Plemer Publishers.
- USA: CRC Press Inc..
- McWilliam, M.(2001). *Foods – Experimental Perspectives* (4th Ed.), New Jersey: Prentice Hall Inc.
- Weaver, C. (1996), *Food Chemistry Laboratory – A manual for Experimental Foods*,

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA103	Biochemistry and Food Analysis	5	50	2

BIOCHEMISTRY AND FOOD ANALYSIS

No. of Credits: 2

Objectives

1. Theoretical knowledge remains incomplete unless complemented by a course in practical in which laboratory techniques common to both basic and applied food chemistry & biochemistry is taught to students.
2. Practical help to understand the principles behind analytical techniques
3. To select and standardize the appropriate analytical technique.
4. Demonstrate practical proficiency in the laboratory
5. Learn to manage time effectively.
6. Be equipped to work in a food industry or a clinical biochemistry laboratory.

Course Content		Periods
UNIT I	a) Standardization of acids and alkalies b) Preparation of buffers and indicators - Use of pH meter c) Paper chromatography of amino acids, sugars d) Agarose gel electrophoresis of serum proteins	15
UNIT II	a) Estimation of calcium from serum by Trinder's method b) Phosphorus by Fiske – Subbarow method	15
UNIT III	a) Serum Iron by Dipyrindyl method b) Serum Creatinine by Jaffe's method c) Serum uric acid by caraway method	15
UNIT IV	a) Serum Blood Urea Nitrogen b) Serum Cholesterol, Triglycerides c) Serum Bilirubin Evelyn-Malloy	15
UNIT V	a) Isolation, Partial purification, calculation of % yield of Amylase from sweet potato and study of optimum pH, Km b) Pectin from apples/ bananas/ oranges c) Starch from potato	15

References

- Dandekar, S. P., Rane S. A. (2004). *Practicals & Viva in Medical Biochemistry*, New Delhi: Elsevier/Reed Elsevier India Pvt Ltd.
- Godkar, P. B. (2003). *Textbook of Medical Laboratory Technology* 2nd Ed. Mumbai. Bhalani Publishing House.
- Jayaram J., (1981) *Laboratory Manual in Biochemistry*, New Delhi: Wiley Eastern Ltd.
- Pearson, D. (1970). *Chemical Analysis of Foods*, (6th Ed), London: T.A. Churchill.
- Plummer, D. T. (1979). *Introduction to Practical Biochemistry*. Bombay: Tata McGraw Hill Pub. Co. Ltd.
- S. Sadasivan and A. Manickam, (2003). *Biochemical Methods*, 2nd ed. New Age International (P) Ltd.. Publishers.
- Varley, Harold, & others. (1980) *Practical Clinical Biochemistry*. 5th Ed. Delhi: CBS Publishers & Distributors.

SEMESTER II

Course Code	Title	Credits	Periods	Marks
PSHSIA201	Research Methods and Statistics	4	4	100
PSHSIA202	Nutritional Biochemistry	3	3	75
PSHSIA203	Clinical Nutrition and Therapeutic Dietetics	3	3	75
PSHSIA204	Food Science and Processing	3	3	75
PSHSIA205	Nutrition through Life Cycle	3	3	75
PSHSPIA201	Practicum in Research Methods	2	3	50
PSHSPIA202	Food Science	2	2	50
PSHSPIA203	Biochemistry and Food Analysis	4	5	100
	Total:	24	26	600

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA201	Research Methods and Statistics II	4	100	4

RESEARCH METHODS AND STATISTICS

No. of Credits: 4

Objectives

1. To help students develop the skills needed in conducting a research in their specialisation.
2. To promote academic, research and professional ethics in students.
3. To introduce students to principles of good scientific writing.
4. To enable in students the skills in selecting, computing, interpreting and reporting statistics.

Course Content	Lectures
UNIT I 1 A. Sampling techniques in quantitative research (a) Sampling methods in current use/examples from current research (b) Issues with regard to sampling techniques I B. Research designs in quantitative research Distinguishing between the following research designs; and, selecting research designs that are congruent with one's research purpose. (a) Longitudinal versus cross-sectional (b) Experimental versus quasi-experimental versus correlational (c) Exploratory versus descriptive versus explanatory	15
UNIT II 2 A. Qualitative research methods (a) Ideology/worldview of the qualitative researcher (b) Research designs in qualitative research (c) Sampling techniques in qualitative research (d) Data collection methods in qualitative research (e) Data analytic strategies in qualitative research (f) Reporting of results in qualitative research 2B. Scientific writing (a) Distinguishing scientific writing from popular and literary writing styles (b) Characteristics/principles of scientific writing (c) Examples of good scientific writing (d) Writing a research proposal (d) Reporting statistical findings in text 2 C. Ethics (a) In academia (b) In research in general (c) In research with human subjects (d) In research with animal subjects	15
UNIT III 3 A. Other concepts needed for the use of advanced/inferential statistics (a) Types of distribution Frequency distribution Normal distribution Probability distribution Sampling distribution (b) Type I and type II errors (c) Central limit theorem (d) Point estimation vs. interval estimation (e) Standard error (and confidence intervals)	15

	(f) Parametric and nonparametric methods 3 B. Using an advanced statistical method (steps in using an advanced statistical method)	
UNIT IV	4 A. To study statistics that allows us to contrast phenomena (a) Univariate chi-square test (b) Bivariate chi-square test (c) t- or z- test for contrasting two independent groups (d) Paired t-test (e) ANOVA 4 B. To study statistics that allows us to examine relationships between variables (a) Bivariate chi-square test (b) Product-moment correlation coefficient 4 C. Ethics in the use of statistics (e.g., the importance of test assumptions, the number of statistical tests in a research and levels of significance)	15

References

- Bhattacharyya, G.K. & Johnson, R. A. (1977). *Statistical Concepts and Methods*. NY: John Wiley.
- Dwiwedi, R. S. (1997). *Research Methods in Behavioral Sciences*. Delhi: Macmillan India.
- Gravetter, F. J. & Waillnau, L. B. (2000). *Statistics for the Behavioral Sciences*. Belmont, CA: Wadsworth/Thomson Learning.
- Kerlinger, F. N. & Lee, H. B. (2000). *Foundations of Behavioral Research*. Orlando, Florida: Harcourt.
- Leong, F.T.L., & Austin, J. T. (Eds.) (1996). *The Psychology Research Handbook*. New Delhi: Sage.

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA202	Nutritional Biochemistry	3	75	3

NUTRITIONAL BIOCHEMISTRY

No. of Credits: 3

Objectives

At the completion of this course the student should be able to:

1. Describe structure, functions and metabolism of macronutrients.
2. Describe hormonal and enzymatic modulators to the metabolism of macronutrients.
3. Describe the biochemistry and metabolism of the macronutrients during different physiological states.
4. List important micronutrients needed as cofactors involved in macronutrient metabolism.
5. Explain the metabolic inter-relationship between macronutrients.
6. Have knowledge of current research on nutrition and metabolism.

Course Content		Lectures
UNIT I	Chemistry of Nucleic Acids a) Structure of DNA, RNA b) Replication of DNA c) Disorders of purine, pyrimidine d) Transcription, translation e) Regulation of gene expression f) Nutrient gene interactions	15
UNIT II	Enzyme chemistry a) IUB Classification, Identification of active site, factors affecting enzyme activity, Km and its significance, enzyme inhibition, drug-enzyme interactions, enzymes of clinical significance. b) Nutrient and Drug Interactions: Effect of drugs on nutrient status. Food and drug-nutrient incompatibilities	15
UNIT III	Enzyme chemistry a) Body defense mechanisms b) Detoxification and role of cytochrome p450 c) Free radicals, antioxidants. Hormones a) Chemistry b) Mechanism of action c) Physiological functions and disorders associated with Thyroxine, Catecholamines, Insulin, Glucagon, Corticosteroids and Growth hormone	15

References

- Berg, J. M., Tynocrko, J. L. et al. (2002). *Biochemistry*, 5th Ed. New York: W.H. Freeman and Co.
- Brody T. (2004) *Nutritional Biochemistry* 2nd Ed. New Delhi: Elsevier/Reed Elsevier India Pvt. Ltd.
- Chatterjee, M. N., Shinde and Rana, (2005). *Textbook of Medical Biochemistry* 6th Ed. New Delhi Jaypee Brothers Medical Publishers.
- Montgomery, Rex and others (1977). *Biochemistry A case oriented Approach* St. Louis The C.V. Mosby Co.
- Murray, R. K. and others. (). *Harper's Biochemistry* 25th Ed. Connecticut: Appleton and Large Publications.
- Nelson D.L. and Cox. M.M. Lehminnges, (2000). *Principles of Biochemistry* 3rd Ed. New York: Worth Publishers Macmullan Press.
- Puri, D. (2002). *Textbook of Biochemistry- A Clinically Oriented Approach*, New Delhi: B.I. Churchill Livingstone Pvt. Ltd.
- Thomas, D. M (Ed) (1997). *Textbook of Biochemistry with Chm, Corr.* New York: John Wiley and Sons Inc.

Course Code	Title	Lectures/ week	Marks	Credits
PSHSIA203	Clinical Nutrition and Therapeutic Dietetics	3	75	3

CLINICAL NUTRITION AND THERAPEUTIC DIETETICS

No. of Credits: 3

Objectives

1. To provide an overview of the physiology and functions of different organ systems, nutritional care process, the role of a nutritionist and the methods employed in nutrition provision and intervention.
2. To impart in-depth knowledge regarding prevalence, etiology, diagnosis, pathophysiology, drug nutrient interactions, gene – nutrient interactions and medical, nutritional and lifestyle management in different disease conditions.
3. To enable students to focus on advancements in clinical nutrition, emerging modes of therapy and intervention and ongoing research in the field
4. To emphasize the importance of nutrition in the prevention of chronic disease.

Course Content	Lectures
UNIT I Nutrition in lifestyle related and chronic degenerative disease <ol style="list-style-type: none"> a) Weight management <ol style="list-style-type: none"> i. Regulation of body weight ii. Genetics and body weight iii. Obesity: Etiology, Assessment, Classification, Management of Obesity (Medical, Nutritional, Lifestyle management, Role of exercise, Surgical and complications, Childhood Obesity, Nutrition in exercising obese individuals) iv. Underweight: Etiology Metabolic consequences of starvation and Management v. Eating Disorders: <ul style="list-style-type: none"> - Anorexia Nervosa - Bulimia - Binge eating disorders 	15
UNIT II Nutrition in Diabetes Mellitus <ol style="list-style-type: none"> a) Physiology and functions of the pancreas. b) Etiology, classification, complications and management <ol style="list-style-type: none"> i. Medical (insulin and OHA) ii. Nutritional and Lifestyle Modification. iii. Role of exercise iv. Management of DM in special condition of infection v. Surgery vi. Gestational DM vii. Nutrition in Athletes and exercising Diabetic patients 	15
UNIT III Nutrition in Cardiovascular Diseases <ol style="list-style-type: none"> a) Physiology and functions of cardiovascular system – heart, blood, blood cells, blood vessels b) Regulation of blood pressure c) Regulation of lipoproteins d) Atherosclerosis - Etiology and Risk factors, Pathophysiology e) Complications and their management <ul style="list-style-type: none"> - Myocardial infarction - Hypertension - Congestive Cardiac Failure - Hyperlipidemia f) Nutrition in athletes and Exercising patients with hypertension & hyperlipidemia 	15

	<p>Nutrition and Metabolic Syndrome: Prevalence, Etiology, Risk factors, Complications and Management. Special emphasis to preventive role of nutrition and lifestyle</p> <p>Nutrition in the hyper-catabolic state</p> <ol style="list-style-type: none"> a) Physiological, endocrine, metabolic and nutritional alteration in physiological stress b) Nutritional management of the hyper-catabolic patients c) Burns d) Trauma e) Surgery f) Sepsis (SIRS, MODS) g) Drug nutrient interaction 	
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References

- Barrer. K. (2007) *Basic Nutrition Counselling Skill Development* Wadsworth Pub. Co.
- Bendich. A. (1997) *Preventive Nutrition* Humana Press
- Blackwell Scientific Publication. (1994). *Manual Of Dietetic Practice*. 2nd ed.
- British Nutrition Foundation. (1999). *Obesity*. Blackwell Science Pub.
- Brown. J. (2002). *Nutrition Through The Lifecycle*. Wadsworth Pub Co.
- Gable. J. (1997) *Counselling skills for Dietitians*, Blackwell Publishing House
- Garrow .J.S (1993). *Human Nutrition and Dietetics*, 9th ed., Churchill Livingstone Pub.
- Gibney, J. M. (2005). *Clinical Nutrition*. Blackwell Publishing House.
- Gopalan .C.(2000). *Nutritive Value of Indian Foods*. NIN ICMR Pub.
- ICMR Pub. (2000). *Nutrient Requirement and Recommended Dietary Allowances for Indians*
- Jamison. J. (2003). *Clinical Guide To Nutrition and Dietary Supplements in Disease Management*, Churchill – Livingstone Pub.
- Jeejeebhoy et al. (1988). *Nutrition and Metabolism in Patient Care* W.B.Saunders CO.
- King K. (2003). *Nutrition Therapy* 2nd Ed. Texas: Helm Publishing.
- Lee. R.D. (2003). *Nutritional Assessment* 3rd ed. M c Graw Hill Pub.
- Mahan .K.L. (2008). *Krause’s Food and Nutrition Therapy* Saunders Pub.
- McCormic .D. (1999). *Annual Review of Nutrition* vol 19 & 20. Annual Reviews , California.
- Peckenpaugh.N. (2003) *Nutrition Essentials and Diet Therapy*. 9th ed. Saunders Pub Co.
- Sauberlich .H (1999). *Laboratory Tests for the Assessment of Nutritional Status* 2nd ed. CRC Press
- Scott .A.S. (1997). *Nutrition Support –Theory and Therapeutics*. Chapman and Hall
- Shills. M. (2006). *Modern Nutrition in Health and Disease*. 10th ed. Lippincot William and Wilkins.
- Whitney .C. (2006). *Understanding Normal and Clinical Nutrition*. Wadsworth publication
- Zaloga G. (1994). *Nutrition in Critical Care*. Mosby Pub.

Journals

- American Journal of Clinical Nutrition
- Journal of American Dietetic Association.
- Nutrition Reviews

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA204	Food Science and Processing	3	75	3

FOOD SCIENCE AND PROCESSING

No. of Credits: 3

Objectives

1. To enable understanding of the chemistry of food components, the chemical and biochemical reactions in foods.
2. To impart a systematic knowledge of basic and applied aspects of food processing and technology
3. To enable students to become familiar with the quality and safety of food.

Course Content		Lectures
UNIT I	a) Evaluation of food quality – subjective and objective evaluation, Requirements and techniques. Biosensors and E-nose b) Food laws and standards: Nutrition and Food labeling Brief overview of general principles of food preservation – heat preservation, cold preservation, ionizing radiation, dehydration and concentration and fermentation. Minimally processed foods c) Use of hurdle technology, Application of Nanotechnology, Biotechnology in food preservation & processing	15
UNIT II	Processing technology of foods: <ol style="list-style-type: none"> i. Cereals & Millets – Milling of cereals(rice,wheat ,corn) & millets (ragi & bajra), breakfast cereals, fortified cereals Processes involved in certain baked and extruded products using cereals and millets. ii. Pulses – Processing, elimination of toxic factors soyabean products. iii. Oil seeds – oil extraction, purification, fully refined oil, margarine, peanut butter, salad dressings. iv. Fruits and vegetables – Changes during ripening storage, dehydrated, canned and frozen vegetables, fruit processing – jams, jellies, mamalades, puree, pastes, powders, beverages, fruit juices 	15
UNIT III	Processing technology of foods: <ol style="list-style-type: none"> i. Milk and Milk products – Milk processing, pasteurization, homogenization, standardization. Milk products, cheese, butter, cream, ghee, milk powder, ice cream concentrated milk, skim milk, lactone, Vit. D milk. ii. Eggs - Quality of eggs, deterioration, egg processing – dehydration and freezing, egg products. iii. Poultry processing and Tandoor chicken iv. Fish spoilage in fish, canned, dehydrated and frozen, fish meal, fish protein concentrate fish oils. v. Meat – Meat tenderization ageing and curing, sausages. vi. Sugar and Jaggery - manufacture of sugar, HFCS Convenience foods & ready to eat foods	15

References

- Borvers, J. (1992). *Food Theory and Application* (2ndEd), New York: Maxwell MacMillan International Edition.
- Manay, N. S. and Sharaswamy, S. M. (1997). *Foods: Facts and Principles* New Delhi: New Age International Publishers.
- McWilliams, M (2007). *Foods: Experimental Perspectives* 5th Ed, New Jersey: Macmillan Publishing Co.
- Potter, N. N. and Hutchkiss, J. H. (1997). *Food Science*, 5th Ed, New Delhi: CBS Publishers and Distributors.
- Rick Parker (2003) *Introduction to Food Science*, New York: Delmar Thomson Learning.
- Scottsmith and Hui Y.H (Editors) (2004) *Food Processing – Principles and Applications* London Blackwell Publishing.

Subbulakshmi, G and Udipi, S. A. (2001). *Foods Processing and Preservation*, New Delhi: New Age International (P) Ltd. Publishing.

Swaminathan, M. (1995). *Food Science Chemistry and Experimental Food*. The Bangalore Printing and Publishing Co. Ltd.

Vacklavick, V. and Christian, E. (2003). *Essentials of Food Science*. New York: Kluwer Academic/ Plenum Publisher.

Course Code	Title	Lectures/week	Marks	Credits
PSHSIA205	Nutrition Through the Life Cycle	3	75	3

NUTRITION THROUGH THE LIFE CYCLE

No. of Credits: 3

Objectives

1. To understand the changes in human body composition during different stages of life.
2. To study the influence of nutrition on man during the different stages of life cycle.
3. To be aware and update the knowledge in the field of applied nutrition during the life cycle.

Course Content		Lectures
UNIT I	Nutrition in adolescence <ol style="list-style-type: none"> a) Growth and development b) Physiological and Psychological changes c) Nutritional requirements of adolescents d) Health and eating related behavior Nutrition situation with special needs <ol style="list-style-type: none"> a) Pregnancy b) Eating disorders c) Obesity – underweight d) Substance abuse e) Deficiency conditions f) Sports and athletics 	15
UNIT II	Nutrition in the adult years <ol style="list-style-type: none"> a) Physiological and Psychosocial changes b) Common nutritional concerns c) Defensive Nutrition paradigm d) Nutritional requirements and dietary recommendation. e) Physical Activity in adulthood 	15
UNIT III	Nutrition in Aging/Elderly <ol style="list-style-type: none"> a) Theories of Aging, Physiological and Psychosocial changes b) The Aging Process c) Nutritional requirements of the Elderly d) Nutrition care Nutrition needs during illness and chronic conditions <ol style="list-style-type: none"> a) Sensory loss b) Oral health c) GI functions d) Neuromuscular and skeletal functions e) Renal and cardiac function f) Immuno-competence 	15

References

- Bennion, H. (1979) *Clinical Nutrition*, New York Harper and Raw Publishers
- Brown, J. E. (1998). *Nutrition Now*, West/Wadsworth: International Thomson Pub. Co.
- Brown, J. E., Sugarman, I. J. (2002). *Nutrition through the Life Cycle*, Wadsworth Thomson Learning.
- Donald, B., MCColmick, Bier, D. M. (1997). *Annual Review of Nutrition* (vol. 19)
- Goodhart, R. S. S. and Shils, M. E. (1998). *Modern Nutrition in Health and Disease*. Philadelphia: Lea and Febiger.
- Groff, J. L and Gropper, S. S. (1999). *Advanced Nutrition and Human Metabolism*, Belmont CA: Wadsworth/Thomson Learning.
- Jackson, M. S., Rees, Jane, M., Golden, Neville, H.; Irwin Charles, E. (ed) (1997). *Adolescent Nutritional Disorders*. New York: The New York Academy of Science.
- Lee, R. S. and Marcus, C. (1990) *Omega – 3 Fatty Acids in Health and Disease*. – Marcel dekker Inc.

Mahan L. K. & Stump S.E. (11th ed.) (2004) *Krause's Food Nutrition and diet Therapy* – Saunders USA: Elsevier.
Wardlawy, G. M. Insel, P. M. and Seyler M. F. (1994). *Contemporary Nutrition; Issues and Insights* St. Lopuis Masby.
Warthington, R., Vermeersch J. and Willams, S. (1985). *Nutrition in Pregnancy and Lactation* St. Louis Times Mirror.Mosby College Publishing.
Ziegler, E. E. and Filer L. J. (1996). *Present Knowledge in Nutrition*, Washington D.C.: International Life Science institute.

Journals

Journal of American Dietetic Association USA – The American Dietetics Association.
Nutrition Reviews, New York Springton Verlag
The American – Journal of clinical Nutrition – USA Official Journal of the American Society for Clinical Nutrition Inc
The Indian Journal of Nutrition and Dietetics

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA201	Practicum in Research Methods	3	50	2

PRACTICUM IN RESEARCH METHODS

No. of Credits: 2

Objectives

To provide students with opportunities for hands-on exercises with regard to many steps of the research process, such that they have met the prerequisites for research work

Course Content		Periods
UNIT I	Middle steps in the research process: the methods, examining and evaluating the methods used to accomplish a stated research aim using examples from various dissertations and research articles both in writing and orally, in particular, the: a) research designs (e.g., qualitative, quantitative) b) sampling techniques, sample sizes, and sample characteristics c) data collection/measurement d) plan of analysis	15
UNIT II	Latter steps in the research process: results a) examining key features of the results section of dissertations and research articles b) using analyzed data to write the results (making tables, making figures, scientific protocol in communicating statistical findings in text, qualitative research and thick description)	15
UNIT III	Latter steps in the research process: discussion, and references a) examining key features of the discussion section of dissertations and research articles (corroboration, explanation, implications, and recommendations) b) using various findings sections and writing the discussion of the findings c) Reviewing, summarizing, and evaluating the complete research article in writing (maintaining a research journal) and orally (developing professional skills in presentation of a research)	15

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA202	Food Science	3	50	2

FOOD SCIENCE

No. of Credits: 2

Objectives

1. To guide the students in their quest for the scientific principles involved in the attainment of food quality.
2. To observe and identify physical and chemical changes underlying the preparation diverse of foods.

Course Content		Periods
UNIT I	<p>Milk and Milk products</p> <ol style="list-style-type: none"> a) Effect of heat and acid on cooking of milk. b) Effect of Gums on milk Gelation. c) Effect of fat content, pH stabilizers in cream and whipped toppings. d) Differences between Natural and Processed cheese. <p>Eggs</p> <ol style="list-style-type: none"> a) Denaturation and Coagulation of egg proteins in a variety of egg products. b) Coagulation and gelation in Custards. c) Egg white foams – Volume and stability 	15
UNIT II	<p>Gelatin</p> <ol style="list-style-type: none"> a) Effect of Temperature of liquid. b) Effect of Proteolytic enzyme c) Effect of Whipping <p>Pigments and Pectins in Fruits and vegetables</p> <ol style="list-style-type: none"> a) Identification colour and texture changes on select vegetables after heat treatments, and treatment with acid and alkalines. b) Gel forming properties of natural pectin in fruits. 	15

References

- Jameson K. (1998). *Food Science – A Laboratory Manual*, New Jersey:Prentice Hall Inc.
- Lawless, H. and Heymann, H. (1998). *Sensory Evaluation of Food – Principles and Practices*, Kluwer Academic/Plemer Publishers.
- USA: CRC Press Inc.
- Weaver, C. (1996), *Food Chemistry Laboratory – A Manual for Experimental Foods*,

Course Code	Title	Periods/week	Marks	Credits
PSHSPIA203	Biochemistry and Food Analysis	5	50	2

BIOCHEMISTRY AND FOOD ANALYSIS

No. of Credits: 2

Objectives

1. Theoretical knowledge remains incomplete unless complemented by a course in practical in which laboratory techniques common to both basic and applied food chemistry & biochemistry is taught to students.
2. Practical help to understand the principles behind analytical techniques
3. To select and standardize the appropriate analytical technique.
4. Demonstrate practical proficiency in the laboratory
5. Learn to manage time effectively.
6. Be equipped to work in a food industry or a clinical biochemistry laboratory.

Course Content		Periods
UNIT I	Isolation and estimation of a) Cholesterol from egg-yolk b) Curcumin from turmeric	15
UNIT II	Isolation and estimation using Thin layer chromatography for pigments from turmeric, carrots, spinach	15
UNIT III	Urine Analysis: Detection of abnormal Constituents	15
UNIT IV	Enzyme Chemistry: SGOT – SGPT and Alkaline Phosphatase	15
UNIT V	Hematology: Estimation of Hb by Sahli's/Drabkin's method, Demonstration of ESR, PCV, Bleeding & Clotting time, RBC, WBC count	15

References

- Dandekar, S. P., Rane S. A. (2004). *Practicals & Viva in Medical Biochemistry*, New Delhi: Elsevier/Reed Elsevier India Pvt Ltd.
- Godkar, P. B. (2003). *Textbook of Medical Laboratory Technology* 2nd Ed. Mumbai. Bhalani Publishing House.
- Jayaram J., (1981) *Laboratory Manual in Biochemistry*, New Delhi: Wiley Eastern Ltd.
- Pearson, D. (1970). *Chemical Analysis of Foods*, (6th Ed), London: T.A. Churchill.
- Plummer, D. T. (1979). *Introduction to Practical Biochemistry*. Bombay: Tata McGraw Hill Pub. Co. Ltd.
- S. Sadasivan and A. Manickam, (2003). *Biochemical Methods*, 2nd ed. New Age International (P) Ltd.. Publishers.
- Varley, Harold, & others. (1980) *Practical Clinical Biochemistry*. 5th Ed. Delhi: CBS Publishers & Distributors.