THE UNIVERSITY OF BURDWAN



SYLLABUS FOR 2-YEAR M.SC. IN NUTRITION AND PUBLIC HEALTH

UNDER CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES (CCFPP) AS PER NEP 2020

WITH EFFECT FROM 2026–2027

SCHEME AND SYLLABUS FOR SEMESTERWISE AND COURSEWISE CREDITS AND MARKS DISTRIBUTION STRUCTURE UNDER CCFPP AS PER NATIONAL EDUCATION POLICY 2020 FOR 2-YEAR M.Sc. IN NUTRITION AND PUBLIC HEALTH

SEMESTER - I						
Course Name	**Title of the Course**	**Credits**	**Full Marks**	**Marks Division**		
				Th.	**Pr.**	**IA**
		L-T-P				
Major/DS Course (NUTR 1011)/	**ADVANCED FOOD SCIENCE, NUTRITION AND HEALTH**	**6 (5-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 1012)	**NUTRITIONAL BIOINFORMATICS AND IMMUNO-GENETICS**	**6 (5-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 1013)	**RESEARCH METHODOLOGY AND BIO-STATISTICS**	**6 (5-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 1014)	**PRACTICAL (BIO-STATISTICS, BIOINFORMATICS AND IMMUNO-GENETICS)**	**6 (0-0-6)**	**75**	**-**	**60**	**15**
Minor Course (NUTR 1021)	**NUTRITIONAL ASSESSMENT AND PROGRAMMES**	**4 (3-0-1)**	**75**	**40**	**20**	**15**
----------	**Total**	**28**	**375**	**-**	**-**	**-**
SEMESTER – II						
Major/DS Course (NUTR 2011)	**MEDICAL PARASITOLOGY AND MICROBIOLOGY**	**6 (5-1-0)**	**75**	**60**	**-**	**15**
Minor Course (NUTR 2021)	**COMMUNITY NUTRITION**	**4 (3-0-1)**	**75**	**40**	**20**	**15**
Research Project/ Dissertation (NUTR 2091)	**RESEARCH PROJECT/ DISSERTATION**	**12 (0-0-12)**	**225**	Seminar Presentation, Preparation & Submission of Research		

				Project/ Dissertation - 135 +Viva - 90
---------	**Total**	**22**	**375**	

OR **SEMESTER – II (HONS.)**						
Course Name	**Title of the Course**	**Credits**	**Full Marks**	**Marks Division**		
		L-T-P		**Th.**	**Pr.**	**IA**
Major/DS Course (NUTR 2011)	**MEDICAL PARASITOLOGY AND MICROBIOLOGY**	**6 (5-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 2012)	**FOOD PROCESSING AND PACKAGING TECHNIQUES**	**4 (3-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 2013)	**APPLIED BIOCHEMISTRY AND PHYSIOLOGY**	**4 (3-1-0)**	**75**	**60**	**-**	**15**
Major/DS Course (NUTR 2014)	**PRACTICAL (FOOD PROCESSING, BIOCHEMISTRY AND MICROBIOLOGY)**	**4 (0-0-4)**	**75**	**-**	**60**	**15**
Minor Course (NUTR 2021)	**COMMUNITY NUTRITION**	**4 (3-0-1)**	**75**	**40**	**20**	**15**
-	**Total**	**22**	**375**	**-**	**-**	**-**
-	**Grand Total (Semester I – II)**			**-**	**-**	**-**

SEMESTER – I

MAJOR COURSE

ADVANCED FOOD SCIENCE, NUTRITION AND HEALTH

(Code: NUTR 1011)
[TOTALCREDITS: 6 (THEORY-5, TUTORIAL-1)]

Course Outcome:

This course provides an advanced understanding of nutritional science, public health, and holistic wellness through the study of core and functional foods. Students explore the technology and ethics behind GM crops while analyzing the therapeutic role of nutraceuticals in managing chronic diseases like diabetes. The curriculum covers food enhancement techniques, such as fortification and probiotics, to improve community health outcomes. By bridging biological population dynamics with public health strategies, the course addresses India's specific nutritional challenges. Additionally, it integrates the principles of yoga and physical activity to promote psychological resilience and preventive healthcare. Ultimately, graduates will be equipped to apply evidence-based nutrition and lifestyle interventions for comprehensive health promotion.

1. Overview of Food and Nutrition:

- Core foods, Secondary foods and Peripheral foods
- Public Health Nutrition, Community Nutrition, Different levels of studying Nutrition, Services and activities of Public Heath Nutrition.
- Functional foods -Definition, development of functional foods, Use of bioactive compounds in appropriate form

2. Genetically modified foods/crops:

- Techniques for GM foodpreparation, available genetically modified (GM) foods in India
- **Advantages, Limitations**: Bt brinjal, Bt maize, Golden Rice.

3. Nutraceutical and Health:

- Concept, classification, sources and importance of nutraceuticals.
- Natural occurrence of certain phytochemicals and their role- flavonoids, omega–3 fatty acids, carotenoids, dietary fiber, phytoestrogens, glucosinates, organosulphur compounds.
- Role of nutraceuticals in the management of diabetes, obesity and cardiovascular diseases.
- Concept of oxidant and ROS, Antioxidant (Natural and synthetic), Enzymatic and non-enzymatic antioxidant, Oxidative stress and nutraceutical on oxidative stress.

4. Prebiotic, Probiotic and Enhanced quality of foods:

- Types of prebiotics and their effects on gut microbes, Health benefits and recent development of prebiotics, probiotics and Symbiotics
- Fundamentals of Germination and Fermentation.
- Food Fortification and Enrichment: Methods, advantages and limitations and safety

5. Nutraceutical Enriched Medicinal Plants:

- Importance of Medicinal Plants - Amla, Brahmi, Arjuna, Garlic, Ginger, Tulsi,

Turmeric, Ashwagandha, Aloe-Vera, Sarpgandha, Isubgol.

6. Population, Community and Public Health:

- Population dynamics - Natality, Mortality, Survivorship and age distribution.
- Community structure, Major and Minor community, Relationship between species and number (Abundance, Density, Frequency, Relative abundance, Dominance, Dominance index, Species diversity), Community boundary
- Concept of Public Health and Nutritional Public Health problems in India, Important Public Health Acts,

7. Physical activity, Yoga and Health:

- Importance and benefits of physical activity
- Physical Activity – frequency, intensity, time and type with examples, physical activity guidelines and physical activity pyramid.
- Yoga and Health Promotion: Fundamental concepts of yoga and its role in health promotion, the impact of yoga on physical, mental, and psychological well-being, the application of yoga in stress management, principles of a yogic diet; the preventive role of yoga in common diseases and the contribution of yoga to personality development.

Suggested readings:

- Ramesh C. Chandan & Arun Kilara, *Dairy Ingredients for Food Processing*, 2011, Wiley-Blackwell, John Wiley & Sons Inc., Hoboken, New Jersey, USA.
- M. G. Traber & J. Packer, *Nutrition and Health: Oxidative Stress and Antioxidant Protection*, 2008, CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.
- Fereidoon Shahidi, *Nutraceuticals and Functional Foods*, 2004, CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.
- Norman J. Temple, Ted Wilson & David R. Jacobs, *Nutritional Health: Strategies for Disease Prevention*, 2012, Humana Press (Springer), New York, USA.
- M. S. Swaminathan, *Food and Nutrition*, 2011, Bappco Publishers, Bangalore, India.
- Shyam S. Chauhan & M. P. Dobhal, *Medicinal Plants of India*, 2010, Bishen Singh Mahendra Pal Singh, Dehradun, Uttarakhand, India.
- Gibson, Glenn R. & Roberfroid, Marcel B., *Handbook of Prebiotics and Probiotics*, 2008, CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.

MAJOR COURSE

NUTRITIONAL BIOINFORMATICS AND IMMUNO-GENETICS

(Code: NUTR 1012)
[TOTALCREDITS: 6 (THEORY-5, TUTORIAL-1)]

Course outcome: Upon completion of this program, students will gain a strong foundation in biology and computer science, along with the ability to analyze bioinformatics data and effectively use relevant software tools and biological databases. They will understand the relationship between

nutrition, gene expression, and individual genetic variation, as well as key concepts in human genetics, genomics, pharmacogenomics, and nutrigenomics. The course will also provide fundamental knowledge of immunology, including the immune system, its components, antibody structure and function, as well as principles of vaccination and immunization schedules.

1. **Biological Data Bases**:
   - General Introduction of Biological Databases; Nucleic acid databases, Protein databases (Primary, Composite, and Secondary). Nutrition and Food-safety Data Bases.
2. **Sequence alignments:**
   - Local alignment and global alignment, pairwise alignment and multiple sequence alignment. Features and types of BLAST and Clustal W. Significance of multiple sequence alignment, Phylogenetic tree: Concept, types and importance of phylogenetic tree.
3. **Expression of genetic information:**
   - Nucleic acid: Bases, nucleosides and nucleotides, Types and features of DNA and RNA, Structure of DNA (Watson & Crick model), DNA replication: enzymes and mechanism.
   - Transcription and Translation (Basic Process).
   - Genomics and Proteomics: Basic idea of Genomics and Proteomics.
   - Nutrigenomics and Pharmacogenomics: Basic concept of Nutrigenomics and Gene-Diet interaction, Nutritional regulation of gene expression, Relation between food and medicine in controlling of diseases, Individual-specific diets and Personalized Nutrition.
4. **Human Genetics and Genetic diseases:**
   - Basic idea about Human Genome Project
   - Monogenic disease and Polygenic diseases: Thalassemia, Albinism, Haemophilia, Colour blindness, Hyperlipidemia, Diabetes mellitus
   - Genetic basis of Myocardial Infarction and Obesity
   - Genetic syndromes: Down syndrome, Turner syndrome, and Klinefelter syndrome, Prenatal and Post-natal screening of genetic diseases. Amniocentesis, Chronic Villus sampling. Scope of genetic counselling
5. **Cells and organs of the immune system:** Leucocytes, APC, Macrophage-cell and B-cell, Mast cell, Dendritic cell and APC, NK cells Structure and Function of MHC.
   - **Types of antigen and antibodies:** Definition and properties of antigenic determinants of immunoglobulin (Isotype, allotype & idiotype). Structure, classes and biological activities of antibodies. Antigenic determinants, Types of immune response: Innate and acquired Immunity, Humoral and Cellular Immunity.
   - **Vaccination and Immunization schedule**: Types of vaccines, National immunization schedule

Suggested readings:

- Lesk, A.M. (2009). An Introduction to Bioinformatics. Ed 2. Oxford Principles of Gene Manipulation
- R.W. Old and S. B Primrose, An Introduction to Genetic Engineering6th edition, Blackwell Science Inc.
- Andreas D. Baxevanis and B.F. Fancis Ouellette (2002). Bioinformatics: A practical guide to the analysis of genes and proteins 2nd edition Wiley Interscience.
- David Freifelder, George Malacinski. (2005). Essentials of Molecular Biology. - 4th edition.
- David Webster. (2000). Protein Structure prediction: Methods and Protocols, Human Press.
- T. A. Brown. (2006). Genomes, 2nd edition, Garland Science publisher
- Abbas, A. K., Lichtman, A. H. and Pillai, S. (2006). Cellular and molecular Immunology. 6th ed. Saunders.
- Alberts, B., Johnson, A. Lewis J., Raff, M., Roberts, K. and Walter, P. (2008).
- Molecular Biology of the Cell. 5th Ed. Garland Publishing House.
- Coico R, Sunshine, G., Benjamini, E. (2003). Immunology: A short Course. 5th ed. Wiley-Liss: New Jersey. English, L. S. (1994). Technological Applications of Immunochemicals (BIOTOL). Butterworth- Heinemann, Oxford Freeman and Co.
- Cooper, G. M. (2004). The Cell. 3rd ed. ASM Press.
- Goldsby, R. A., Kindt, T. J., Kuby, J. and Osborne, B. A. (2003). Immunology. 5th ed.W. H. Freeman and Co.

MAJOR COURSE

RESEARCH METHODOLOGY AND BIOSTATISTICS

(Code: NUTR 1013)
[TOTALCREDITS: 6 (THEORY-5, TUTORIAL-1)]

Course Outcome:

After completing this course, students will understand the fundamental concepts, objectives, types, and ethical principles of research. They will be able to identify appropriate research methods, design research steps, and differentiate between action and applied research. Students will gain skills in data collection, sampling techniques, and effective presentation of data. They will develop an understanding of techniques used in food science and health research. Learners will acquire basic knowledge of statistical concepts, variables, and the scope and limitations of statistics.

1. Fundamental of research:

- Meaning, Objectives, Types and characteristics of research
- Methods of Research: Experimental, Descriptive, Historical, Qualitative and Quantitative methods, Concept on Action research and Applied research, Steps of research, Research ethics.
- Concept on bibliography and references

2. Data and Data Types:

- Primary data and Secondary Data, Methods of data collection, Presentation of data-diagrammatic and graphical.
- Sampling of data, Types of sampling techniques, Design of Sampling, Characteristics of good sampling.

3. Techniques in Food Science and Health Research:

- Extraction methods: Definition, Importance, Principle of extraction (Solubility and polarity, Mass transfer and diffusion, Effect of Temperature, time, and solvent ratio). types of Extraction Methods (Maceration, Soxhlet extraction, Percolation). Solvents used in extraction (Polar and non-polar solvents, Food-grade solvents, Solvent selection criteria, Safety and environmental concerns).
- Principles and applications of Microscopes: Simple, Compound, Phase-contrast, Scanning Electron and Transmission Electron Microscope
- Chromatographic techniques: Concept, Principle and Application- Paper and Thin layer chromatography (TLC).
- Spectroscopic methods: Concept, Principle and applications: UV-Vis, NMR, IR, MS

4. Introduction to Statistics:

- Definition, statistical methods and principles.
- Variables - measurements, functions, limitations and uses of statistics.

5. Descriptive Statistics:

- Applications of descriptive statistics

- Measures of Central tendency (Mean, Median, Mode).
- Measures of Dispersion (Range, Mean deviation, Standard Deviation).

6. Statistical inference:

- Concepts of Hypothesis - Null and Alternative Hypothesis.
- Error in inference (Type I and type II errors).
- Concept of parametric and nonparametric statistics.
- Hypothesis Testing: Chi-square Test, Student't' test, Analysis of Variance (ANOVA), Correlation and Regression.

Suggested readings

- C. R. Kothari, *Research Methodology: Methods and Techniques*, 2019, New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi, India.
- Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 2018, Sage Publications India Pvt. Ltd., B-42, Panchsheel Enclave, New Delhi, India.
- S. K. Gupta & B. L. Gupta, *Research Methodology and Statistical Techniques*, 2017, Sultan Chand & Sons, 23, Daryaganj, New Delhi, India.
- B. K. Mahajan, *Methods in Biostatistics*, 2018, Jaypee Brothers Medical Publishers (P) Ltd., 4838/24, Ansari Road, Daryaganj, New Delhi, India.
- D. A. Skoog, F. J. Holler & S. R. Crouch, *Principles of Instrumental Analysis*, 2014, Cengage Learning, 5191 Natorp Boulevard, Mason, Ohio, USA.
- A.O. Pearson, *Chemical Analysis of Foods*, 2016, CBS Publishers & Distributors Pvt. Ltd., 4596/1A, 11 Daryaganj, New Delhi, India.
- V. K. Rohatgi & A. K. Md. Ehsanes Saleh, *An Introduction to Probability and Statistics*, 2015, John Wiley & Sons (Asia) Pvt. Ltd., Noida, Uttar Pradesh, India.

MAJOR COURSE (PRACTICAL)

(BIO-STATISTICS, BIOINFORMATICS AND IMMUNO-GENETICS)

(Code: NUTR 1014)

[TOTALCREDITS: 6 (PRACTICAL-6)]

BIOSTATISTICS:

1. Calculation of Mean, Median and Mode
2. Calculation of Standard Deviation and Variance
3. Graphical Representation (Bar graph, Pie chart, Histogram, Line diagram)
4. Student's t-test (Comparison of two samples)
5. Chi-square Test (Test of association)

BIOINFORMATICS:

1. Retrieval of nucleic acid from Nucleic acid Data Base
2. Retrieval of proteins from Protein Data Base
3. Analysis of DNA and Protein sequences
4. Alignment of DNA /Protein sequence

IMMUNO-GENETICS:

1. Determination of human blood groups (ABO & Rh typing).
2. Demonstration of immunological reactions (Flocculation and Precipitation).
3. Demonstration of ELISA (Direct ELISA, Indirect ELISA, Sandwich ELISA).
4. Demonstration of Polymerase Chain Reaction (PCR).
5. Demonstration of Immunoblotting (Western blotting).

MINOR COURSE

NUTRITIONAL ASSESSMENT AND PROGRAMMES (Code: NUTR 1021)

[TOTALCREDITS: 4 (THEORY-3, PRACTICAL-1)]

Course Outcome:

After completing this course, students will be able to understand the concepts and applications of nutritional assessment, monitoring, and surveillance in public health. They will gain the ability to assess nutritional status of individuals and communities using direct and indirect assessment methods. Learners will be able to analyze major national nutritional intervention programmes, their objectives, target groups, and implementation strategies.

1. **Assessment of Nutritional Status and Surveillance:**
   - Nutrition Monitoring and Surveillance: Objectives, Components, Process and Uses.
   - Direct Nutritional status assessment of human groups - Anthropometric, Biochemical, Biophysical, Clinical and Diet survey methods.
   - Indirect assessment: Secondary sources of community health data.
2. **Concept of Surveillance systems:**
   - Role of international and national organizations and agencies (WHO, UNICEF, ICMR).
3. **Communication in Nutrition and Health Education:**
   - Type, process and media of communication.
   - Importance and relevance of Information, Education and communication (IEC) in Nutrition and Public Health.
4. **National Nutritional Intervention Programmes:**
   - Objective, Target group, Scheme details - Integrated Child Development Services (ICDS), Mid-Day Meal Programme (MDMP), Vit-A prophylaxis Prophylaxis programme, Anemia prophylaxis programme, Iodine deficiency disorders control programme.

- POSHAN Abhiyan (Prime Minister's Overarching Scheme for Holistic Nutrition)- Objective, Component, Target group and outcome.
- Concept on public distribution system.

5. **Immunization Programme:**
   - Preliminary concept of immunity-innate, acquired, active and passive immunity.
   - Immunization: National Immunization schedule for children and adults

Practical:

1. Anthropometric measurement of Weight for age, height for age, weight for height and interpretation of the result.
2. Determination of BMI and comments on results.
3. Measurement of circumference of chest, upper arm, waist - hip ratio and comments on results.
4. Clinical assessment and sign of nutrient deficiency disorders: Protein energy malnutrition (PEM), Anaemia, Rickets, Goiter, Vitamin A, Vitamin C and Vitamin B complex (Slide/Photography).

Suggested readings:

- B. Srilakshmi, *Nutrition Science*, 2017, New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi, India.
- M. Swaminathan, *Essentials of Food and Nutrition (Vol. II: Applied Nutrition)*, 2016, Bappco Publishers, Bangalore, Karnataka, India.
- Park, K., *Park's Textbook of Preventive and Social Medicine*, 2021, M/s Banarsidas Bhanot Publishers, 1167, Prem Nagar, Jabalpur, Madhya Pradesh, India.
- Mahtab S. Bamji, N. Pralhad Rao & Vinodini Reddy, *Textbook of Human Nutrition*, 2016, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
- WHO, *Nutrition Monitoring and Surveillance*, 2013, World Health Organization, Avenue Appia 20, 1211 Geneva, Switzerland.
- UNICEF, *Improving Child Nutrition: The Achievable Imperative for Global Progress*, 2013, United Nations Children's Fund, 3 United Nations Plaza, New York, USA.
- ICMR–NIN, *Dietary Guidelines for Indians*, 2020, National Institute of Nutrition, Indian Council of Medical Research, Jamai-Osmania, Hyderabad, Telangana, India.

SEMESTER – II

MEDICAL PARASITOLOGY AND MICROBIOLOGY (Code: NUTR 2011)

[TOTALCREDITS: 6 (THEORY-5, TUTORIAL-1)]

Course Outcome:

This programme provides comprehensive knowledge and practical training in the spread of microorganisms (predominantly bacterial and viral pathogens), disease causation and diagnosis and treatment of pathogens significant to public health. The increasing incidence of microbial infections worldwide is being compounded by the rapid evolution of drug-resistant variants and opportunistic infections by other organisms. After completion of this course, students will be able to explore the biology, pathogenesis, immunology, epidemiology, and diagnosis of parasitic and microbial infections in humans. They will be able to analyse strategies for controlling vectors and intermediate hosts of human parasites, and carry out practical laboratory identification of parasite stages both in free form and within tissues. Students will also learn to sample and identify medically important vectors or intermediary hosts and determine their role in disease transmission. Furthermore, they will be able to design laboratory or field-based research projects, apply research skills, and interpret data. Finally, they will develop specialized skills through modules covering advanced diagnostic, molecular, immunological, genetic, and other aspects of the subject.

1. **Host, Parasites and Vectors:**
    - General idea: Parasites and Parasitism, Mutualism and Commensalism, Vectors and Hosts. Host–parasite interactions, virulence factors and pathogenicity islands, Epidemiology of parasitic diseases, Biology, medical importance, and control of *Aedes, Anopheles, Culex and Phlebotomus*
2. **Protozoology:**
    - Classification of parasitic Protozoa, General account, morphology, life cycle, pathogenicity, and control of *Plasmodium vivax* and *Plasmodium falciparum, Leishmania donovani, Trypanosoma cruzi, Entamoeba histolytica and Giardia lamblia*
3. **Helminthology:**
    - Introduction to helminthes, General account, morphology, life cycle, pathogenicity, and control of *Schistosoma haematobium, Paragonimus westermani, Taenia saginata, Trichinella spiralis* and *Wuchereria bancrofti*
4. **Bacteriology:**
    - Bacterial cell wall, plasmid, Endospore, Nutrition and nutritional types of bacteria; Types of culture media: natural, synthetic, semi-synthetic and selective media; Composition and principles of: Nutrient Agar, MacConkey Agar, Triple-Sugar-Iron Agar, Pseudomonas Isolation Agar, Blood Agar, XLD agar, Mannitol Salt Agar
    - Bacterial Growth: Phases of growth, Kinetics of growth, generation time, Batch culture, continuous culture and synchronous culture, Chemostat and Turbidostat. Pure culture techniques, Preservation of bacteria, Environmental factors influencing growth: Temperature, pH, salt concentration, oxygen, osmotic concentration

5. **Virology:**
    - Structural organization of viruses, Prions and viroids, Lytic cycle of bacteriophages with reference to *E. coli* and T4, Lysogeny, lysogenic conversion, induction and significance
6. **Microbial Diseases and Control:**
    - Mode of transmission, pathogenicity and prevention of bacterial diseases: Tuberculosis, Cholera, Typhoid, Anthrax, Tetanus and Botulism.
    - Classification, phenotypic, biochemical and toxin features, pathogenesis and laboratory diagnosis of: *Staphylococcus, Streptococcus, Escherichia coli*.
    - Morphology, chemical composition and mode of reproduction, Herpes simplex virus, Poliovirus and HIV-Mode of transmission, pathogenicity and prevention of viral diseases, Dengue, Common cold, Mumps, Measles, Hepatitis and Rabies.
    - Antiviral Therapy and Vaccines: Types of antiviral drugs, Mechanisms of action, Vaccine types (live, attenuated).

Suggested readings

- Alexander, M. (1977). *Introduction to Soil Microbiology*. John Wiley and Sons, New York.
- Atlas, R. M. (1984). *Microbiology, Fundamentals and Applications*. Macmillan.
- Atlas, R. M. and Bartha, R. (1997). *Microbial Ecology: Fundamentals and Applications.* 4th Ed. Benjamin/ Cummings.
- Black, J. G. (2011). *Microbiology: Principles and Explorations.* 8th Ed. John Wiley and Sons, New York.
- Bogitsh, B. J. and Cheng, T. C. (2000). *Human Parasitology*. 2nd Ed. Academic Press, New York.
- Campbell, R. (1983). *Microbial Ecology*. 2nd Ed. Oxford, Blackwell.
- Chatterjee, K. D. (1981). *Parasitology (Protozoology and Helminthology*). 13th Ed. CBS.
- Cox, F. E. G. (1993). *Modern Parasitology*. 2nd Ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
- Davis, B. D., Dulbecco, R., Eisen, H.N. and Ginsberg, H.S. (1990). *Microbiology.* 4th Ed. Harper and Row.
- Dimmock, N. J. and Primrose, S. B. (1994). *Introduction to Modern Virology*. 4th Ed. Blackwell Scientific Publications. London.
- Hati, A. K. (2001). *Medical Entomology*. Allied Book Agency, Kolkata.
- Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.

MINOR COURSE

COMMUNITY NUTRITION

(Code: NUTR 2021)

[TOTALCREDITS: 4 (THEORY-3, PRACTICAL-1)]

Course Outcome:

After completing this course, students will understand the concepts of community health and the environmental, social, and economic factors influencing the nutritional health of communities. They will be able to identify common community nutritional problems. Students will gain the ability to assess nutritional status using direct and indirect methods. Learners will be able to analyze major national nutritional intervention programmes, with respect to their objectives, target groups, and outcomes.

1. **Community and Nutritional Health:**
   - Concept of community and community health.
   - Factors affecting health of a community – environmental, social and economic.
   - Nutritional problems in community - Kwashiorkor, Marasmus, Goiter and Nutritional anemia
   - Importance and relevance of Information, Education and communication (IEC) in Nutrition and Public Health.
2. **Assessment of Nutritional Status and Surveillance:**
   - Nutrition Monitoring and Surveillance: Objectives, Components, Process and Uses.
   - Direct Nutritional status assessment of human groups - Anthropometric, Biochemical, Biophysical, Clinical and Diet survey methods.
   - Indirect assessment: Secondary sources of community health data.
3. **Concept of Surveillance systems:**
   - Role of international and national organizations and agencies (WHO, UNICEF, ICMR).
4. **National Nutritional Intervention Programmes:**
   - Objective, Target group, Scheme details - Integrated Child Development Services (ICDS), Mid-Day Meal Programme (MDMP), Vit A prophylaxis Prophylaxis programme, Anemia prophylaxis programme
   - POSHAN Abhiyan (Prime Minister's Overarching Scheme for Holistic Nutrition)- Objective, Component, Target group and outcome.
   - Concept on public distribution system.
5. **Immunization Programme:**
   - Preliminary concept of immunity-innate, acquired, active and passive immunity.
   - Immunization: National Immunization schedule for children and adults,

Practical:

1. Anthropometric measurement of Weight for age, height for age, weight for height and interpretation of the result.
2. Determination of BMI and comments on results.
3. Measurement of circumference of chest, upper arm, waist - hip ratio and comments on results.

4. Clinical assessment and sign of nutrient deficiency disorders: Protein energy malnutrition (PEM), Anaemia, Rickets, Goiter, Vitamin A, Vitamin C and Vitamin B complex (Slide/Photography).

Suggested readings:

- B. Srilakshmi, *Community Nutrition*, 2016, New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi, India.
- M. Swaminathan, *Essentials of Food and Nutrition – Vol. II (Applied Nutrition)*, 2014, Bappco Publishers, No. 6, 1st Main Road, Gandhinagar, Bangalore, Karnataka, India.
- Mahtab S. Bamji, N. Pralhad Rao & Vinodini Reddy, *Textbook of Human Nutrition*, 2016, Oxford & IBH Publishing Co. Pvt. Ltd., 66 Janpath, New Delhi, India.
- Park, K., *Park's Textbook of Preventive and Social Medicine*, 2021, Banarsidas Bhanot Publishers, 1167, Prem Nagar, Jabalpur, Madhya Pradesh, India.
- ICMR–National Institute of Nutrition, *Dietary Guidelines for Indians*, 2020, ICMR–NIN, Jamai-Osmania, Hyderabad, Telangana, India.
- WHO, *Nutrition Monitoring and Surveillance*, 2013, World Health Organization, Avenue Appia 20, 1211 Geneva, Switzerland.
- UNICEF, *Improving Child Nutrition: The Achievable Imperative for Global Progress*, 2013, United Nations Children's Fund, 3 United Nations Plaza, New York, USA.
- Gopalan, C., B. V. Rama Sastri & S. C. Balasubramanian, *Nutritive Value of Indian Foods*, 2017 (Revised), National Institute of Nutrition, ICMR, Hyderabad, Telangana, India.

Research Project / Dissertation

(Code: NUTR 2031)

Total Credit – 12

Full Marks. 225 (Theory: 0; Internal Assessment: 0; Practical: 225)

Seminar Presentation, Preparation and Submission of Research

Project/Dissertation: 135 + Viva: 90

Dissertation Submission Guidelines

The dissertation shall be carried out by the student under the guidance of Supervisor / Supervisors from a College, University, Research Institutions or Research Centers.

The dissertation will have the following contents:

Title Page, Declaration, Acknowledgement, Certificate from Supervisor/Supervisors, Abstract (250–300 words), Table of Contents, List of Tables / Figures (if applicable), Introduction,

Review of Literature, Objectives and Significance of the Study, Materials and Methods/Methodology, Results, Discussion, Conclusion and References/Bibliography.

The examinee is required to provide a declaration confirming that the complete dissertation has been checked by plagiarism and AI-content detection software.

OR

SEMESTER – II (HONS.)

MEDICAL PARASITOLOGY AND MICROBIOLOGY (Code: NUTR 2011)

[TOTALCREDITS: 6 (THEORY-5, TUTORIAL-1)]

Course Outcome:

This programme provides comprehensive knowledge and practical training in the spread of microorganisms (predominantly bacterial and viral pathogens), disease causation and diagnosis and treatment of pathogens significant to public health. The increasing incidence of microbial infections worldwide is being compounded by the rapid evolution of drug-resistant variants and opportunistic infections by other organisms. After completion of this course, students will be able to explore the biology, pathogenesis, immunology, epidemiology, and diagnosis of parasitic and microbial infections in humans. They will be able to analyse strategies for controlling vectors and intermediate hosts of human parasites, and carry out practical laboratory identification of parasite stages both in free form and within tissues. Students will also learn to sample and identify medically important vectors or intermediary hosts and determine their role in disease transmission. Furthermore, they will be able to design laboratory- or field-based research projects, apply research skills, and interpret data. Finally, they will develop specialized skills through modules covering advanced diagnostic, molecular, immunological, genetic, and other aspects of the subject.

1. **Host, Parasites and Vectors:**
   - General idea: Parasites and Parasitism, Mutualism and Commensalism, Vectors and Hosts. Host–parasite interactions, virulence factors and pathogenicity islands, Epidemiology of parasitic diseases, Biology, medical importance, and control of *Aedes, Anopheles, Culex and Phlebotomus*
2. **Protozoology:**
   - Classification of parasitic Protozoa, General account, morphology, life cycle, pathogenicity, and control of *Plasmodium vivax* and *Plasmodium falciparum*, *Leishmania donovani, Trypanosoma cruzi, Entamoeba histolytica and Giardia lamblia*
3. **Helminthology:**
   - Introduction to helminthes, General account, morphology, life cycle, pathogenicity, and control of *Schistosoma haematobium, Paragonimus westermani, Taenia saginata*, *Trichinella spiralis* and *Wuchereria bancrofti*
4. **Bacteriology:**

- Bacterial cell wall, plasmid, Endospore, Nutrition and nutritional types of bacteria; Types of culture media: natural, synthetic, semi-synthetic and selective media; Composition and principles of: Nutrient Agar, MacConkey Agar, Triple-Sugar-Iron Agar, Pseudomonas Isolation Agar, Blood Agar, XLD agar, Mannitol Salt Agar
- Bacterial Growth: Phases of growth, Kinetics of growth, generation time, Batch culture, continuous culture and synchronous culture, Chemostat and Turbidostat. Pure culture techniques, Preservation of bacteria, Environmental factors influencing growth: Temperature, pH, salt concentration, oxygen, osmotic concentration

5. Virology:

- Structural organization of viruses, Prions and viroids, Lytic cycle of bacteriophages with reference to *E. coli* and T4, Lysogeny, lysogenic conversion, induction and significance

6. Microbial Diseases and Control:

- Mode of transmission, pathogenicity and prevention of bacterial diseases: Tuberculosis, Cholera, Typhoid, Anthrax, Tetanus and Botulism.
- Classification, phenotypic, biochemical and toxin features, pathogenesis and laboratory diagnosis of: *Staphylococcus, Streptococcus, Escherichia coli*.
- Morphology, chemical composition and mode of reproduction, Herpes simplex virus, Poliovirus and HIV-Mode of transmission, pathogenicity and prevention of viral diseases, Dengue, Common cold, Mumps, Measles, Hepatitis and Rabies.
- Antiviral Therapy and Vaccines: Types of antiviral drugs, Mechanisms of action, Vaccine types (live, attenuated).

Suggested readings

- Alexander, M. (1977). *Introduction to Soil Microbiology*. John Wiley and Sons, New York.
- Atlas, R. M. (1984). *Microbiology, Fundamentals and Applications*. Macmillan.
- Atlas, R. M. and Bartha, R. (1997). *Microbial Ecology: Fundamentals and Applications.* 4th Ed. Benjamin/ Cummings.
- Black, J. G. (2011). *Microbiology: Principles and Explorations.* 8th Ed. John Wiley and Sons, New York.
- Bogitsh, B. J. and Cheng, T. C. (2000). *Human Parasitology*. 2nd Ed. Academic Press, New York.
- Campbell, R. (1983). *Microbial Ecology*. 2nd Ed. Oxford, Blackwell.
- Chatterjee, K. D. (1981). *Parasitology (Protozoology and Helminthology*). 13th Ed. CBS.
- Cox, F. E. G. (1993). *Modern Parasitology*. 2nd Ed. Blackwell Scientific Publications. Lea and Febiger, Philadelphia.
- Davis, B. D., Dulbecco, R., Eisen, H.N. and Ginsberg, H.S. (1990). *Microbiology.* 4th Ed. Harper and Row.
- Dimmock, N. J. and Primrose, S. B. (1994). *Introduction to Modern Virology*. 4th Ed. Blackwell Scientific Publications. London.
- Hati, A. K. (2001). *Medical Entomology*. Allied Book Agency, Kolkata.
- Hati, A. K. (2001). *Medical Parasitology*. Allied Book Agency, Kolkata.

- Holt, J. G., Krieg, N. R., Sneath, P. H. A. Staley, J. T. and Williams, S. T. (1994). *Bergey's Manual of Determinative Bacteriology*. 9th Ed. Baltimore (MD): Williams and Wilkins.
- Kettle, D. S. (1995). *Medical and Veterinary Entomology*. 2nd Ed. CAB International.
- Maloy, S. R., Cronan, E. J. and Freifelder, D. (1994). *Microbial Genetics*. 2nd Ed. Jones and Bartlett.
- Mullen, G. R. and Durden, L.A. (2009). *Medical and Veterinary Entomology*. 2nd Ed. Academic Press.

MAJOR COURSE

APPLIED BIOCHEMISTRY AND PHYSIOLOGY

(Code: NUTR 2012)

[TOTALCREDITS: 4]

Course Outcome:

This course integrates human biochemistry, physiology, and developmental biology to bridge molecular mechanisms with clinical health outcomes. Students will master macronutrient metabolism, enzyme kinetics, and endocrine signaling to understand the systemic regulation of homeostasis and its related pathologies. By analyzing blood disorders and receptor biology, learners gain the diagnostic framework necessary to evaluate physiological dysfunctions. Additionally, the curriculum tracks physical and cognitive development from prenatal stages through adulthood, emphasizing the impact of nutrition and hormones. Ultimately, students will be equipped to apply this integrated knowledge to evaluate nutritional needs and understand the holistic progression of human life.

1. **Carbohydrates, Proteins and Fats:**
   - Carbohydrates in the human diet and their relative importance, Carbohydrate metabolism (digestion, absorption, glucose transport, glycolysis, metabolism of lactate and pyruvate, citric acid cycle, gluconeogenesis, pentose phosphate pathway), Health implications of dietary carbohydrates, Health aspects of sugar and non-starch polysaccharides.
   - Composition and nature of proteins and identification of protein-providing foods in the diet, Basic structure of proteins and their alternation by cooking, Digestion and absorption of proteins, Amino-acid metabolism, Control of Protein metabolism, Role of proteins in the body, The role of proteins and amino acids in the body, in health and disease.
   - Nature and characteristics of fats important in human nutrition, Digestion and absorption of fats, Importance of the essential fatty acids, Role of fats in the diet and trends in fat consumption, Advantages and disadvantages of fat in the diet, Importance of omega-3 fatty acids in the body, Role of adipose tissue.
2. **Enzymes:**
   - General properties, Classification and functions, Enzymes in clinical diagnosis.
   - Enzyme kinetics - Factors affecting enzyme action; Mechanism of enzyme action;

Enzyme regulation.

- Coenzymes in metabolism, isozymes, role of vitamins and minerals in the mechanism of enzyme action.

3. The Blood:

- Cellular content of blood, Plasma and plasma proteins, Structure and function of Haemoglobin and role in oxygen transport. Structure and function of Leucocytes and platelets.
- Erythrocyte disorders (Iron deficiency anaemia, Megaloblastic anaemia, Aplastic anaemia, Haemolytic anaemias, Acquired haemolytic anaemia, Normocytic Normochromic anaemia, Polycythemia).
- Leucocytic disorders (Leucopenia, Leucocytosis, Leukaemia); Haemorrhagic diseases (Thrombocytopenia, Vitamin K deficiency, Congenital disorders).
- Thalassemia: Definition, Classification, Symptoms, Treatment, Prevention and Genetic basis of Alpha and Beta Thalassemia.

4. Endocrinology:

- Endocrine function of Pancreas and its role in regulation of metabolism. Thyroid gland – calorigenic function. Adrenal medulla and adrenal cortex - Mechanism of action of steroid and protein hormones.
- Gastro-intestinal hormones - Site of origin, chemical nature and mode of action. Pituitary – Anterior pituitary (TSH, ACTH, GH), Posterior pituitary (ADH). Hypothalamic control of pituitary. Role of hormones, Vitamins and minerals in bone formation. Ovulation and menstrual cycle. Puberty.

5. Fundamentals of Receptors and Their Role:

- Definition, Classification, Location and Principles of biological receptors.
- Mechanism of action, Significance in physiological processes and clinical practice.

6. Human Development and Stages of Human Development:

- Definition and meaning of human development, Growth vs. development, Basic principles of development - Cephalocaudal trend, Proximodistal trend, Sequential and predictable patterns, Individual differences**,** Domains of development - Physical development, Cognitive development, Emotional development and social development.
- Prenatal Development: Germinal, embryonic, fetal stages, Maternal nutrition and its impact Infancy (0–2 years) and Early Childhood (2–6 years): Physical growth patterns, Motor and sensory development, Cognitive and emotional development, Adolescence (12–18 years) and Adulthood: Puberty and growth spurts, Hormonal changes, Early, middle adulthood changes

MAJOR COURSE

FOOD PROCESSING AND PACKAGING TECHNIQUES

(Code: NUTR 2013)

[TOTALCREDITS: 4]

Course Outcome:

Students will be able to understand the 'Unit operations in food processing'. They will be acquainted with the processing techniques of fruits, vegetables and fruit beverages, preparation of jams, jellies and marmalades, pickles, chutneys, sauces and tomato products, processing of dairy products, egg and egg products, fish and meat. They can gain the knowledge of GM foods.

1. **Basic concept of food processing, packaging and preservation:**
   - Unit operations - Cleaning, sorting, grading, peeling, Size reduction, mixing and forming, Separation techniques.
   - Preservation techniques – Objectives of food preservation, Principles of various preservation techniques (high temperature, low temperature, moisture control, irradiation and chemical preservatives).
   - Packaging components: Types of packaging materials, Primary packaging materials, Secondary packaging materials and Ancillary packaging materials.
   - Packaging requirements for different types of foods such as fruits, vegetables, meat, fish, edible oils, spices, bakery foods, confectionaries, snack foods, alcoholic and non-alcoholic carbonated beverages. Concept on Labelling and Bar Coding.
2. **Processing of fruits, vegetables and fruit beverages:**
   - Selection of fruits and vegetables, process of canning, factors affecting the process-time and temperature, containers of packing, lacquering, syrups and brines for canning.
   - Processing of fruit juices (selection, juice extraction, deaeration, straining, filtration and clarification).
   - Jams, Jellies and Marmalades: Jam - Constituents, selection of fruits, processing and technology**,** Jelly-Essential constituents (Role of pectin), Theory of jelly formation, processing and technology, Marmalade-Types and processing technology
3. **Pickles, Chutneys, Sauces and Tomato Products:**
   - Selection of tomatoes, pulping and processing of tomato juice, tomato puree, paste, ketchup, sauce, and soup**.**
4. **Dairy products processing:**
   - Milk and milk products processing- cream, butter oil, cheese, cheese spread, condensed milk,evaporated milk, whole milk, skimmed milk powder, ice cream, khoa, chhana, panner, fermented milk products, yogurt, dahi and srikhand.
5. **Processing of meat, fish and egg:**
   - Quality of meat, rigor mortis, cold shortening, thaw rigor
   - Red meat processing (Canning, role of chemical additives, cold storage, comminution

and curing, drying, fermentation, irradiation, restructuring, smoking and vacuum packaging)

- General methods of fish and egg processing

6. **Food Quality Assessment:** Sensory Assessment-Appearance of food- visual perception, colour of foods, smell, flavour and taste.
7. **Fermentation and types of fermentation:**
   - Solid and submerged fermentation
   - Homolactic, Heterolactic, Alcoholic fermentation
   - Bioreactor, Types of bioreactors, Advantages and disadvantages

Suggested readings:

- Norman N. Potter & Joseph H. Hotchkiss, *Food Science*, 2008, Springer (CBS Publishers & Distributors Pvt. Ltd., Indian reprint), 4596/1A, 11 Daryaganj, New Delhi, India.
- B. Srilakshmi, *Food Science*, 2018, New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi, India.
- S. Ranganna, *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*, 2001, Tata McGraw-Hill Publishing Company Limited, 7 West Patel Nagar, New Delhi, India.
- R. Paul Singh & Dennis R. Heldman, *Introduction to Food Engineering*, 2014, Academic Press (Elsevier), 525 B Street, Suite 1900, San Diego, California, USA.
- Rahman, M. Shafiur, *Handbook of Food Preservation*, 2007, CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Boca Raton, Florida, USA.
- Gordon L. Robertson, *Food Packaging: Principles and Practice*, 2016, CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.
- K. L. Yam & Dong Sun Lee, *Emerging Food Packaging Technologies*, 2012, Woodhead Publishing (Elsevier), Cambridge, United Kingdom.
- Qasim Ahmed & S. M. Jaffery, *Food Preservation and Processing*, 2015, CBS Publishers & Distributors Pvt. Ltd., 4596/1A, 11 Daryaganj, New Delhi, India.

MAJOR COURSE (PRACTICAL)

FOOD PROCESSING, BIOCHEMISTRY AND MICROBIOLOGY

(Code: NUTR 2014)

[TOTALCREDITS: 4 (PRACTICAL-4)]

FOOD PROCESSING:

1. Drying process of fruits and vegetables.
2. Preparation of fruit preserves (Jam / Jelly).
3. Preparation of vegetable preserves (Pickle).
4. Preparation of tomato sauce.
5. Preparation and standardization of traditional Indian fermented food or drink (Kanji / Buttermilk / Curd).

BIOCHEMISTRY:

1. Preparation of buffer solution (Acidic, Basic and Neutral Buffer Systems).
2. Preparation of different strength of solution (Normal, Molar and Molal solution)
3. Techniques for obtaining serum and plasma from blood samples.
4. Biochemical estimation of Sugar
5. Qualitative detection of heavy metals in water.
6. Graphical plotting of dose–response data and determination of LD_{50} values.
7. Study of blood cell types, morphology, and differential staining techniques (e.g., Leishman or Wright staining).

MICROBIOLOGY

1. Culture techniques: Spread plate, Pour plate and Streak plate.
2. Isolation and enumeration of bacteria from environmental sources (Soil and Air).
3. Determination of bacterial load in various foods using the standard plate count method.
4. Evaluation of drinking water quality using the Most Probable Number (MPN) method.
5. Application of differential staining methods including Gram staining and endospore staining for microscopic examination of bacterial morphology and classification.
6. Determination of bacterial antibiotic sensitivity using the disc diffusion technique.
7. Demonstration of virus isolation and cultivation techniques.
8. Demonstration of cell culture techniques and plaques assay.

MINOR COURSE

COMMUNITY NUTRITION
(Code: NUTR 2021)

[TOTALCREDITS: 4 (THEORY-3, PRACTICAL-1)]

Course outcome:

After completing this course, students will understand the concepts of community health and the environmental, social, and economic factors influencing the nutritional health of communities. They will be able to identify common community nutritional problems. Students will gain the ability to assess nutritional status using direct and indirect methods. Learners will be able to analyze major national nutritional intervention programmes, with respect to their objectives, target groups, and outcomes.

1. **Community and Nutritional Health:**
   - Concept of community and community health.
   - Factors affecting health of a community – environmental, social and economic.
   - Nutritional problems in community - Kwashiorkor, Marasmus, Goiter and Nutritional anemia
   - Importance and relevance of Information, Education and communication (IEC) in Nutrition and Public Health.

2. **Assessment of Nutritional Status and Surveillance:**
   - Nutrition Monitoring and Surveillance: Objectives, Components, Process and Uses.
   - Direct Nutritional status assessment of human groups - Anthropometric, Biochemical, Biophysical, Clinical and Diet survey methods.
   - Indirect assessment: Secondary sources of community health data.
3. **Concept of Surveillance systems:**
   - Role of international and national organizations and agencies (WHO, UNICEF, ICMR).
4. **National Nutritional Intervention Programmes:**
   - Objective, Target group, Scheme details - Integrated Child Development Services (ICDS), Mid-Day Meal Programme (MDMP), Vit A prophylaxis Prophylaxis programme, Anemia prophylaxis programme
   - POSHAN Abhiyan (Prime Minister's Overarching Scheme for Holistic Nutrition)-Objective, Component, Target group and outcome.
   - Concept on public distribution system.
5. **Immunization Programme:**
   - Preliminary concept of immunity-innate, acquired, active and passive immunity.
   - Immunization: National Immunization schedule for children and adults,

Practical:

a. Anthropometric measurement of Weight for age, height for age, weight for height and interpretation of the result.
b. Determination of BMI and comments on results.
c. Measurement of circumference of chest, upper arm, waist - hip ratio and comments on results.
d. Clinical assessment and sign of nutrient deficiency disorders: Protein energy malnutrition (PEM), Anaemia, Rickets, Goiter, Vitamin A, Vitamin C and Vitamin B complex (Slide/Photography).

Suggested readings:

- B. Srilakshmi, *Community Nutrition*, 2016, New Age International (P) Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi, India.
- M. Swaminathan, *Essentials of Food and Nutrition – Vol. II (Applied Nutrition)*, 2014, Bappco Publishers, No. 6, 1st Main Road, Gandhinagar, Bangalore, Karnataka, India.
- Mahtab S. Bamji, N. Pralhad Rao & Vinodini Reddy, *Textbook of*

Human Nutrition, 2016, Oxford & IBH Publishing Co. Pvt. Ltd., 66 Janpath, New Delhi, India.

- Park, K., *Park's Textbook of Preventive and Social Medicine*, 2021, Banarsidas Bhanot Publishers, 1167, Prem Nagar, Jabalpur, Madhya Pradesh, India.
- ICMR–National Institute of Nutrition, *Dietary Guidelines for Indians*, 2020, ICMR–NIN, Jamai-Osmania, Hyderabad, Telangana, India.
- WHO, *Nutrition Monitoring and Surveillance*, 2013, World Health Organization, Avenue Appia 20, 1211 Geneva, Switzerland.
- UNICEF, *Improving Child Nutrition: The Achievable Imperative for Global Progress*, 2013, United Nations Children's Fund, 3 United Nations Plaza, New York, USA.
- Gopalan, C., B. V. Rama Sastri & S. C. Balasubramanian, *Nutritive Value of Indian Foods*, 2017 (Revised), National Institute of Nutrition, ICMR, Hyderabad, Telangana, India.