

Food Technology (Nutrigenomics)

Scheme & Syllabus

for
M. Tech.



I. K. Gujral Punjab Technical University Jalandhar
Jalandhar-Kapurthala Highway
Kapurthala 144603, Punjab

FIRST SEMESTER

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|--------------|---------------------------------|-----------------|----------|----------|--------------------|------------|-------------|--------------|
| | | L | T | P | Internal | External | | |
| PFNB-101 | Nutraceuticals& Functional Food | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-102 | Human Physiology | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-103 | Molecular Biology | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-104 | Food Biochemistry | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-105 | Biomaterial Engineering | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-106 | Lab –I | - | - | 4 | 40 | 60 | 100 | 2 |
| | Journal Club | - | - | 2 | Mandatory | | | 2* |
| TOTAL | | 15 | 5 | 6 | 240 | 360 | 600 | 22+2* |

SECOND SEMESTER

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|--------------|---|-----------------|----------|----------|--------------------|------------|-------------|--------------|
| | | L | T | P | Internal | External | | |
| PFNB-201 | Nutrigenomics | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-202 | Pharmacology Pathophysiology | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-203 | Advances in Phytochemical Analytical Techniques | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-204 | Design & Development of Functional Food & Nutraceutical | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-205 | Regulatory Affairs | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-206 | Lab –II | - | - | 4 | 40 | 60 | 100 | 2 |
| | Journal Club | - | - | 2 | Mandatory | | | 2* |
| TOTAL | | 15 | 5 | 6 | 240 | 360 | 600 | 22+2* |

THIRD SEMESTER

| Course Code | Course Title | Load Allocation | | | Marks Distribution | | Total Marks | Credits |
|--------------|-----------------------|-----------------|----------|-----------|-------------------------------|------------|-------------|-----------|
| | | L | T | P | Internal | External | | |
| PFNB-301 | Research Methodology | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-302 | Elective –I | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-303 | Elective –II | 3 | 1 | - | 40 | 60 | 100 | 4 |
| PFNB-304 | Seminar | - | - | 2 | 40 | 60 | 100 | 2 |
| PFNB-305 | Dissertation (Part-I) | - | - | 8 | Satisfactory/ Un-Satisfactory | | | 8 |
| TOTAL | | 9 | 3 | 10 | 160 | 240 | 400 | 22 |

FOURTH SEMESTER

| Course Code | Course Title | Load Allocation | | | Marks Distribution | Credits |
|-------------|-------------------------|-----------------|---|----|-------------------------------|-------------|
| | | L | T | P | | |
| PFNB-401 | Dissertation (Part –II) | - | - | 22 | Satisfactory/ Un-Satisfactory | 22** |

* Not to be shown in DMC

**Non credit (only satisfactory or Un-satisfactory grade to be shown in DMC)

Terminology: L means Lecture, T means Tutorial, P means Practical, MST means Mid Semester Test, DMC means Detailed Marks Certificate

Credit System: 01 Credit for 01 Lecture / Tutorial / Seminar / Dissertation hour per week.

01 Credit for 02 Practical hour per week

Elective-I

| Sr No. | Subject |
|--------|--|
| 1. | Modelling & Simulation |
| 2. | Energy Management in Processing Industry |
| 3. | Unit Operations |
| 4. | Genetic Engineering |

Elective-II

| Sr No. | Subject |
|--------|---------------------------------------|
| 1. | Processing of Plant Bioactive |
| 2. | Processing of Animal Bioactive |
| 3. | Preservation and Packaging Technology |
| 4. | Nutraceutical Discovery Process |

PFNB-101 NUTRACEUTICAL AND FUNCTIONAL FOOD

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To teach basic understanding of the concepts of nutraceutical and functional food, and their use for managing chronic diseases

MODULE 1 (10 hrs)

NUTRACEUTICAL

Historical perspective; definition, nature, nutraceutical compounds and their classification based on chemical/biochemical nature with suitable and relevant descriptions; scope and future prospects. Applied aspects of the nutraceutical science, relation of nutraceutical science with other sciences: medicine, human physiology, genetics, food technology, chemistry and nutrition.

Functional food

Overview; definition, classification; functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.

MODULE 2 (16 hrs)

ANTIOXIDANTS

Concept of free radicals and antioxidants; antioxidants role as nutraceuticals and functional foods.

FOOD AS REMEDIES

Nutraceuticals bridging the gap between food and drug; nutraceuticals for specific situations such as cancer, heart disease, diabetes, stress, osteoarthritis, hypertension; nutraceutical remedies for common disorders like arthritis, bronchitis, circulatory problems, hypoglycemia, liver disorders, osteoporosis, psoriasis and ulcers, etc.

MODULE 3 (14 hrs)

FOOD SOURCES

Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants. Coffee, tea and other beverages as functional foods/drinks and their protective effects.

PROPERTIES AND FUNCTIONS OF VARIOUS NUTRACEUTICALS/FUNCTIONAL FOOD INGREDIENTS

Protein, complex carbohydrates like dietary fibers as functional food ingredients; probiotic, prebiotics and symbiotic foods, and their functional role. Sources and role of isoprenoids, isoflavones, flavonoids, carotenoids, tocotrienols, chlorophyll, polyunsaturated fatty acids, lecithin, choline, terpenoids. Glucosamine, lycopene, proanthocyanidins.

MODULE 4 (14 hrs)

ANTI-NUTRITIONAL FACTORS PRESENT IN FOODS

Types of inhibitors present in various foods and their inactivation. Assessment of nutritional status and recommended daily allowances. Effects of processing, storage and interactions of various environmental factors on the potentials of such foods.

Marketing and regulatory issues for functional foods and nutraceuticals. Recent development and advances in the areas of nutraceutical and functional foods.

References Books

- Giuseppe Mazza; *Functional Foods: Biochemical and Processing Aspects, Volume 1; CRC Press*
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press*
- Massimo Maffei; *Dietary Supplements of Plant Origin; CRC Press*
- Fereidoon Sahidi, Deepthi K. Weerasinghe; *Nutraceutical Beverages, Chemistry, Nutrition and Health Effects; American Chemical Society*
- Ronald R. Watson; *Vegetables, Fruits, and Herbs in Health Promotion; CRC Press*
- Fruit and Cereal Bioactives: Sources, Chemistry and Applications; Özlem Tokusoglu; Clifford Hall III; CRC Press
- Susan Sungsoo Cho, Mark L. Dreher; Marcel; *Dekker Handbook of Dietary Fibre*

PFNB-102 HUMAN PHYSIOLOGY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: This is a foundation course which will help students to relate the effects of nutraceuticals/functional foods on human body, and to understand the modulation of underlying physiology by use of nutraceuticals/functional food

MODULE 1 (10 hrs)

SKELETAL MUSCLES: Gross anatomy; physiology of muscle contraction, physiological properties of skeletal muscles and their disorders.

SMOOTH MUSCLES: Morphology, electrical and mechanical activity, molecular basis of contraction, relation of length to tension and plasticity.

DIGESTIVE SYSTEM: Gross anatomy of the gastro-intestinal tract, functions of its different parts including those of liver, pancreas and gall bladder, various gastrointestinal secretions and their role in the absorption and digestion of food.

MODULE 2 (16 hrs)

HAEMOPOIETIC SYSTEM: Composition and functions of blood and its elements, their disorders, blood groups and their significance, mechanism of coagulation, disorders of platelets and coagulation.

CARDIOVASCULAR SYSTEM: Morphology, electrical properties of cardiac muscle, pacemaker tissue, basic anatomy of the heart, physiology of heart, blood vessels and circulation, cardiac cycle, heart sounds, cardiac cycle, blood pressure and its regulation.

LYMPH AND LYMPHATIC SYSTEM: Composition, formulation and circulation of lymph; disorders of lymph and lymphatic system. Basic physiology and functions of spleen.

MODULE 3

(14 hrs)

CENTRAL NERVOUS SYSTEM: Brain, spinal Cord, neurohumoral transmission in the central nervous system

AUTONOMIC NERVOUS SYSTEM

ENDOCRINE SYSTEM: Basic anatomy and physiology of pituitary, thyroid, parathyroid, adrenals, pancreas, testes and ovary, their hormones and functions.

MODULE 4 (8 hrs)

URINARY SYSTEM: Various parts, structures and functions of the kidney and urinary tract. Physiology of urine formation and acid-base balance.

SENSE ORGANS: Basic anatomy and physiology of the taste buds, nose (smell) and skin (superficial receptors), ear and eye.

Reference Books

- Authors: Kim E. Barrett, Susan M. Barman Scott Boitano, Heddwen Brooks; *Ganong's Review of Medical Physiology, 24th Edition. Publisher: Lange.*
- Authors: Arthur C. Guyton , John E. Hall; *Guyton and Hall Textbook of Physiology, 12th Edition. Publisher: Saunders-Elsevier.*
- Author: AnneWaugh and Allison Grant; *Ross and Wilson Anatomy and Physiology in Health and Illnes, 11th edition. Publisher: Churchill Livingstone.*

PFNB-103 MOLECULAR BIOLOGY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: Molecular biology deals with nucleic acids and proteins, and how these molecules interact within the cell to promote proper growth, division and development. This course will emphasize the molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation in different organisms. Techniques and experiments used to discern these mechanisms, often referring to the original scientific literature, shall be studied. In addition, an in-depth look at some rapidly evolving fields, including chromatin structure and function, RNA polymerase dynamics, and regulation of gene expression by different types of RNAs shall also be studied.

MODULE 1 (12 hrs)

GENOME ORGANIZATION: Organization of bacterial genome; structure of eukaryotic chromosomes; role of nuclear matrix in chromosome organization and function; matrix binding proteins; heterochromatin and euchromatin; DNA reassociation kinetics (Cot curve analysis); repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; nucleosome phasing; DNase I hypersensitive regions; DNA methylation and imprinting.

DNA STRUCTURE; REPLICATION, REPAIR AND RECOMBINATION: Structure of DNA A, B, Z- and triplex DNA; measurement of properties -- spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; replication initiation, elongation and termination in prokaryotes and eukaryotes; enzymes and accessory proteins; fidelity; replication of single stranded circular DNA; gene stability and DNA repair enzymes; photoreactivation; nucleotide excision repair; mismatch correction; SOS repair; recombination: Homologous and non-homologous; site specific recombination; Chi sequences in prokaryotes; gene targeting; gene disruption; FLP/FRT and Cre/Lox recombination.

Module 2 (12 hrs)

PROKARYOTIC AND EUKARYOTIC TRANSCRIPTION: Prokaryotic transcription; transcription unit; Promoters -- constitutive and inducible; operators; regulatory elements; initiation; attenuation; termination-rho-dependent and independent; anti-termination; transcriptional regulation-Positive and negative; Operon concept -- lac, trp, ara, his, and gal operons; transcriptional control in lambda phage; transcript processing; processing of tRNA and rRNA; eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; eukaryotic promoters and enhancers; general transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); activators and repressors; transcriptional and post-transcriptional gene silencing.

Post transcriptional modifications: Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Slicing; RNA editing; nuclear export of mRNA; mRNA stability; catalytic RNA.

MODULE 3 (12 hrs)

TRANSLATION AND TRANSPORT: Translation machinery; ribosomes; composition and assembly; universal genetic code; degeneracy of codons; termination codons; isoaccepting tRNA; Wobble hypothesis; mechanism of initiation, elongation and termination; Co- and post-translational modifications; genetic code in mitochondria; transport of proteins and molecular chaperones; protein stability; protein turnover and degradation.

MODULE 4 (12 hrs)

MUTATIONS; ONCOGENES AND TUMOR SUPPRESSOR GENES: Nonsense, missense and point mutations; intragenic and intergenic suppression; Frameshift mutations; physical, chemical and biological mutagens; transposition -- transposable genetic elements in prokaryotes and eukaryotes; mechanisms of transposition; role of transposons in mutation; viral and cellular oncogenes; tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; activation of oncogenes and dominant negative effect; suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Reference Books

- Jones and Barlett; *Benjamin Lewin, Gene IX, 9th Edition, Publishers, 2007.*
- J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz and A.M. Weiner; *Molecular Biology of the Gene, 6th Edition Benjamin Cummings Publishing Company Inc, 2007.*
- Alberts et al; *Molecular Biology of the Cell, 4th edition, Garland, 2002.*
- Lodish , *Molecular Cell Biology, 7th edition, Freeman, 2013.*

PFNB 104 FOOD CHEMISTRY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: The objective of this course is to impart the knowledge of bio-chemical fate of food materials, natural products & nutraceuticals to the students at molecular level.

MODULE 1 CHIRALITY

(12 hrs)

Introduction, isomerisation in organic/bioorganic compounds, Fischer projections and conventions, D-L configuration, R-S systems, stereoisomerism, threo- and erythro- nomenclature and syn-anti systems, meso- compounds, diastereoisomerism, optical activity, optical isomers, epimerisations in sugars, prostereoisomerism and prochirality, stereoselective and stereospecific synthesis.

WATER

Weak interactions in Aqueous Systems, ionization of water, weak acids, and weak bases, buffering against pH changes in biological systems, water as a reactant, The fitness of the aqueous environment for living organisms.

PRINCIPLE OF BIOENERGETICS

Bioenergetics and thermodynamics, phosphoryl group transfers and ATP, biological oxidation-reduction reactions, biological membranes and transport.

MODULE 2

(12 hrs)

CARBOHYDRATES

MONOSACCHARIDES: - Structure and nomenclature, configuration, conformation, physical properties, optical rotation, mutarotation, chemical reactions, caramelization, reactions with amino compounds (*Maillard* Reaction), initial phase of the *Maillard* reaction, redox reactions, *Strecker* Reaction:

Disaccharide— structure, different types, sucrose biosynthesis

Oligosaccharides: - structure and nomenclature, properties and reactions

Polysaccharides:- different types, agar, enzymatic degradation of polysaccharides, amylases, gluco-1,4- α -D-glucosidase (glucoamylase), pectinolytic, thickening agents, metabolism of carbohydrates, glycolysis, gluconeogenesis, pentose phosphate pathway, citric acid cycle.

MODULE 3

(12 hrs)

AMINO ACIDS AND PROTEINS:

amino acids, Occurrence: structure, classification, physical & chemical properties, peptides, polypeptide, proteins & their properties, sequence of amino acids, structure of protein denaturation, major source of protein

Metabolism of protein, digestion, absorption & functions, end products of protein metabolism inter-medially metabolism of amino acids & the urea cycle, metabolic Fates of amino groups, nitrogen excretion and the urea cycle, pathways of amino acid degradation, protein targeting and degradation.

MODULE 4

(12 hrs)

OILS AND FATS:

Introduction, occurrence, composition, classification of glycosides, structure, physical and chemical properties, rancidity and flavor, reversion processing of oil bearing materials, refining of oils and fats, splitting & esterification hydrogenation, shortenings and low fat spreads.

Lipid metabolism: digestion, absorption and functions. Oxidation of fatty acids, biosynthesis of fatty acids and fats. Food emulsions, digestion, mobilization, transport of fats, oxidation of fatty acids, ketone bodies,

Biosynthesis of fatty acids and eicosanoids, biosynthesis of triacylglycerols, biosynthesis of membrane phospholipids, biosynthesis of cholesterol, steroids, isoprenoids.

Reference Books:

- P.S. Kalsi, *Stereochemistry; New Age international; 2000.*
- H.-D. Belitz, Werner Grosch, Peter Schieberle; *Food Chemistry, Springer, 2010.*
- David L. Nelson and Michael M. Cox; *Lehninger Principal of Biochemistry, , Sixth Edition*
- Robert K. Murray, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Roadwell, P. Anthony Weil; *Harper's Illustrated Biochemistry,*
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer; *Biochemistry,.*

PFNB-105 BIOMATERIAL ENGINEERING

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To acquaint students with biomaterial engineering and processes involved for new food product design.

MODULE 1

(10 hrs)

Introduction and review of engineering properties of food material. Physico-chemical characteristics: Shape, sphericity, size, volume, density, porosity, surface area, coefficient of friction, angle of repose and their role in the designing of the equipments. Aero and hydrodynamic characteristics: concept and use of drag coefficient, terminal velocity in food products processing and handling.

MODULE 2

(13 hrs)

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity.
Electrical properties: Electrical resistance, conductance, dielectric constant.
Optical properties: Reflectivity, transmittivity, absorptivity of incident rays.
Role of thermal, electrical and optical properties in the products/process designing, processing and/or handling.

MODULE 3

(13 hrs)

Rheological properties: Overview, basic concepts of rheology relevant to food texture, elastic vs. textural characteristics of foods, viscoelastic behaviour of food material, viscometry approaches. Time temperature dependency of linear viscoelastic behaviour of agricultural products.
Textural properties: Classification, objective methods of texture evaluation, engineering approach and techniques for evaluation of food texture.

MODULE 4

(12 hrs)

Visco-elastic rheological models, mathematical modelling for rheology and texture of food materials. Sensory evaluation and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination, flow behavior of granular and powdered food materials.

Reference Books

- Malcolm C. Bourne; An Elsevier Science Imprint; *Food Texture and Viscosity; Concept and Measurement*;
- James F. Steffe; *Rheological Methods in Food Process Engineering*; Freeman Press.
- Rao and Razvi; *Engineering Properties of Foods*
- Mohsenin; *Physical Properties of Plant and Animal Material*;

PFNB-106 LABORATORY- I

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 2 |

| L | T | P |
|---|---|---|
| - | - | 4 |

LIST OF EXPERIMENTS

1. Preparation of standard solution.
2. Carbohydrates: qualitative tests, estimation of reducing/non-reducing sugars, total sugars, starch and polarimetry of sugars.
3. Lipid extraction and its evaluation. Solvent extraction method, PV, saponification, iodine value, acid value, free fatty acid.
4. Protein estimation.
5. Mineral Estimation.
6. Crude fiber estimation.
7. Determination of moisture content by
 - a. loss on drying (using oven and vacuum oven).
 - b. Moisture meter.
 - c. Distillation.
7. Estimation of total phenolic content of biomaterial.
8. Estimation of total flavonoids content of biomaterial.
9. Estimation of total antioxidant activity of biomaterial.
10. Estimation of FRAP (Ferric reducing antioxidant activity) assay or reducing power.
11. Estimation of hydrogen peroxide (H₂O₂) scavenging activity.
12. Estimation of Free radical scavenging activity on DPPH· (α , α -diphenyl - β - picrylhydrazyl).
13. Organoleptic evaluation of food materials.
14. Objective evaluation of food materials: water activity, viscosity, texture analysis, color.

Reference Books

- Brain S. Furniss, A.J.Hannaford; *Vogel's Text Book of Practical Organic Chemistry*,
- John Wiley & sons; *P.W.G. Smith. A.R.Tatchell, 5th Edition, Inc. New York, 1989.*
- Skoog and West; *Instrumental Methods of Analysis*,
- C.K. Kokate, VallabhPrakashan; *Practical Pharmacognosy*., New Delhi.
- K.R., NiraliPrakashan, *Practical Pharmacognosy: Khandewal, Pune.*

PFNB 201 NUTRIGENOMICS

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Prerequisite: Knowledge in Basic Molecular Biology & related techniques and Applied Biochemistry

Objective and Expected Outcome: To familiarize students with the basic concepts in NUTRITIONAL GENOMICS and to develop an understanding of GENOMICS AND GENE REGULATION WITH RESPECT TO DIET and to obtain an appreciation for the role and importance of nutrition in prevention of POLYGENIC DISEASES. Students will gain knowledge to apply NUTRIGENOMICS and to design nutritional strategies for prevention of chronic diseases such as cardiovascular disease, obesity, type-2 diabetes and cancer. To reach these objectives students will need to search literature and learn how to use genomic databases, read relevant original research papers, actively participate in preparing specific lecture topics, and discuss concepts and ideas with in the class. In addition, students will work in groups and/or individually on several class/home assignments and write a research grant application

MODULE 1

(12 hrs)

INTRODUCTION TO GENE-DIET INTERACTIONS

Nutrigenomics: Scope and Importance to Human Health and Industry
 Transporter gene polymorphisms -interaction with effects of micronutrients in humans. Polymorphisms in genes affecting the uptake and transport of omega-6 and omega-3 polyunsaturated fatty acids: interactions with dietary lipids and chronic disease risk. Nutrigenomics approaches to unraveling physiological effects of complex foods. The intestinal microbiota - role in nutrigenomics.

MODULE 2

(12 hrs)

MODIFYING DISEASE RISK THROUGH NUTRIGENOMICS:

Modulating the risk of cardiovascular disease through nutrigenomics; Modulating the risk of diabetes through nutrigenomics; Modulating the risk of inflammatory bowel diseases through nutrigenomics; Modulating the risk of obesity through nutrigenomics; Modulating the risk of cancer through nutrigenomics; Modulating the malnutrition through nutrigenomics

MODULE 3

(12 hrs)

TECHNOLOGIES IN NUTRIGENOMICS

GENOMICS TECHNIQUES: Different sequencing approaches, Microarray, Massarray, SNP genotyping, PCR and RT-PCR techniques

PROTEOMICS TECHNIQUES: 1-D, 2-D gel electrophoresis, DIGE, novel peptide identification, peptide sequencing methods

METABOLOMICS TECHNIQUES: Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders

COMPUTATIONAL APPROACHES: Introduction to different types of public domain databases, data mining strategies, primer designing.

MODULE 4

(12 hrs)

BRINGING NUTRIGENOMICS TO INDUSTRY, HEALTH PROFESSIONALS, AND THE PUBLIC:

Bringing nutrigenomics to the food industry: Industry-Academia partnerships as an important challenge; Bringing nutrigenomics to the public: Is direct-to-consumer testing the future of nutritional genomics? Interaction with health professionals in bringing nutrigenomics to the public; Is contemporary society ready for nutrigenomic science?Public health significance of nutrigenomics and nutrigenetics

Reference Books:

- Journal Nutrients 2012, 4, 1898-1944; *Molecular Nutrition Research—The Modern Way Of Performing Nutritional Science.*
- Journal Nutrients 2013, 5, 32-57; *Nutrigenetics and Metabolic Disease: Current Status and Implications for Personalized Nutrition*
- J Nutrigenetics Nutrigenomics 2011;4:69–89; *Nutrigenetics and Nutrigenomics: Viewpoints on the Current Status and Applications in Nutrition Research and Practice.*
- J Am Diet Assoc. 2006;106:569-576; *Nutrigenomics: From Molecular Nutrition to Prevention of Disease.*
- The Journal of Nutrition; *Nutritional “Omics” Technologies for Elucidating the Role(s) of Bioactive Food Components in Colon Cancer Prevention.*
- *Nutrition 25 (2009) 1085–1093; Proteomics at the center of nutrigenomics: Comprehensive molecular understanding of dietary health effects.*

<http://www.ga-online.org/files/Antalya2011/WS2-Daniel.pdf>

<http://www.authorstream.com/Presentation/winingneeraj01-1272374-nutritional-genomics/>

PFNB-202 PATHOPHYSIOLOGY OF COMMON DISEASES & GENERAL PHARMACOLOGY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: This course is designed with the aim to confer student's knowledge about the underlying pathological changes in disease states and the molecular basis of nutraceutical action in such diseased states.

MODULE 1

(12 hrs)

NUTRACEUTICALS: the link between nutrition and medicine

Concepts of health and disease: disease causing agents and prevention of disease

ONCOLOGY: cancer cell biology and angiogenesis, apoptosis. Nutraceuticals in chemoprevention

Pathophysiology of Inflammatory diseases: rheumatoid arthritis, osteo-arthritis, gout, asthma

Bone Health

PATHOPHYSIOLOGY OF CARDIAC DISORDERS: hypertension, angina, congestive heart failure, atherosclerosis and myocardial infarction

MODULE 2

(12 hrs)

Pathophysiology liver cirrhosis, pancreatitis

Pathophysiology of CNS disorders: depression, mania, epilepsy, Alzheimer's disease and Parkinson's disease

OBESITY: Biology of obesity, evaluation and management of obesity, eating disorders

Gastrointestinal disorders: dysphagia, nausea, vomiting, constipation, ulcerative colitis, inflammatory bowel disease

Pathophysiology of common diseases: diabetes, malaria, AIDS

MODULE 3

(14 hrs)

INTRODUCTION TO PHARMACOLOGY: Mechanisms of drug action, introduction to receptors, neurotransmitters, drug transporter, basic mechanisms of membrane transport, membrane transporters, ion channels, second messengers, downstream signaling pathways.

MODULE 4

(10 hrs)

Drug response, adverse drug reactions, drug interactions and pharmacogenetics. Drug resistance and tolerance, orphan drugs, essential drug concept, dose response curve, competitive and non- competitive drug antagonism, agonists, antagonist, partial agonist, reverse agonist. Principles of basic and clinical pharmacokinetics

Reference Books:

- By Vinay Kumar, Abul K. Abbas, Nelson Fausto and Jon Aster; *Robbins & Cotran Pathologic Basis of Disease. 8th Edition.. Publisher: Elsevier.*
- By Jo Ann Zerwekh, AZ Jo Carol Claborn, Tom Gaglione; *Mosby's Pathophysiology Memory Note Cards: Visual, Mnemonic, and Memory Aids for Nurses, 2nd Edition. Publisher: Elsevier.*
- By Richard Mitchell, Vinay Kumar, Abul K. Abbas, Nelson Fausto and Jon Aste; *Pocket Companion to Robins & Cortan Pathological Basis of Disease. 8th Edition.. Publisher: Elsevier.*
- Authors: Kathryn L. McCance & Sue E. Huether; *Pathophysiology: The Biologic Basis for Disease in Adults and Children. Publisher: Elsevier.*
- By Porth, Carol; *Essentials of Pathophysiology; Concepts of Altered Health States.. Publisher Lippincott Williams & Wilkins.*
- By Sue E Huether, Kathryn RN; *Understanding Pathophysiology. 5th Edition. Publisher: Elsevier.*
- By Humphrey P. Rang, Maureen M. Dale, James M. Ritter, Rod J. Flower, Graeme Henderson; *Rang & Dale's Pharmacology, 7th Edition. Publisher: Elsevier.*
- . By K D Tripathi; *Essentials of Medical Pharmacology. 6th edition Publisher Jaypee.*

PFNB-203 ADVANCES IN PHYTOCHEMICAL ANALYTICAL TECHNIQUES

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To develop capabilities for performing analysis of phytochemical constituents and subsequent evaluation in nutraceuticals and natural products.

MODULE 1

(10 hrs)

INTRODUCTION; Production Processes for Herbals and Botanicals: Introduction, Cultivation, Collection from the Wild, Pre-preparation Technique (Cleaning, Drying, Packaging of Dried Plants, grinding, peeling etc.); Selection of Plant and Plant Parts for Phytochemical Analysis

METHODS OF EXTRACTION: Introduction, Organic Solvent Extraction, Extraction with Supercritical Gases, Steam Distillation, Extraction of Essential Oil, Soxhlet Extractor, Accelerated Solvent Extractor, Purification and Concentration of Miscella, Schemes of procedure for extracting Plant Tissues, Other Minor Extraction Methods, Advances in extraction techniques (Ultrasound extraction, microwave extraction etc).

QUALITATIVE PHYTOCHEMICAL SCREENING: Detection of: Alkaloids, carbohydrates and Glycosides, saponins, proteins and Amino Acids, Phytosterols, Fixed Oils and Fats, Phenolic Compounds and Tannins, Gum and Mucilages, Volatile Oil.

MODULE 2

(14 hrs)

METHODS FOR SEPARATION OF PHYTOCHEMICALS: Introduction, Chromatography, Paper Chromatography, Thin layer Chromatography, Column Chromatography (Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data).

QUALITATIVE AND QUANTITATIVE ESTIMATION OF PHYTOCHEMICAL: Introduction, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography, High Performance Thin layer Chromatography, Optimum Performance Laminar Chromatography (OPLC) (Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data).

MODULE 3

(16 hrs)

METHODS OF IDENTIFICATION: Introduction; Physical Characteristics;

Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data – Spectroscopy; Ultra Violet Spectroscopy; Infrared Absorption Spectroscopy; Near-Infrared Absorption Spectroscopy; Mass Spectroscopy; Nuclear Magnetic Resonance Spectroscopy; CHN Analysis; x-Ray Crystallography .

MODULE 4

(8 hrs)

CATEGORIES OF PHYTOCHEMICALS OVERVIEW OF DIFFERENT PHYTOCHEMICALS: Introduction, Terpenoids, Steroids, Phenolic Compounds, Alkaloids, Glycosides, Carbohydrates, Lipids and Related Compounds, Plant Pigments, Vitamins, Amino Acids, Proteins, Nucleic Acids.

TOXIC RESIDUE DETERMINATION: Pesticide residue, Arsenic and Heavy Metals

Reference Books:

- By Prof N Raman; *Phytochemical Techniques*, , New India Publishing Agency.
- By Veronika R. Meyer, *Practical High- Performance Liquid Chromatography*; John Wiley & sons.
- By W. Jeffery Hurst; *Methods of Analysis for Funtional Foods & Nutraceuticals*, CRC Press.

PFNB – 204 FUNCTIONAL FOOD & NUTRACEUTICAL: DESIGN & DEVELOPMENT

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To develop capability for devising research problem in the area of interest.

MODULE 1 (10 hrs)

Introduction – design & development, Project- Meaning, Characteristics, levels, classification, aspects – Preliminary & Feasibility and approach, Project cycle, Project Analysis. Product Design & development – Concept, Factor affecting development of a new product, People involved in Product Design and development, Product Life cycle

MODULE 2 (14 hrs)

The Process of product development- product strategy, Idea/Concept Generation, feasibility/Optimization, product design and process development, pre-launch, product commercialization, product launch and evaluation. Role of consumers research & market research in product development, Requirements for development of food products vs. functional food/nutritional products, Steps to bring Functional foods on the market. The knowledge base for product development technology - knowledge and the food system, knowledge management, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing.

MODULE 3 (12 hrs)

Structural Design Principles for improved Food Performance & Processing technology approaches to produce encapsulation and delivery systems – Emulsion, spray drying, freeze drying, co-extrusion, microencapsulation and Nano-laminated Biopolymer Structures in Foods; The shelf life of foods. Reverse pharmacology for developing functional foods/herbal supplements. New trends for food product design & case studies.

MODULE 4 (12 hrs)

Natural Products Drug Discovery: Introduction, the current pharmaceutical Scenario, why Natural products are intrinsically useful for drug discovery, possible reasons for the current downsizing of natural product drug discovery, Strategies in natural product drug discovery; Ayurveda in modern medicine-development and modification of bioactivity. Case study of Cancer Drug Discovery and Development

Reference Books:

- Clarke & Wright W. 1999; *Managing New Product and Process Development*; Free Press.
- Earle and Earle 2001; *Creating New Foods*, Chadwick House Group.
- Earle R & Anderson A. 2001; *Food Product Development Earle R*, Woodhead Publications.
- Fuller 2004; *New Food Product Development - from Concept to Market Place*,. CRC.
- Nissim Garti and D. Julian McClements; *Encapsulation technologies and delivery systems for food ingredients and nutraceuticals*; Woodhead Publishing Ltd.
- D.Julian McClements and Eric A. Decker, *Designing functional foods*; Woodhead Publishing Ltd.
- Jim Smith and Edward, *Functional Food Product Development*; Blackwell Publishing Ltd

PFNB – 205 QUALITY & SAFETY STANDARDS & REGULATION AFFAIRS

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To develop the capability for ensuring regulatory obligations in the area of interest nationally as well as internationally

MODULE 1

(12 hrs)

Introduction quality control & quality assurance; Statistical approaches in quality control and quality assurance; Production planning and Control

WTO, GATT, GATS, Codex Alimentarius Commission, Requirement of good manufacturing practices (GMP), good hygienic process (GHP), Cleaning and disinfection Principles.

MODULE 2

(10 hrs)

Hazard Analysis Critical Control Point (HACCP) and its implication ISO – 22000:2005, Food safety and standards act – 2006, British Retail consortium, Safe quality food.

AGMARK- 1937, FPO 1955, PFA –1954, BIS –1952, consumer protection act –1986, Vanaspati control order –1978, export quality control and inspection act- 1963, Green Label certification, Organic food certifications, Certifications for GMFs.

MODULE 3

(12 hrs)

ISO–9000 series (2008), Concept of total quality control (TQM), ISO- 19011, GLP, ISO-17025.

Functional foods associated health claims for consumer: Introduction, EU legislation, U.S. regulation, Japan, Asia, Australia, New Zealand and other countries regulations on nutrition, health and related claims made on functional foods & their support, regulatory Issues/challenges for herbal medicinal plants. Harmonisation of regulations, DSHEA.

MODULE 4

(14 hrs)

Materia-medica. Ayurvedic Pharmacopoeia of India (API), United States Pharmacopoeia (USP), European Pharmacopoeia (EP), European evaluation agency (EMA), Drug and cosmetic Act. ICMR., ESCOP, ICH, FDA, WHO, GCLP.

Industrial legislation and laws, acts and disputes. Industrial disputes act –1947, Intellectual Property: concept and fundamental- Patent Laws, copy right, trade mark and IPR governing discovery and development of drugs from natural sources, IPP, WIPO (World Intellectual Property Organization), TRIPS, Trade Related Investment Measures (TRIMS), Biopiracy of Medicinal plants;

Reference Books:

- By Mike Dillon & Chris Griffith; *Auditing in the Food Industry*; CRC Press
- By Norman G. Marriott ; *Essentials of Food Sanitation*
- By Michael M. Cramer; *Food Plant Sanitation (Design, Maintenance & Good Manufacturing Practices)*, CRC Press
- By Inteaz Alli; *Food Quality Assurance Principles & Practices*, CRC Press
- By Sandy Weinberg; *Good Laboratory Practice Regulations Drugs & Pharmaceutical Sciences*, CRC Press
- By Sidney H. Willing, Marcel Dekkerine; *Good Manufacturing Practices for Pharmaceutical (A Plan for Total Quality control from Manufacturer to Consumer)*.

- By Micle D. Pierron & Donald A. Corlett, Van Nostrand Reinhold; *HACCP (Principle and Applications)*
- By H.L M. Lelieveld, M.A. Mastert & J. Holah; *Handbook of Hygiene Control in the Food Industry CRC Press*
- By Ian Smith and Anthony Furness; *Improving Traceability in Food Processing & Distributions, CRC Press*
- By Graham D Dgg; *A Practical Guide to Quality Management in Clinical Trial Research,, CRC Press*
- By Merton R. Hubbard, Kluwer Academic; *Statistical Quality Control for the food Industry, Plaenum Publishers*
- The CRC Master Keyword Guide for Food : 21 CFR Regulations of Food & Drug Administration, CRC Press
- By Wilbur A. Gould; *Total Quality management for the Food Industries, CTI Publications*
- By Jurg P. Seiler; *Good Laboratory Practice the why & the How, Springer.*

International Standard

ISO 2000: 2005 ; ISO 9001 : 2008 ; Codex Alimentarius – 17th procedural Manual & all other respective standards Act & Regulation

Websites

www.icmr.nic.in. ; www.whoindia.org. ; www.fda.gov. ; www.wto.org.

PFNB – 301 RESEARCH METHODOLOGY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: Basic understanding of research concepts and its methodologies. After completion of this course, student will be enabled to select and define appropriate research problem, prepare project proposal and to write research report and thesis.

MODULE 1 (8 hrs)

INTRODUCTION: Definition, general and specific characteristics of research, classification, types and objective of research, research process, criteria of good research, basic concept of experiments and research, significance of research. Planning and designing a research study: choosing a research topic, literature review, research problem formulation, articulating hypothesis, selection of variables, research participants.

MODULE 2 (14 hrs)

Meaning, nature and types of data: primary and secondary; observational; experimental. Data Collection: types of sampling design. Principles of research design and methodology, general types of research designs and approaches. Experimental designs, quasi-experimental designs, non-experimental or qualitative designs, designing a questionnaire, method of survey, epidemiological studies. General approaches for controlling artifact and bias: validity, sources of artifact, bias and their control (randomization and blinding).

DATA ANALYSIS: statistics-concept and types, descriptive and inferential, parametric and non-parametric, stochastic and deterministic. Tools of descriptive statistics and their application. Central tendency, dispersion, measures of association, correlation and regression

MODULE 3 (18 hrs)

Concept of probability, probability distribution, normal distribution, poisson distribution. Hypothesis testing and level of significance. Paired and unpaired t-test, Chi-square, F-test, ANOVA: one way and two way, Tukey's HSD, interpreting data and drawing inferences. Multiple correlation and regression, index number.

Non-parametric tests: sign test; Mc Nemer test, Mann-Whitney test, Kruskal-Wallis test, Spearman's rank correlation, principal component analysis.

MODULE 4 (8hrs)

Ethical considerations in research; disseminating research result & distilling principles of research design and methodology: sharing the result of research studies, presentation of result. Research report: need of research report, overall structure of research report, tips on writing specific sections. Types of publication. Writing review and research papers: overall structure of review and research report, general guidelines

Reference Books

- Luciene TM Blessing and Amaresh Chakrabarti; *DRM, a design research methodology.. Springer.*
- Yogesh Kumar Singh; *Fundamental of Research Methodology and Statistics. New Age International (P) Limited, Publishers.*
- Geoffrey Marczyk, David DeMatteo, David Festinger;. *Essential of Research Design and Methodology. John Wiley & Sons*
- Kothari, C.R; *Research Methodology: Methods and Techniques.. New Age International Publishers, New Delhi.*
- Arya. P.P. and Pal; *Research Methodology in Management: Theory and case Studies. Y. Deep and Deep Publishers Pvt. Ltd., New Delhi*

PFNB – 302.1 MODELLING & SIMULATION

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: This course covers modelling and simulation principles with applications of modelling and simulation concepts in different biological process.

MODULE 1**(8 hrs)**

Modelling and simulation: fundamentals of modeling and simulation; definition of basic terms like system, entity attribute, activity, state of system, system environment; categories of system, stochastic activities; different steps for modeling and simulation. Types of models, advantages and disadvantages of modelling and simulation. Application areas of modeling & simulation.

MODULE 2**(12 hrs)**

Role of numerical analysis in modelling and simulation: overview. Optimization: introduction, optimization theory, optimization methods, graphical and numerical methods of optimization. Unconstrained optimization, constrained optimization, programming optimization, experimental optimization. Full factorial design; fractional factorial designs.

MODULE 3**(16 hrs)**

Response surface methodology (RSM), Monte Carlo Method or random simulation.

Curve fitting and regression analysis: concept and types. Different methods of curve fitting: linear, log linear, semi log linear and quadratic and their applications. Method of derivation and interpretation of results. Bivariate regression and correlation analysis. Multiple and partial regression and correlation analysis.

Synthetic biology redux—computer simulation and artificial life. Modelling and simulation for system (circulatory system), disease (cancer), cell, system biology (protein interaction).

MODULE 4**(12 hrs)**

Optimization of some engineering operations: thermal processing, dehydration & drying, freezing process; extrusion process; filtration processes; membrane separation process; distillation and extraction processes.

Reference Books

- Douglas C. Montgomery; *Design and Analysis of Experiments Response surface methodology.. Wiley*
- R. H. Myers; *Response Surface Methodology. Wiley.*
- A. I. Khuri & J. A. Cornell; *Response surfaces design and analysis. Wiley*
- Luca Formaggia; Alfio Quarteroni & Alessandro Veneziani; *Cardiovascular Mathematics. Springer.*
- Luigi Preziosi; *Cancer Modelling And Simulation. Chapman & Hall/CRC.*
- Evelyn Fox Keller; *Making Sense Of Life (Explaining Biological Development with Models, Metaphors, and Machines).. Harvard University Press.*
- Alexander R. A. Anderson; Mark A. J. Chaplain & Katarzyna A. Rejniak; *Single-Cell based Models In Biology And Medicine.. Birkhäuser Verlag AG*

PFNB – 302.2 ENERGY MANAGEMENT IN PROCESSING INDUSTRY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To enable the students to maximize energy efficacy and energy audit and use of energy in different processing industry.

MODULE 1

(6 hrs)

Fundamentals of heat transfer, fluid mechanics, and thermodynamics in pharmaceutical and food processing industry. Fundamentals of Energy Auditing: Introduction, Procedures for Energy Audit, Measurements, Instrumentation, and Data Collection.

MODULE 2

(12 hrs)

Energy project management in pharmaceutical and food processing facilities: introduction, energy analysis, sustainability in the industry, economic analysis, financial analysis, energy management project planning, implementation, and evaluation.

MODULE 3

(14 hrs)

Energy consumption and saving opportunities in existing processing facilities. Energy efficiency and conservation in the industry. Energy conservation in unit operations. Conversion of food processing wastes into energy: Food processing wastes and utilizations, anaerobic digestion of food processing wastes, fermentation of food processing wastes into transportation alcohols.

MODULE 4

(16 hrs)

Energy conservation technologies applied to processing facilities. Introduction: steam generation and consumption system, compressed air system, power and electrical systems, heat exchangers, waste-heat recovery and thermal energy storage in processing facilities. Novel thermodynamic cycles applied to the processing industry for improved energy efficiency. Energy efficiency and conservation in emerging processing systems.

References Books

- . Lijun Wang; *Energy Efficiency and Management in Food Processing Facilities* CRC Press.

PFNB – 302.3 UNIT OPERATIONS

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: The main objective of the course is to examine methodologies, both applied and fundamental, to analyze and scale up different health product manufacturing processes.

MODULE 1

(8 hrs)

Unit operations: introduction, unit systems, state of system. Classification; transport phenomena: definition, mechanisms. Process control: automatic control and computer based systems. Cleaning, sorting, grading & peeling. Size reduction: introduction, factor affecting, theory, equipments and applications

MODULE 2

(12 hrs)

Mixing, separation and concentration. Fermentation; irradiation, high hydrostatic pressure, light or ultrasound: introduction, factor affecting, theory, equipments and applications.

MODULE 3

(14 hrs)

Heat processing operations: blanching, pasteurisation, heat sterilisation, evaporation and distillation, extrusion. Heat processing using hot air (dehydration, baking and roasting). Heat processing using hot oils (frying); crystallization.

MODULE 4

(14 hrs)

Dielectric, ohmic and infrared heating. Heat removal processing operation: chilling, freezing, freeze drying and freeze concentration. Post-processing operations: coating or enrobing, filling and sealing of containers, materials handling, storage and distribution.

Reference Books

- Albert Ibarz, Gustavo V. Barbosa-Cánovas; *Unit Operations in Food Engineering*. CRC Press.
- R. Paul Singh, Dennis R. Heldman; *Introduction to Food Engineering*. Elsevier Inc.
- Dennis R. Heldman, Daryl B. Lund; *Handbook of Food Engineering*. CRC Press.
- Anthony J. Hickey, David Ganderton; *Pharmaceutical Process Engineering.. Informa Healthcare*
- Fellows, P. J.; *Food processing technology*. CRC Press

PFNB – 302.4 GENETIC ENGINEERING

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: The objective of the course is to explain the concepts underlying the molecular cloning and describe its application in the upcoming field of Nutraceuticals.

MODULE 1 (12 hrs)

PRINCIPLES OF GENE CLONING: Gene Cloning; principle; its significance; vehicles (plasmids and bacteriophages); DNA Isolation and its purification; Manipulation of Purified DNA; Introduction of DNA into living Cells

MODULE 2 (12 hrs)

VECTORS: Basic Biology; Principle of generation of the vectors and its applications (plasmid, phage vectors, cosmid, phasmid and other advanced vectors); Transformation; Transfection; Applications of Vector Mediated Gene Transfer.

MODULE 3 (12 hrs)

Cloning Strategies, Amplification, Principles and Techniques involved in Sequencing and Mutagenesis, Gene Transfer to Plants, Recent Advances in Transgenic Technology in context to Nutrition enhancement

MODULE 4 (12 hrs)

GENE CLONING IN RESEARCH AND NUTRACEUTICAL BIOTECHNOLOGY: Principle involved in gene cloning of agriculture (Rice Wheat, Brinjal and Cotton); Production of Proteins from Cloned Genes; Regulatory Affairs involved in Gene Cloning

Reference Books

- by SB Primrose; *Principles of Gene Manipulations* RM Twyman and RW Old 7th Edition
- Gene Cloning: *An Introduction* by TA Brown 3rd edition

PFNB – 303.1 PROCESSING OF PLANT BIOACTIVES

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To understand the main classes of bioactive phytoconstituents their identification and their health effects.

MODULE 1

(12 hrs)

Phytoconstituents role and distribution. Biotechnology of plant-derived dietary supplements, plant toxins. Beverages (tea, coffee, cocoa, wine, beer): Introduction, pre-processing techniques, different bioactive components and related processed functional products.

MODULE 2

(12 hrs)

Cereal (wheat, oat, rice, maize) structure and composition, pre-processing techniques, different bioactive components. Dietary recommendations and cereal based processed functional products. Legumes composition, pre-processing techniques, different bioactive components & their Health Benefits and legumes based processed functional products.

MODULE 3

(12 hrs)

Fruits (grapes, citrus fruits and others fruits) composition, pre-processing techniques, different bioactive components. Fruits based processed functional products. Vegetables (cruciferous, onion, garlic & other vegetables) composition, pre-processing techniques, different bioactive components and vegetables based processed functional products.

MODULE 4

(12 hrs)

Modified fats and oils: introduction, specialty oils, specialty processed and formulated fats, engineered lipids-modification of triacylglyceride structure. Herbs, spices & medicinal plants, pre-processing techniques, bioactive components, processed functional products.

Reference Books

- Giuseppe Mazza; *Functional Foods: Biochemical and Processing Aspects, Volume 1.* CRC Press.
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition.* CRC Press.
- Massimo Maffei; *Dietary Supplements of Plant Origin.* CRC Press.
- Fereidoon Sahidi, Deepthi K. Weerasinghe; *Nutraceutical beverages Chemistry, Nutrition and health Effects.* American Chemical Society.
- Ronald R. Watson; *Vegetables, fruits, and herbs in health promotion.* CRC Press.
- Özlem Tokusoglu; *Fruit and Cereal Bioactives: Sources, Chemistry, and Applications.* Clifford Hall III. CRC Press.
- Leland J. Cseke; Ara Kirakosyan Peter B. Kaufman; Sara L. Warber James A. Duke; Harry L. Briemann; *Natural Products from Plants.* CRC Press

PFNB – 303.2 PROCESSING OF ANIMAL BIOACTIVES

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To understand the main classes of animal derived bioactive compounds their identification and health effects.

MODULE 1

(10 hrs)

Bioactive metabolites from animal sources and their extraction and utilization.

MODULE 2

(14 hrs)

Bioactive components in milk and milk products: overview; bioactive components in milk (bovine, goat, sheep, buffalo, camel and mare). Bioactive Components in manufactured dairy products (caseins, caseinates, cheese, yogurt, kefir and koumiss & whey). Probiotics and prebiotics as bioactive components in dairy products.

MODULE 3

(12 hrs)

Bioactivity of Marine Organisms: classification of marine organisms; Biosynthesis of Bioactive Metabolites of Marine Organisms, medicinal foods: current status and prospects. Bioactive Metabolites of marine algae, fungi, bacteria and animals. Marine Toxins; interaction between marine organism bioactives and health.

MODULE 4

(12 hrs)

Meat and meat products: bioactive contents from various meat. Egg: nutrient rich eggs. Insects bioactives: terpenoids, fatty acid and other polyacetate derivatives, polyketides, alkaloids and amines, nucleoside derivatives and miscellaneous compounds.

Reference Books

- D.S. Bhakuni; D.S. Rawat; *Bioactive Marine Natural Products.. Springer.*
- Colin Barrow; Fereidoon Shahidi; *Marine Nutraceuticals and Functional Foods. CRC Press.*
- Marine Medicinal Foods: Implications and Applications - Animals and Microbes
- Se-Kwon Kim; (*Advances in Food Nutrition and research: volume 65*).. Elsevier
- Giuseppe Mazza; *Functional Foods: Biochemical and Processing Aspects, Volume 1.. CRC Press.*
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition. CRC Press.*
- Lew Mander and Hung-Wen (Ben) Liu; *Comprehensive Natural Products II (Chemistry and Biology). Elsevier.*
- Young W. Park; *Bioactive Components in Milk and Milk Products. Wiley-Blackwell.*

PFNB – 303.3 PRESERVATION AND PACKAGING TECHNOLOGY

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: To introduce students to the practice of food preservation and packaging.

MODULE 1

(8 hrs)

Food preservation: introduction, type of food, major processes of food deterioration, what, why, how, how long, what to preserve; phase transition and other structural changes in foods; water activity and food preservation.

MODULE 2

(10 hrs)

Food preservation methods: Introduction, principle of heat treatment (thermal processing, drying), natural antimicrobials, antioxidants, pH, combined methods for food preservation. Chemical hurdle technology. Surface treatments and edible coatings in food preservation; encapsulation and controlled release in food preservation.

MODULE 3

(16 hrs)

Packaging: introduction, types of packaging, general aspects of drug packaging, differences between pharmaceutical and food packaging, function of packaging.

Pharmaceutical packaging materials: introduction (glass, plastic, metal container etc.). Container and closure. Completing all types of filled, pharmaceutical containers; labels and labelling

MODULE 4

(14 hrs)

Active and intelligent packaging: introduction, types, advantages and disadvantages. Integrating intelligent packaging, storage and distribution.

Packaging-flavour interaction, consumers and novel packaging; safety and legislative aspects of packaging, issues facing modern drug packaging.

Reference Books

- Raija Ahvenainen; *Novel Food Packaging Techniques*. Woodhead Publishing.
- Gordon L. Robertson; *Food Packaging: Principles and Practice*. CRC Press.
- Hanlon, Kelsey & Forcinio; *Handbook of Package Engineering*. Technomic Publishing Company.
- Paine and Paine; *A Handbook of Food Packaging*. Springer.
- Edward J. Bauer; *Pharmaceutical Packaging Handbook*. Informa Healthcare.
- G. W. Gould; *New Methods of Food Preservation(Non Thermal Processing of Foods)*. Marcel Dekker, Incorporated.
- R. Paul Singh, Dennis R. Heldman; *Introduction to Food Engineering*. Elsevier Inc.
- Fellows, P. J.; *Food processing technology*. CRC Press.

PFNB303.4-NUTRACEUTICAL DISCOVERY PROCESS

| Internal Marks | External Marks | Total Marks | Credits |
|----------------|----------------|-------------|---------|
| 40 | 60 | 100 | 4 |

| L | T | P |
|---|---|---|
| 3 | 1 | - |

Objective: The course aims to provide students with the understanding of the process of novel nutraceutical discovery beginning from identification to introduction into the clinical practice.

MODULE 1 (14 hrs)

Irrational and rational approaches in nutraceutical discovery and evaluation; historical, phytochemical, pharmacological and new approaches. Combinatorial chemistry, high throughput screening, ultra high throughput screening and high content screening, pharmacogenomics and proteomics. Regulatory Considerations for Dietary Supplements.

MODULE 2 (14 hrs)

Pre-clinical evaluation of nutraceuticals: Pharmacological profile tests, safety tests and toxicology tests. Acute, sub-acute and chronic studies (in-vivo and in-vitro studies) and special studies including carcinogenicity, mutagenicity and teratogenicity

MODULE 3 (10 hrs)

Clinical evaluation of nutraceuticals ; Principles of controlled clinical trials. Phase 0, Phase I, Phase II, Phase III and Phase IV trials.

MODULE 4 (10 hrs)

Pharmacokinetic characterization of nutraceuticals: Biopharmaceutics; bioavailability and bioequivalence. Drug Metabolism and drug Interactions

Reference Books:

- Bennett PN and Brown MJ. *Clinical Pharmacology*. Churchill Livingstone, Edinburgh. Latest Edition
- Walker R and Edwards C. *Clinical Pharmacy and Therapeutics*. Churchill Livingstone, London. Latest Edition.
- Laurence DR. *Clinical Pharmacology*. Churchill Livingstone, London. Latest Edition.
- Vogel HG and Vogel WH. *Drug Discovery and Evaluation*. Springer-Verlag, Berlin. Latest Edition.
- Edwards LD, Fletcher AJ, Fox AW, Stonier PD. *Principles and Practice of Pharmaceutical Medicine*, Wiley, England
- Pathak Y. *Handbook of Nutraceuticals; Ingredient, Formulations, and Applications*. CRC Press, Taylor & Francis Group, London.
- Atkinson AJ, Abernethy DR, Daniels CE, Dedrick RL, Markey SP. *Principles of Clinical pharmacology*. Academic Press, Elsevier, USA. Second Edition.