AC 4-3-2014
Item No. – 4.66

UNIVERSITY OF MUMBAI

Revised Syllabus
M.Sc. Sem I, II, III, IV

Program: M.Sc.
Course: Nutraceuticals

(Credit Based Semester and Grading System with effect from the academic year 2014–2015)

Preamble:

Indian Nutraceutical industry

Indian Nutraceutical industry has recently proved its mite both at national and international arena. With the *WTO* regime just rising on the horizon our nutraceuticals are in for a great boom especially in European and American regions. The market for these products is expected to rise in the coming years especially in the area of lifestyle medicines. Traditional systems of medicine in India will be playing a major role in these since Indian systems of medicines have been traditionally emphasizing on constitutional medicines.

Inadequacy of Trained personnel

Major hurdle faced by the R&D centers at various companies is the lack of adequately trained and appropriately oriented personnel. The lacunae become more evident when dealing with newer formulations and naturally derived food supplements.

There is a dire need for standardization techniques based on modern instrumental procedures and principles to ensure consistent quality of the nutraceutical products. A major hurdle in achieving this is the lack of adequate expertise among the manufacturers, the national laboratories and other Testing and research centers.

This lacunae needs to be addressed very diligently and the proposed programme is a step in this direction. Nutraceutical science is an interdisciplinary knowledge area and requires highly skilled personnel with strong background of both instrumental and non-instrumental (bio-assays) techniques. There is no programme available today for such a training to generate such expertise in students. There is a dire need of technical personnel with an overall expertise in human nutrition, various bioanalytical techniques, biological techniques and regulatory requirements to be able to take up R&D in nutraceutical industry.

The proposed programme has been planned to address this need of trained personnel.

Objectives of the Course

1. Develop trained manpower in the field of nutraceutical Sciences with specific emphasis for exploitation of traditional system of medicine as well as the need for changing trends in the nutraceutical Industry.

2. Training in the formulation, processing, manufacture and packaging requirements of nutraceuticals.

3. Amalgamate conventional biological sciences with modern genomic and proteomic technologies of manufacturing and analysis of nutraceuticals.

4. Impart knowledge of specialty nutraceuticals their design requirements.

5. Exposure to National & International regulatory affairs with reference to

Nutraceuticals.

M.Sc. Nutraceuticals: SYLLABUS IN BRIEF
Distribution of Credits

Semester I

PAPER	CODE	LECTURES (hr)	Credits Earned	Code	Practical (hr)	Credits Earned
Food Chemistry and Biochemistry (FCB-I)	PSNT101	60	4	PSNTP101	60	2
Human Nutrition and Physiology, Clinical dietetics NPC-I	PSNT102	60	4	PSNTP102	60	2
Nutraceuticals and Functional Foods NFF-I	PSNT103	60	4	PSNTP103	60	2
Biostatistics, Instrumentation and Biological Evaluation BIB-I	PSNT104	60	4	PSNTP104	60	2
TOTAL		**240**	**16**		**240**	**8**
TOTAL CREDITS		**24**				

M.Sc. Nutraceuticals: SYLLABUS IN BRIEF
Distribution of Credits

Semester II

PAPER	CODE	LECTURES (hr)	Credits Earned	Code	Practical (hr)	Credits Earned
Food Chemistry and Biochemistry (FCB-II)	PSNT201	60	4	PSNTP201	60	2
Human Nutrition ad Physiology, Clinical dietetics NPC-II	PSNT202	60	4	PSNTP202	60	2
Nutraceuticals and Functional Foods NFF-II	PSNT203	60	4	PSNTP203	60	2
Biostatistics, Instrumentation and Biological Evaluation BIB-II	PSNT204	60	4	PSNTP204	60	2
TOTAL		**240**	**16**		**240**	**8**
TOTAL CREDITS		**24**				

M.Sc. Nutraceuticals: SYLLABUS IN BRIEF
Distribution of Credits

Semester III

PAPER	CODE	LECTURES (hr)	Credits Earned	Code	Practical (hr)	Credits Earned
Microbiology, Quality and process control MQP – I	PSNT301	60	4	PSNTP301	60	2
Development and marketing of nutraceutical products: Product Development, Packaging and Safety Evaluation DMN - I	PSNT302	60	4	PSNTP302	60	2
Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods MBB - I	PSNT303	60	4	PSNTP303	60	2
Total Quality Management, Regulatory Affairs and Intellectual Property Rights QAR - I	PSNT304	60	4	PSNTP304	60	2
TOTAL		**240**	**16**		**240**	**8**
TOTAL CREDITS		**24**				

M.Sc. Nutraceuticals: SYLLABUS IN BRIEF
Distribution of Credits

Semester IV

PAPER	CODE	LECTURES (hr)	Credits Earned	Code	Practical (hr)	Credits Earned
Microbiology, Quality and process control MQP – II	PSNT401	60	4	PSNTP401	60	2
Development and marketing of nutraceutical products: Product Development, Packaging and Safety Evaluation DMN - II	PSNT402	60	4	PSNTP402	60	2
Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods MBB – II	PSNT403	60	4	PSNTP403	60	2
Total Quality Management, Regulatory Affairs and Intellectual Property Rights QAR - II	PSNT404	60	4	PSNTP404	60	2
TOTAL		**240**	**16**		**240**	**8**
TOTAL CREDITS		**24**				

NEW REVISED SYLLABUS FOR M. Sc. NUTRACEUTICALS (2014-15)

DISTRIBUTION OF TOPICS

SEMESTER I	SEMESTER II
PSNT101: Food Chemistry and Biochemistry - I **101.1** Carbohydrates **101.2** Bioenergetics **101.3** Proteins **101.4** Nucleic acids	**PSNT 201: Food Chemistry and Biochemistry - II** **201.1 Enzymes & Flavors** **201.2** Food preservation- Principles and Techniques **201.3** Membrane Biochemistry and Biochemistry of tissues **201.4** Endocrinology
PSNT102: Human Nutrition, Physiology and Clinical dietetics - I **102.1 Lipids and its Metabolism** **102.2 Vitamins and Minerals** **102.3** Nutritional Requirements **102.4** Special Dietary Needs	**PSNT 202: Human Nutrition, Physiology and Clinical dietetics - II** **202.1** Human physiology – I **202.2** Human physiology – II **202.3 Clinical Dietetics - I** **202.4 Clinical Dietetics - II**
PSNT103: Nutraceuticals and Functional Foods - I **103.1** Introduction to Nutraceuticals as Science **103.2 Properties, structure and functions of various Phytonutraceuticals** **103.3** Food as remedies **103.4 Nutritional Factors- Promoters and Inhibitors**	**PSNT 203: Nutraceuticals and Functional Foods - II** **203.1** Functional Foods – I **203.2 Phytonutrients** **203.3 Food Genomics** **203.4** Nutritional Genomics
PSNT104: Biostatistics, Instrumentation and Biological Evaluation - I **104.1** Biostatistics – I **104.2 Preclinical testing and clinical trials** **104.3** Introduction to Instrumentation techniques –I **104.4** Introduction to Instrumentation techniques –II	**PSNT204: Biostatistics, Instrumentation and Biological Evaluation - II** **204.1** Biological testing and bioassays **204.2** Organoleptic responses **204.3 Immune system in health and diseases** **204.4** Advanced Instrumentation techniques

DISTRIBUTION OF TOPICS (Contd.)

SEMESTER III	SEMESTER IV
PSNT301: Microbiology, Quality and Process Control for nutraceuticals - I **301.1** Basic Microbiology **301.2** Fermentation Technology **301.3** Downstream processing **301.4** Unit operations in manufacturing	**PSNT401: Microbiology, Quality and Process Control for nutraceuticals - II** **401.1 Medicinal Plants: Ethnomedicine in India** **401.2** Monitoring of food quality **401.3** Nutraceutical Industry and Market Information **401.4 Unit operations in Nutraceuticals**
PSNT302: Development and marketing of Nutraceutical products - I: Product Development, Packaging , label claims, consumer acceptance, future prospects **302.1 Future of health management** **302.2** Consumers' views on nutraceuticals **302.3** Packaging strategies for nutraceutical products **302.4** Labeling and claims for Nutraceuticals products	**PSNT402: Development and marketing of Nutraceutical products - II: Product Development, Packaging , label claims, consumer acceptance, future prospects** **402.1 Application of some technologies in development of Nutraceuticals and functional foods** **402.2** Chemoprevention and Nutraceuticals **402.3 Packaging strategies for nutraceutical products** **402.4** The role of marketing Communication in the introduction of functional foods to the Consumer
PSNT303: Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods -I **303.1 Scope of Genetic engineering, Library construction and screening** **303.2 Bioinformatics** **303.3** Animal Biotechnology **303.4** Development of Novel Food and Food Ingredients	**PSNT403: Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods -II** **403.1** Plant Biotechnology **403.2** Plants as Factories **403.3** Metabolic engineering & industrial products **403.4** Bioinformatics
PSNT304: **Total Quality management, Regulatory Affairs and Intellectual Property Rights - I** **304.1** Quality Control **304.2** Quality Assurance **304.3** Intellectual Property Rights (IPR)-I **304.4 Biostatistics - II**	**PSNT404: Total Quality management Regulatory Affairs and Intellectual Property Rights - II** **404.1 Intellectual Property Rights (IPR)-II** **404.2** Chemi-informatics and Pharmainformatics **404.3 Food Regulation- I** **404.4 Food Regulation- II**

M.Sc. Nutraceuticals: REVISED SYLLABUS IN DETAIL

SEMESTER I

PSNT101: Food Chemistry & Biochemistry - I

101.1 Carbohydrates: (15L)

Structure, Function, Classification, Food Sources, Digestion and Absorption, Characteristic Reactions, physical and Chemical properties, Derivatives, Glycogen metabolism, Glycolysis, Alcoholic Fermentation Formation of Lactate in Muscles, Gluconeogenesis, Hexose monophosphate Shunt and its significance, Regulation of carbohydrate metabolism. Glycemic index, load & fiber. Health benefits of dietary fiber.

101.2 Bioenergetics: (15L)

Electron Transport Chain, Inhibitors of ETC, energy rich compounds (e.g. ATP, PEP etc.), role of high energy phosphates in bioenergetics and energy capture, coupled reactions, Biological oxidation reduction, redox potentials, mechanism of oxidative phosphorylation.

101.3 Proteins: (15L)

Proteins: Essential and nonessential amino acids, peptide bond, structure, function, classification, denaturation of proteins, active amines, glutathione, Metabolism and synthesis of amino acids and proteins, Urea cycle, Food Proteins and their quality, Protein energy malnutrition, Methods of evaluating protein quality Processed food protein: protein concentrates, hydrolysates, textured vegetable proteins, proteins of egg, fish, milk, soya, Storage proteins of cereals and legumes.

101.4 Nucleic Acids: (15L)

Structure of nucleotides, DNA, forms of DNA, protein synthesis, DNA replication, gene regulation in prokaryotes and eukaryotes, Methods of studying Nucleic acids: Isolation of DNA & RNA, PCR Methodology and Application in diagnosis and genome mapping. Principle of following techniques as Nucleic acid hybridization, Nucleic acid sequencing, site directed mutagenesis, Northern, Southern. Western and dot blots. Molecular Markers: RFLP, RAPD, AFLP, STS, SCAR, CAPS, SSCP microsatellites & QTL mapping. Application of molecular markers.

PSNT102– Human Nutrition, Physiology and Clinical Dietetics-I

102.1 Lipids and its Metabolism: (15L)

Lipids: Classification, saturated and unsaturated, essential fatty acids, structure and function, Digestion and absorption of lipids, Characterization of fats, saponification, iodine, acid, peroxide values, Rancidity, Fatty acid oxidation, cholesterol synthesis, Role of fat in prostaglandin modulation for health & disease with emphasis on inflammatory process. Health implication in lipids: Ketone body formation and their utilization& utilization of MCT. Role of cholesterol & lipoprotein status in health & disease.

102.2 Vitamins and Minerals: (15L)

Classification, function, structure, sources, deficiency, excess & requirements for health: Vit A, D, E, K, B complex, C. Vitamin like substance, Minerals: function, structure, sources, deficiency, excess & requirements for health: K, Ca, Na, Mg, Fe, Mn, Se,Cu, Zn.

102.3 Nutritional Requirements: (15L)

Recommended dietary allowances for different sections of population, Balanced Diet, Factors affecting BMR and energy requirements for different activities, Role of different nutrients in health and disease, Bioavailability, Nutrient Interactions, Energy Balance & Weight Control. Proximate composition of foods: Analysis of food items for calorific value, protein, carbohydrates, vitamins, minerals, fiber contents.

102.4 Special Dietary Needs: (15L)

Alterations in carbohydrates, protein and fat metabolism in certain conditions and nutrition needs, Nutritional requirements for different types of physical activities and sports, Special needs before and after certain intensive and prolonged sports (Pre-game and Post-game meals). Nutritional requirements of vulnerable sections such as infants, pregnant and lactating women, elderly and the dietary management. Malnutrition: Occurrence, manifestation, prevention and therapeutic measures including fortification. Formulation of Diet and Foods for Specific Needs.

PSNT103- Nutraceutical and functional Foods-I

103.1 Introduction to Nutraceuticals as Science: (15L)

Historical perspective, classification, scope & future prospects. Applied aspects of the Nutraceutical Science. Sources of Nutraceuticals. Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition.

103.2 Properties, structure and functions of various Phytonutraceuticals: (15L)

Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine, alphaKetoglutarate. Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals.

103.3 Food as remedies: (15L)

Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina

103.4 Nutritional Factors- Promoters and Inhibitors. **(15L)**

Types of inhibitors present in various foods and how they can be inactivated. General idea about role of Probiotics and Prebiotics. Assessment of nutritional status. Recent advances in techniques &feeding of substrates. Assessment of nutritional status.

PSNT104 Biostatistics, Instrumentation and Biological Evaluation

104.1Biostatistics–I: (15L)

General Account, Terms and Symbols used in Biostatistics, Methods of Sampling and Data Collection, Classification, Tabulation and Graphic Representation of Data, Types of Measures of Central Tendency; Mathematical Average; Averages of Position; Measures of Partition Values. Meaning of Dispersion; Range; Quartile Deviation; Mean Deviation; Standard Deviation; Significance of Difference in Means; Standard Error of Mean; Standard Error of Standard Deviation; Variance.

104.2 Preclinical testing and clinical trials: (15L)

Basic Toxicology, Acute Toxicity studies, Multiple exposure studies, Basic Pharmacology & pharmaceutical chemistry, Phases of clinical trials, Metabolism studies, Clinical trials and Regulatory affairs.

104.3 Introduction to Instrumentation Techniques- I: (15L)

Centrifuge techniques: zonal, density, gradient and ultra-centrifugation techniques and their applications. Electrophoresis: zonal, paper, gel electrophoresis and isoelectric focusing and their application.

104.4 (204.4) Introduction to Instrumentation Techniques- II: (15L)

Chromatography: Paper, TLC, adsorption, ion exchange, gel filtration, affinity, GC & HPLC. General idea about hyphenated techniques in chromatography. Techniques of cellular fractionation.

Spectroscopy: Basic concepts, Beer-Lambert law & brief description of colorimetry, UV–VIS, IR, NMR

PRACTICALS

PSNTP101

1. Study of mitosis and meiosis from given plant/animal material.

2. Study of ANY TEN I P monographs and their identification using characteristic features of nutracuetically important plants like; *Phyllanthus emblica, Curcuma longa, Zinziber officinalis,* Solanaceae (*Withania somnifera), Aloe vera,* Lilliaceae (*Alium sativum*), Lamiaceae (*Ocimum sanctum*), Apiaceae (*Coriandrum sps*) and Liliaceae (*Asparagus sps.*), *Centella asiatica*.

3. Study of following Parasites/Vectors/pests: Identification, Habits and control measures (museum specimens / slides):
Entamoeba histolytica, Taenia sps, Ascaris lumbricoides, Ancylostoma dueodenaei, Trichinella spiralis, Trichura trichuris, Mosquito (*Culex and Anopheles*), House fly, Green bottle fly, Head Louse, Cockroach (*Periplanata & Blatta*), bed bug, *Mus* sps. (Mouse) and *Rattus* sps. (House rat)

PSNTP102

1. IR patterns of calcium supplement tablets/Ca containing shanka bhasma-comparison with pure $CaCo_{3.}$

2. Reactions of mono, di and polysaccharides and their identification in unknown mixtures.

3. Determination of Acid value, Saponification and Iodine number of natural fats & oils.

4. Estimation of proteins with various methods.

PSNTP103

1. Extraction and estimation of total sugars from food products (dairy product, fruit juices, bread).

2. Estimation of crude fat contents of foods by Soxhlet's method (Butter, Margarine, edible oil).

3. Estimation of total Nitrogen of foods by Kjeldahl and Micro Kjeldahl methods.

4. To separate the Milk proteins on Native and SDS gels.

5. To prepare plasmid DNA from given sample and its digestion by restriction enzymes and separation of DNA fragments by gel electrophoresis (Suitable teaching kits may be used)

PSNTP104

1. Students must submit a Report of the Industrial Visits and a Field Note Book of their Visits.

2. Students must make a presentation on the allotted topic.

3. Problem solving using MS Excel.

SEMESTER II

PSNT201: Food Chemistry & Biochemistry-II

201.1 Enzymes & Flavors: (15L)

Enzymes: Characteristics of Enzymes as biological catalysts , classification, nomenclature, cofactors, mechanism of action, inhibitions- Competitive and non-competitive, definition of unit of enzyme activity, regulation of enzyme activity, Isoenzymes, immobilized enzymes abzymes, synzymes. Food additives: flavors, food colours, antioxidants Natural and synthetic flavors, food colors, types properties, regulatory aspects, safety issues

201.2 Food preservation- Principles and Techniques: (15L)

Water: Functions of water,significance of water in body and its regulation. Solution interactions, water in food, water quality, Water activity, Osmolarity, Relation between viscosity and temperature; Acid, base and pH.
Food stability: freezing, spray drying lyophilization, air drying and shelf life. Gels and emulsions.Contamination and microbial spoilage of various food products: Milk and milk products; eggs and poultry, fish, breads and cereals, meat, canned foods, vegetables and fruits. Food borne infections and intoxications.Methods of food preservation. Radiation and Food Preservation:

Role of radiation in food preservation,Traditional methods of Food Preservation.Principles underlying destruction of microorganisms by irradiation.Effect of irradiation on food constituents.Legal status of food irradiation.

201.3 Membrane Biochemistry and Biochemistry of tissues: (15L)

Membrane Biochemistry: Structure, supramolecular architecture, transport of substances through membranes- passive, active, facilitated, Molecular mechanism of signal Transduction- gated ion channels, G protein coupled receptors and second messengers, cell interaction. Biochemistry of tissues: Biochemistry of muscle, bone and nerve, collagen Metabolism.

201.4 Endocrinology: (15L)

Characteristics, classification of hormones and hormone receptors, location of glands,Mechanism of hormone action, secondary messengers, Biosynthesis, transport and metabolic effects of hormones.

PSNT202- Human Nutrition, Physiology and Clinical Dietetics II

202.1 Human physiology – I: (15L)

Nervous System: Function of various parts of Brain: spinal cord, hypothalamus, cerebrospinal fluid, cerebral cortex; reflex action and coma.
Circulatory system: Structure and function of heart. Composition & function of blood, coagulation of blood, Rh factor & Blood Groups, hypertension. Lymphatic & Immune System, Reproductive system: In Male & female and related disorders; sex hormones.

202.2 Human physiology– II: (15L)

Digestive system; secretory & digestive functions of salivary glands, stomach, pancreas, liver & intestine, Respiratory system: Respiratory organs, gaseous exchange, laryngitis, pharyngitis, & asthma (in brief), Skeletal system: Functions of skeletal system, Urinary System: Function of kidney, urine formation, haematourea and uremia, Physiology of vision, taste & smell.

202.3 Clinical Dietetics - I: (15L)

Role of diet in hypertension, heart diseases and their prevention, cardiovascular disease, Diabetes Mellitus and disorders of reproductive system

202.4 - Clinical Dietetics II: (15L)

Functions of dietary fiber, soluble and insoluble in control of certain disease conditions. GI Disease, Renal Disease, Disorders of bone & joints, Respiratory illness and cancer.Effect of

drugs on ingestion, digestive absorption & metabolism of nutrients, Effect of food nutrients & nutritional status in drug dosage & efficacy.

PSNT 203: Nutraceutical and Functional Foods II

203.1 Functional Foods – I: (15L)

Definition, Relation of functional foods & Nutraceutical (FFN) to foods & drugs. Applications of herbs to functional foods.Concept of free radicals and antioxidants; Nutritive and Non-nutritive food components with potential health effects.Effect of processing on Nutrients.Soy proteins and soy isoflavones in human health;Role of nuts in cardiovascular disease prevention.Functional foods from wheat and rice and their health effects.

203.2 Phytonutrients-: (15L)

Phytonutrients & Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols,Polyunsaturated fatty acids, sphingolipids, lecithin, choline. terpenoids. Vegetables, Cereals, milk and dairy products as Functional foods. Health effects of common beans, Capsicum annum, mustards, Ginseng, garlic, grape, citrus fruits, fish oils, and sea foods, traditional spices.

203.3 Food Genomics - I: (15L)

Foodomics impact on optimal impact: Introduction, Nutrigenomics, Nutrigenetics, Personalized nutrition,The added value of foodomics for the food industry

203.4 Nutritional Genomics – II: (15L)

Plants as ‘bioreactors’ as a tool for production of Nutraceuticals. ‘Tailor-made’ carbohydrates and lipids of plant and non-plant origin.Plants as an alternative for biotransformation of raw materials into special chemicals.

PSNT204: Biostatistics, Instrumentation and Biological Evaluation -II

204.1 Biological testing and bioassays: (15L)

Testing drugs in-vitro and in-vivo, Sampling for microbiological assays, Laboratory set up for microbiological testing, Microbiological Assays, Microbiological testing for Nutraceuticals, Evaluation of toxicity and safety for new products, emerging new models for testing the claims.and Safety tests.

204.2 Organoleptic responses: (15L)

Basics of organoleptic responses, evaluation methodologies for taste, aroma, etc. Role of sensory evaluation as an aid to product development & quality control. Sensory analysis vocabulary. Types of sensory evaluation panels. General guidelines for setting up of trained food sensory panels. General guidelines for consumer sensory evaluation of foods & beverages. Types of sensory evaluation test.

204.3 Immune system in Health and disease:

Antigen Antibody reactions (15L): Precipitation, Agglutination, Passive agglutination, Agglutination inhibition, Complement fixation, Radioimmunoassay, Enzyme immune assay(ELISA), Immuno fluorescence, Immunohematology, Human blood group system, ABO, coombs test,coombs and Gells classification Type I to IV hypersensitivity Mechanism and Manifestation

204.4 Advanced Instrumentation Techniques: (15L)

Radio-isotopic techniques: - Nature of radioactivity properties of alpha, beta & gamma rays. Measurement of radioactivity and radiation hazards. Application of radio-isotopes. fluorescence, mass spectroscopy, flame photometry and x-ray diffraction.

PRACTICALS

PSNTP201

1. TLC separation of Plant pigments – Curcumin and carotene.

2. To isolate DNA and RNA from given plant/animal material and estimate DNA by Diphenylamine (DPA) method and RNA by Orcinol reagent.

3. Extraction, purification and evaluation of activity of any one digestive enzyme (e.g. Beta amylase from sweet potato.)

4. Estimation of crude fiber/pectic substances from plant material.

PSNTP202

1. Estimation of ascorbic acid from lemon & amla juice by titration method.

2. Estimation of Ca, Na and K in various foodstuffs by flame photometry.

3. Detection and estimation of metals – ANY ONE from - Fe, Cu, Zn, Mg, Se, and ANY ONE from - As, Hg, Pb,

4. Identification & adulteration of food:
• Milk and Paneer
• Butter/ ghee and hydrogenated fat (Vanaspati Ghee)
• Spices and condiments
• Tea and coffee
• Fruit juice
• Pulses

5. Estimation of Bio-burden by viable count method.

PSNTP203

1. To study nutritional composition (Proteins, carbohydrates, lipids, vitamin C and presence of secondary metabolites) of the following: Bee honey, Mushrooms, dairy products, Beans, Spinach, Carrot, Apple, Amla, Pineapple, Papaya, Lentil and Soya.

2. Extraction and estimation of oil or crude fat content in oil seeds.

3. Estimation of total phenols and chlorogenic acid (Phenolic compound) in plant material.

4. Qualitative test for tannins, phenolics and alkaloids using TLC.

5. To estimate cholesterol content in given sample by Zak's method.

PSNTP204

o Students must submit a Report of the Industrial Visits and a Field Note Book of their Visits.

o Students must make a presentation on the allotted topic

SEMESTER III

PSNT301: Microbiology, Quality and Process Control for Nutraceuticals-I

301.1 Basic Microbiology: (15L)

Microbial Cell structure, Study of Characteristics of microorganisms: microscope and microscopic methods, morphology, cultivation, reproduction and growth (growth curve), isolation techniques, Culture media, Culture preservation,Sterilization methods physical, chemical methods.

301.2 Fermentation Technology: (15L)

Submerged fermentation, Media for microbial fermentation, nutritional requirements, environmental requirements, medium formulation and optimization for cell growth and product formation, Scale up of a microbial process, Bioreactor designs and types of bioreactors, process parameters, sterility and contamination control, aeration and agitation, Primary and secondary metabolites, Solid state fermentations. Products of microbial fermentations: Organic acids, amino acids, organic acids, vitamins, nucleosides and nucleotide, enzymes, Probiotics, Fermented Food—development and use of microbial starters, Production of yeast biomass, cheese, beer, yogurt, PUFA, Arachidonic acid, γ- Linolenic acid.

301.3 Downstream processing: (15L)

Product recovery and downstream processing: Separation techniques, centrifugation, precipitation, purification processes like chromatographic techniques ultra-filtration, ion exchange, Tangential flow filtration, micro and nanofiltration techniques, reverse osmosis, etc.

301.4 Unit operations in manufacturing: (15L)

Various heating processes and heat transfer mechanisms. Mass transfer operations: drying, evaporation, concentration, particle size reduction, micronization, solvent extraction, filter pressing operation, filtration, centrifugation, and crystallization.

PSNT302: Development and marketing of Nutraceutical products – I

302.1 Future of Health Management: (15L)

Increasing role of Nutraceuticals in management of health and diseases, development of designer foods for specific chronic diseases like diabetes, obesity, bone disorders, cardiovascular diseases, AIDS and degenerative diseases like Parkinson (Arthritis, Alzheimer's), functional foods for specific sports, Dietary fibers of microbial and plant origin as Nutraceuticals future, Role of changing food preferences and globalization on selection of Nutraceutical products.

302.2 Consumers' views on nutraceuticals: (15L)

Current consumer understanding of Nutraceuticals, What are the barriers to acceptance by the consumer? - Value added? Credibility? Ethical issues? Tools for capturing consumer voice & understanding consumer view as well as translating them into product design attribute(CLT), (HUT), & (QFD) Steps that can be taken to bridge the gaps towards consumer acceptance?Steps for effective consumer communication Role of modern media as an effective tool for communicating to consumer as well as understanding consumer feedback.

302.3 Packaging strategies for Nutraceutical products: (15L):

Introduction to Packaging: Fundamentals of Distribution, Uniqueness of Nutraceutical Packaging, Packaging Forms & their Significance, Packaging Materials (covering basic mfg process, applications and significance) Paper, Paperboard and CFB Glass, Metals, Basic Polymer based materials, Polymer based composite materials, Ancillary Mats, Package Material Testing

302.4 Labeling and claims for Nutraceuticals products: (15L)

Overview with respect to Indian & International regulation, need for specific regulation governing dietary supplements, outline for compliance review of dietary supplements compliance label review, designation of ingredients, nutrition labeling for dietary supplements with examples like labeling and claims for multiple vitamins, dietary supplements, amino acids, herbs, etc., Nutritional content claims, health claims and exemption from FSSA requirements, Dietary supplements labeling issues, regulatory agencies views on label claims. Role of FDA in release of new nutraceutical, moral responsibility of food industry, impact of NLEA on claims to be made by industry, Problems associated with advertising of nutraceuticals.

PSNT303: Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods - I

303.1 Scope of genetic engineering, Library construction & screenings:: (15L)

Scope of Genetic engineering, Genetic engineering guidelines, Restriction enzymes: Nomenclature & classification. Gene cloning vector for animals and plants-- Plasmids, bacteriophages,phagemids, cosmids, Artificial chromosomes, reverse transcription, DNA primers, linkers, adapters. Application of cloning in human health and Crop improvement.

303.2 Bioinformatics: (15L)

History, Scope and Importance of Bioinformatics, Sequencing Development; Applications of Bioinformatics; Challenges and Opportunities.

303.3 Animal Biotechnology: (15L)

Evolution and development of cell lines, Apoptosis, Equipment & materials for animal cell culture, culture media, role of various constituents of culture media. Basic techniques of mammalian cell culture, in-vitro maintenance of cell cultures, and applications safety assessment and toxicity. Tissue culture safety & growth maintenance.

303.4 Development of Novel Food and food Ingredients: (15L)

Polysaccharides, low caloric sweeteners. Naturally produced flavor modifiers, Single Cell Proteins, Marine algae as food supplements, Food supplements and food Ingredients as byproducts – Fishery, poultry/animal husbandry & agriculture/dairy industries.

PSNT304: Total Quality Management, Regulatory Affairs and Intellectual property Rights-I

304.1 Quality Control: (15L)

Introduction, what is QC? Requirements for implementing QC, QC concepts in Nutraceuticals and food products. Introduction to a manufacturing of a pharmaceutical/Nutraceutical product and role of various departments, Defining and understanding concept of quality, QC and QA, Tenets of Quality Assurance, problem solving approaches of QA and QC, the 10 pillar approach to working of QA.

304.2 Quality Assurance: (15L)

Preparation and implementation of QA QC including concepts of TQM, Interrelationship between GMP, QC and QA, Quality management principals and Responsibilities of QA personnel, GMP, cGMP and its applicability to nutraceauticals, Validations &Qualifications, Change control, Introduction to GLP, Documentation, SOP, Annual product quality review, Audits, handling of complaints and product recall.

304.3 Intellectual Property Rights (IPR)-1: (15L)

WTO and Global trade: Definition, WTO, Need for harmonization of laws related to IPR, TRIPs and introduction to the articles in TRIPs document , types of TRIPs- patents, copy rights, trademarks, logos, service marks, geographical indicators, Impact of IPR on global trade and economies due to impact of technologies, concept of knowledge worker, Concerns of rich and poor member countries Filing of patents: Criteria to be satisfied like patentability, inventiveness, non-obviousness, novelty, utility, sufficiency of disclosure, Role of patentee and patent offices in patent management including lab documentation, pre- and post-grant opposition servicing of patents. Benefits of creating and / or owning patents.

304.4 Biostatistics–II: (15L)

Types of Theoretical Probability; Normal, Binomial and Poisson distribution, Tests of Significance -- Z- Test; Student’s’t" Test; The Chi-Square Test, ANOVA. Types of Probability; types of Correlation; Properties of Coefficient of Correlation; Methods of Studying Correlation, Regression Analysis; Kinds of Regression Analysis.

PRACTICALS

PSNTP301

1. Estimation of preservatives and antioxidants from food sample.

2. Estimation of protein quality using any one method.

3. Separation and identification of essential amino acids by TLC from given food sample.

4. Fractionation of proteins from given sample (milk / Soya milk / Liver homogenate) using ammonium sulphate precipitation.

5. To study the gluten formation and factors affecting them.

PSNTP302

1. Demonstration of the following;

a. Demonstration of PCR

b. Demonstration of Automated DNA sequencing.

2. To prepare a market survey report on the any one Nutraceutical functional food product.

3. Preparation of Functional food/ Nutraceutical product (Any Four)
a. Rich in Vitamins
b. Rich in Minerals
c. Rich in proteins
d. Rich in carotenoids and vitamin A
e. Rich in medicinally important secondary metabolites
f. Rich in antioxidants

4. Organoleptic & sensory evaluation of the designed product.

PSNTP303

1. Isolation and estimation of Vitamin B2 by HPLC

2. HPLC estimation of Eugenol from Clove and clove oil.

3. TLC estimation of piperine from Pepper.

4. Extraction of free amino acid in given sample

5. Estimation of Curcumin.

6. Estimation of Lycopene.

PSNTP304

•The project should involve industrial training/ project work of 8 to 12 weeks period

• Project must involve application of knowledge and skills as prescribed in the syllabus and data evaluation must involve application of biostatistics.

• Students must submit a project report covering the work undertaken.

• The project report and observations / data generated will be certified and defended before the panel of examiners.

SEMESTER IV

PSNT401: Microbiology, Quality and Process Control for Nutraceuticals - I

404.1 Medicinal Plants: Ethnomedicine in India: (15L)

Traditional Herb for Healthcare and Management of Human Diseases,Addition to Classical Sys of medicine A, S, U; Basic concepts, type of drug formulations, method of preparation, standardization. QC for medicinal plants, Regulatory aspects from Drugs & cosmetic act 1940.

401.2 Monitoring of food quality: (15L)

Chemical and biological quality control for Nutraceuticals. (Quality control manager from Industry, ISI standards for industry, ISO manuals)

401.3 Nutraceutical Industry and Market information: (15L)

Nutraceutical industries in India and abroad (study of 10 reputed Indian and International industries involved in production and development of Nutraceuticals and functional foods).

401.4 Manufacturing Operations in Nutraceuticals (15L)

Procurement of herbal raw material, preservation and storage of herbal raw material,Processing techniques for nutraceutical ingredients to be obtained from leaves, flowers, bark/stem, fruits, seeds and animal tissue.

PSNT402: Development and marketing of Nutraceutical products- II

402.1 Application of some techniques in development of Nutraceuticals and functional foods: (15L)

Supercritical fluid extraction technology-basics and application for extraction of nutraceuticals from various sources, Application of pressurized low polarity water extraction, use of membranes separation technology, distillation and dehydration technologies, application of bioprocess technology for production and enhancement of properties of nutraceuticals.

402.2 Chemoprevention and Nutraceuticals: (15L)

Role of chemoprevention in health, Role of nutraceuticals in management of health and disease, whether nutraceutical will compliment or replace drugs in management of health and curing of diseases.

402.3 Packaging strategies for nutraceutical products: (15L)

Packaging Techniques: Canning, Vacuum packaging, Modified Atmospheric packaging, Controlled Atmospheric packaging, Aseptic packaging, Passive & Active packaging, Smart & intelligent Packaging, Compatibility & Migration Studies, Accelerated Shelf Life Testing :- Theory and Problems.GMP, Packaging of Pharmaceuticals, Packaging of Nutraceuticals, Packaging Validation, Packaging Laws and regulatory compliance New Developments in Packaging.

402.4 The role of marketing Communication in the introduction of functional foods to the Consumer: (15L)

Introduction to marketing and consumer buying behavior, food purchase habits of people, The basics of communication processes used to convey the message- written and oral Communication, Legislation and its impact on advertising and labeling of Nutraceuticals, how to do targeting of food with a health message? How to communicate health claims for functional foods?

PSNT403: Molecular Biology and Biotechnology for Nutraceuticals and Functional Foods – II

403.1 Plant Biotechnology: (15L)

Plant tissue culture, micropropagation, meristem, shoot apices, embryo culture, embryo rescue, production of haploid plants, somatic hybridization, somaclonal variations, plant transformation

by T & R plasmids & viruses. Direct DNA transfer methods. Transgene stability & genes silencing.

403.2 Plants as factories: (15L)

For the production of Nutraceuticals. Commercial transgenic crops like herbicide resistant soybean, maize, vegetables, fruit crops, golden rice.

403.3 Metabolic engineering & industrial products: (15L)

Control mechanism & manipulation of phenyl propanoid pathway and Shikimate pathway, alkaloids, industrial enzymes, therapeutic proteins.

403.4 Bioinformatics: (15L)

Proteomics: Structure Bioinformatics, Genomics: Microarrays (DATA Analyses), Gene Prediction, Metabolimics – Pathways

PSNT404: Total Quality Management, Regulatory Affairs and Intellectual Property Rights – II

404.1 Intellectual Property Rights (IPR)-2: (15L)

Indian patent laws before and after becoming WTO member, Mail box provision, Exclusive marketing rights, Highlights of Indian Patent Laws including measures related to prevention of ever greening of patents, etc.

404.2 Chemi-informatics and Pharma-informatics: (15L)

Use of Chemical Libraries; Discovering a Drug, Target, Identification and Validation.

404.3 Food Regulation:I (15L):

Regulatory aspects of functional products. Marketing issues for functional foods &Nutraceuticals, Salient features of The prevention of Food Adulteration Act 1954 (India) and The Food Safety & Standards Act, 2006 (34 of 2006). International laws pertaining to safety of nutraceuticals. use of functional food to improve /maintain health, treatment of diseases, slowing of biological ageing, etc., Will the nutraceutical be introduced as replacement of current food or it will be an addition?

404.4 Food Regulation:II (15L)

FPO regulations, manufacturing guidelines, Manufacturing and marketing licenses, AGMARK, Green Label certification, Organic food certifications, Certifications for GMFs. Export regulations for Nutraceuticals. Mandatory BIS certifications applicable to foods.

PRACTICALS

PSNTP401

1. Estimation of photochemical.

2. Detection of food additives (list to be given – MSG, Flavours, colours (biological and non-biological etc.) in packaged food products.

3. Study of comparative antimicrobial activity of the following: Penicillin and Curcuma / thyme .

4. Microbial examination of water -- total and coliform count.

5. Microbial production of citric acid by *Aspergillus niger*.

PSNTP402

1. Assessment of quality of beverages -- tea and coffee.

2. Microbial Role in production of alcohol – (arishta / asavas)

3. Production of industrially important enzymes by micro-organisms (Protease and Amylase).

4. Microbial production of antibiotics (Penicillin).

5. Estimation of enzymatic browning in foods.

PSNTP403

1. Preparation of traditional health products – e.g. Satavari kalp, gulkand, Amla syrup, bilwa jam.

2. Extraction and identification of Isoflavones by TLC.

3. Estimation of concentration of starch in a given sample.

4. Study of search tools--- FASTA and BLAST.

5. Estimation of volatile substances from food products / beverages using GC.

PSNTP404

• The project should involve industrial training/ project work of 8 to 12 weeks period

• Project must involve application of knowledge and skills as prescribed in the syllabus and data evaluation must involve application of biostatistics.

• Students must submit a project report covering the work undertaken.

• The project report (including mentors report) and observations / data generated will be presented and defended before the panel of examiners