

AC 6-6-12

Item No. 4.124

UNIVERSITY OF MUMBAI



Syllabus for the M.Sc. Part - I &II **Program: M.Sc.** **Course : Nutraceuticals**

(Credit Based Semester and Grading System with
effect from the academic year 2011–2012)

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

O. 5880Title The degree shall be titled as “M.Sc. degree course in Nutraceuticals”

O. 5881 Eligibility:

A candidate for being eligible for admission to the M.Sc. Degree course in Nutraceuticals must have passed from any recognized University in India with minimum 50% marks in aggregate for students belonging to general category and 45% marks for students belonging to Reserved category or equivalent grade with any of the following science subjects up to the second year of the B.Sc. course: Chemistry, Botany, Zoology, Microbiology, Life science, Biotechnology, Biochemistry . Alternatively students with degree in Medical sciences or Graduation in food and nutrition sciences or Pharmacy with aggregates marks as mentioned above for B.Sc. degrees are also eligible.

Selection: Open Entrance test.

Students seeking admission to the M.Sc. Course in Nutraceuticals will first appear for an open Entrance test of one hour duration. The test will be of objective type questions (multiple choices) based on undergraduate syllabus with emphasis on topics from biological sciences and general knowledge.

Students will be selected for admission strictly on basis of merit list derived on the scores at the entrance examination and as per the reservation policy of the University of Mumbai and Government of Maharashtra. Students featuring in the merit list may be called for an interview and counseling session at the respective institution so that they may be acquainted about the teaching –training programme as envisaged in the syllabus.

R.8132. Fee Structure

Particulars	Amount per year
Tuition fee	Rs.15,000
Laboratory Fee(wet and Instrument Labs)	Rs.15,000
Project/Product Development	Rs.2,500
On job Training	Rs.1,700
Industrial Visit	Rs.1,000
Library	Rs.2,000
Gymkhana	Rs. 300
Utility	Rs. 100
Extracurricular	Rs. 200
Development Fund	Rs. 1,000
Other fee	Rs. 1,000
Miscellaneous	Rs. 2,191
Internet	Rs. 200
Additional Fee	Rs. 200
PTA/NPC	Rs. 1100
	Total Rs.43,491/=

R.8128 No of Lectures:

60 lectures / paper; 4 theory papers in each Semester (2 semester in Part I and Part II each)

R.8129 No of Practical periods:

4 practical of four periods each per week

Work Load:

- Four periods per week per paper where each period is of ONE hour duration
- Four practical per week. Each practical is of Four periods Where each period is of ONE hour duration.
- One Seminar per Week. Each seminar is of ONE hour Duration for a batch of TEN students.
- Guidance to the students for projects

R.8131. Duration:

The course shall be a full time course. The course shall be covered in 2 years in 04 semesters.

R.8133. Number of Students : 20 per batch

R. 8134. The following will be the **staffing pattern** for the course;

- Instrument technician – 01
- Technical Assistant – 02
- Lecturers – 03 (full time)
01 (part – time)

and remaining workload to be completed
using guest faculty.

Core Faculty :

Post-graduate degree with B+ and NET / SET qualified in the subject of Biophysics/ Biochemistry/ Biotechnology /Botany/ Chemistry/ Dietetics/ Life Sciences/ Medicine / Microbiology / Nutrition / Statistics/ Zoology

Visiting Faculty from Industry & Research Institutes

The visiting Faculty will be from a post equivalent to that of Senior Lecturer level with Ph. D and not less than 5 years of research experience or with experience in industry not below Assistant Manager Level.

R.8134-A. Mark-list

- The mark-list of the students must indicate titles of papers in the syllabus

Evaluation:

- Theory and Practical Examination for each Semester.
- Successful completion of Industrial Visits (PSNTP104 for Sem I & PSNTP204 for Sem II respectively).
- Successful completion AND submission of report of Industrial training & project work (PSNTP304 of Semester III and PSNTP404 of Semester IV respectively).
- All rules and pattern as per University of Mumbai for M.Sc courses.

R. 8435 SCHEME OF EXAMINATION

The Scheme of Examination shall be divided into 2 components : Internal assessment and External Assessment (semester end examination) for each course of the program.

Internal assessment of 40% will be as follows:

Sr. no.	Evaluation type	Marks
1.	Two assignments/Case study/Project	20
2.	One class test (multiple choice questions/objective)	10
3.	Active participation in routine class instructional deliveries (case studies/seminars/presentations)	05
4.	Overall conduct as a responsible learner, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities etc	05

Practical:

Each practical course can be conducted out of 50 marks with 20 marks for internal and 20 marks for external.

Sr. no.	Evaluation type	Marks
1.	Two best practicals	10
2.	Journal	05
3.	Viva	05

The marks will be given for all examinations and they will be converted into grade points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

The marks of the Internal Assessment will not be disclosed to the students till the results of the corresponding semester is declared.

All examinations will be held at the end of each semester and will be conducted by the University as per the existing norms.

1. Standard of passing

- The learners shall have to obtain a minimum of 40 % marks in aggregate to qualify the each course where the course consists of internal assessment and semester end examination.
- The learners shall obtain a minimum of 40 % marks (i.e. 16 out of 40) in the internal assessment and obtain a minimum of 40 % marks (i.e. 24 out of 60) in semester end examination.
- To pass the course and minimum grade C shall be obtained in each project wherever applicable in the particular semester.

2. For internal (Continuous) assessment. A teacher may select a variety of procedures for examination such as: 40 marks

- i. Short Quizzes / Viva / Presentations;
- ii. Assignments / Seminars / Laboratory Journal Work ;
- iii. Extension/Field/experimental Work;
- iv. Research Project by individual students or group of students; or
- v. An open Book Test / Review of Research Papers (with the concerned teacher deciding what books / scientific publications / research papers / Chapters from Reference books are to be allowed for this purpose.)
- vi. Two periodical test/case studies/on-line or combination of these
- vii. Overall conduct as a responsible student, mannerism and exhibition of leadership qualities in organizing co-curricular activities and attendance.

3. End semester examination 60 % 60 marks

- Duration – these examinations shall be of two hours duration.
- Questions paper pattern:-
There shall be four questions each of 15 marks.
All questions shall be compulsory with internal choice within the questions. Question may be sub divided into sub- questions a,b,c,d &e only and allocation of marks depends on the weightage of the topic

1. Method to carry forward the marks

- A learner who passes in the internal assessment but fails in the semester end examination of the course shall reappear for the semester end examination of that course. However his/her marks of the internal assessment shall be carried over and he/she shall be entitled for grade obtained by him/ her on passing.
- A learner who fails in the internal assessment but passes in the semester end examination of the course shall resubmit and reappear for the internal assessment on the form of projects of that course. However his/her marks of the semester end examination shall be carried over and he/she shall be entitled for grade obtained by him/ her on passing.
- The evaluation of internal assessment for students who fails and reappear will consist of one project of 40 marks which will be divided into 20 marks for the documentation of the project, 10 marks for the presentation and 10 marks for the viva.

2. ATKT

- A student shall be allowed to keep term for semester II irrespective of the number of heads of failure on the semester I.
- A student shall be allowed to keep term for semester III if she /he passes each of semester I and semester II OR
- A student fails in not more than two courses semester I and semester II taken together.
- A student shall be allowed to keep term for semester IV irrespective of the number of heads of failure on the semester III. However the student has to pass each of semester I and semester II in order to appear for semester IV.

3. Additional examinations

Additional class test or assignment for internal assessment

- There will be one additional class test or assignment for those who have remained absent on valid ground, in such a case student will be allowed to appear for additional class test or assignment by the head of the institution after following necessary formalities.

Semester end examination

- There will be one additional examination for semester I, II, III and IV for those who have failed or remained absent.
- The absent student will be allowed to appear for the examination by the head of the institution after following necessary formalities.
- This examination will be held 20 days after the declaration of results but not later than 40 days.

4. Project evaluation(if applicable)

- A student who passes in all the courses but does not secure minimum grade of C in project as applicable has to resubmit a fresh project till he/she secures a minimum of grade C.
- The credits and grade points secured by him/her in the other courses will be carried forward and he/she shall be entitled for grade obtained by them on passing.
- The evaluation of project and viva –voce examination shall be by awarding grade in the seven point scale.
- A student shall have to obtain minimum of grade C (or its equivalent marks)in project evaluation and viva-voce taken together to obtain 40 % marks in project work.

Conversion of marks to grade and calculations of GPA

Grades	Marks	Grade points
O	70 and above	7
A	60 to 69.99	6
B	55 to 59.99	5
C	50 to 54.99	4
D	45 to 49.99	3
E	40 to 44.99	2
F (Fail)	39.99 and below	1

5. The conversion of marks to grades and calculation of GPA will be as follows. Abbreviations and formulas used are defined below.

G : Grade

GP : Grade points

C : Credits

CP : Credit points

CG : Credits X Grades (product of credits and grades)

$\sum CG$: Sum of product of credits and grade points

$\sum C$: Sum of credit points

SGPA : Semester grade point average shall be calculated for individual semesters. It is also designated as GPA.

$$GPA = \frac{\sum CG}{\sum C}$$

CGPA : Cumulative grade point average shall be calculated for the entire course by taking all semesters taken together

6. Procedures related to grade cards would be as follows:

- The result gazette and the format of the grade cards for the semesters conducted by the colleges on behalf of the university will be uniform for all the colleges / institutions
- The grade cards will be printed along with the marks shown for all the concerned courses in the programme.
- The grade cards will be issued to the learners who will qualify all the courses with credit earned and the remark as "PASSES"
- The SGPA will be calculated only for the learners who will qualify in all the courses and accordingly the grade will be awarded to them
- In case a learner/s is not qualifies in a particular course/s of a programme, he / she shall be allowed to accumulate the credits of qualified courses only of the said programme and the grade card will be issued with "Credit Accumulate" and the remark as "FAIL"

M.Sc. Nutraceuticals: SYLLABUS IN BRIEF

Distribution of Credits

Semester I

Paper	Code	Lectures (h)	Credits earned	Code	Practical (h)	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			

Semester II

Paper	Code	Lectures (h)	Credits earned	Code	Practical (h)	Credits earned
Food Chemistry and Biochemistry (FCB – II)	PSNT201	60	4	PSNTP201	60	2
Human Nutrition and 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			

*Lecture allotment includes periods for seminar & Presentations.

*Units equally distributed between two terms.

Semester III

Paper	Code	Lectures (h)	Credits earned	Code	Practical (h)	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
Quality Assurance, Regulatory Affairs and Intellectual Property Rights QAR - I	PSNT304	60	4	PSNTP304	60	2
TOTAL		240	16		240	8
TOTAL CREDITS			24			

Semester IV

Paper	Code	Lectures (h)	Credits earned	Code	Practical (h)	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
Quality Assurance, Regulatory Affairs and Intellectual Property Rights QAR - II	PSNT404	60	4	PSNTP404	60	2
TOTAL		240	16		240	8
TOTAL CREDITS			24			

*Lecture allotment includes periods for seminar & Presentations.

*Units equally distributed between two terms.

**SYLLABUS FOR M. Sc. NUTRACEUTICALS
DISTRIBUTION OF TOPICS**

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

DISTRIBUTION OF TOPICS (Contd.)

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

M.Sc. Nutraceuticals: SYLLABUS IN DETAIL

SEMESTER I

PSNT101: Food Chemistry and Biochemistry - I

101.1 Carbohydrates: (15L)

Structure, Function, Classification, Characteristic Reactions, physical and Chemical properties, Derivatives, Glycogen metabolism, its breakdown and synthesis, glycogen storage diseases, Glycolysis, gluconeogenesis, synthesis of oligosaccharides and Glycoproteins

101.2 Bioenergetics: (15L)

Enthalpy, Entropy, Free energy, laws of thermodynamics as applied to biochemical systems, energy rich compounds (ATP, PEP), role of high energy phosphates in bioenergetics and energy capture, coupled reactions, Biological oxidation reduction, redox potentials, mechanism of oxidative phosphorylation

101.3 Proteins and Lipids: (15L)

Proteins: Essential and nonessential amino acids, peptide bond, structure, function, classification, denaturation of proteins, Metabolic breakdown and synthesis of amino acids, amino acids as synthetic precursors, heme biosynthesis, active amines, glutathione, Distribution of proteins, amount and type of proteins in food groups, protein concentrates, hydrolysates, textured vegetable proteins, proteins of egg, fish, milk, soya, Storage proteins of cereals and legumes, anti-freeze proteins, stress proteins.

Lipids : Classification, saturated and unsaturated, essential fatty acids, structure and function of acylglycerols, phospholipids, sphingolipids, glycolipids, steroids, Characterization of fats-saponification, iodine, acid, peroxide values, Fatty acid oxidation, biosynthesis of fatty acids, cholesterol, metabolism of prostaglandins, thromboxanes, leukotrienes, lipoproteins

101.4 Nucleic Acids: (15L)

Structure of nucleotides, DNA, forms of DNA, replication, transcription and translation, gene regulation in prokaryotes and eukaryotes

Biosynthesis and degradation of purines and pyrimidines, salvage pathway,

Methods of studying Nucleic acids: Isolation of DNA & RNA, **PCR:** methodology and application in diagnosis and genome mapping. 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 Metabolism of Carbohydrates, Lipids, Vitamins and Minerals: (15L)

Carbohydrate & Lipid Metabolism: Food Sources, Digestion and Absorption, Alcoholic Fermentation, Formation of Lactate in Muscles, Hexose Monophosphate Shunt and its significance, Regulation of carbohydrate metabolism, Glycemic index, Lipid Metabolism: Functions and diet sources of fats. Digestion and absorption of lipids, ketone body formation and their utilization, Role of cholesterol and lipoproteins. **Vitamins and Minerals:** Functions of fat and water soluble vitamins and their deficiency, Vitamin like substances: Choline, Carnitine etc., Minerals: Dietary sources, metabolism, Nutritional significance, functions and deficiency of minerals and trace elements.

102.2 Amino acid and Protein metabolism: (15L)

Functions of proteins. Metabolism and synthesis of amino acids and proteins, Urea cycle, Food Proteins and their quality, Essential amino acids, Protein energy malnutrition, Methods of evaluating protein quality

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 and Weight Control. Proximate composition of foods: Analysis of food items for calorific value, protein, carbohydrates, vitamins, minerals, finer contents, etc.

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: Nutraceuticals 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 Nutraceuticals: (15L)

Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate. 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 Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and *Spirulina* etc.

103.4 Anti-nutritional Factors present in Foods: (15L)

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

PSNT104: Biostatistics, Instrumentation and Biological Evaluation – I

104.1 Biostatistics–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 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. Types of Probability; types of Correlation; Properties of Coefficient of Correlation; Methods of Studying Correlation, Regression Analysis; Kinds of Regression Analysis, Vital Statistics -- Measures of Vital Statistics; Measurement of Mortality; Life Tables.

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 Introduction to Instrumentation Techniques- II: (15L)

Spectroscopy: Basic concepts, Beer-Lambert law & brief description of colorimetry, UV–VIS, IR, NMR, fluorescence, mass spectroscopy, flame photometry and x-ray diffraction.

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 nutraceutically important plants like; *Phyllanthus emblica*, *Curcuma longa*, *Zinziber officinalis*, Solanaceae (*Withania somnifera*), *Aloe vera*, Liliaceae (*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. Problem solving using statistical software.
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 Bradford's and other 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

- Students must submit a Report of the Industrial Visits and a Field Note Book of their Visits.
- Students must make a presentation on the allotted topic

SEMESTER II

PSNT201: Food Chemistry and Biochemistry - II

201.1 Enzymes, Vitamins, Minerals, 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. **Vitamins:** Structure of water and fat soluble vitamins, plant animal sources, vitamins as coenzymes, deficiency of vitamins. **Flavours :** Natural and synthetic flavors, food colors, types properties, regulatory aspects, safety issues

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

Water: Functions of water in body and its regulation. Solution interactions, water in food, water activity; Osmolarity, Relation between viscosity and temperature; Acid, base and pH. **Food stability:** freezing, 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. 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-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, second messengers, Biosynthesis, transport and metabolic effects of hormones.

PSNT202: Human Nutrition, Physiology and Clinical Dietetics -II

202.1 Human physiology – I: (15L)

Functions of skeletal system. Digestive system; different parts, secretory & digestive functions of salivary glands, stomach, pancreas, liver & intestine. Circulatory system: structure and function of heart. Composition & function of blood, coagulation of blood, Rh factor & Blood Groups, hypertension. Respiratory system; Respiratory organs, gaseous exchange, laryngitis, pharyngitis, & asthma (in brief). Reproductive system in male & female and related disorders; sex hormones.

202.2 Human physiology– II: (15L)

Function of kidney, urine formation, haematourea and uremia. Nervous System: Function of various parts of Brain: spinal cord, hypothalamus, cerebrospinal fluid, cerebral cortex; reflex action and coma. Physiology of vision, taste & smell. Endocrine glands: Functions and disorders of thyroid, parathyroid, adrenal and pituitary glands.

202.3 Disease and Nutrition - I: (15L)

Role of diet in hypertension, heart diseases and their prevention, Nutrition in certain conditions like peptic ulcers, diarrhoea, hepatitis. Malabsorption syndrome including intolerances and allergies.

202.4 Disease and Nutrition - II: (15L)

Functions of dietary fibre, soluble and insoluble in control of certain disease conditions like diabetes, cancer, heart diseases etc. Effect of drugs on ingestion, digestive absorption & metabolism of nutrients, Effect of food nutrients & nutritional status in drug dosage & efficacy.

PSNT203: Nutraceuticals and Functional Foods-II

203.1 Functional Foods – I: (15L)

Functional Foods-1: 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. Role of Dietary fibers in disease prevention.

203.2 Functional Foods – II: (15L)

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.

203.3 Nutritional Genomics - I: (15L)

Production technology for recombinant therapeutic products using *E.coli* with examples like human insulin, growth hormones, interferons, erythropoietin.

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. Transgenic plants for the large scale production of proteins for pharmaceutical and industrial uses. 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.

204.2 Organoleptic responses: (15L)

Basics of organoleptic responses, evaluation methodologies for taste, aroma, etc.

204.3 Preclinical testing and clinical trials: (15L)

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

204.4 Advanced Instrumentation Techniques: (15L)

Radio-isotopic techniques:- Nature of radioactivity properties of alpha, beta & gamma rays. Application of radio-isotopes. Measurement of radioactivity and radiation hazards. Chromatography: Paper, TLC, adsorption, ion exchange, gel filtration, affinity, GC & HPLC. General idea about hyphenated techniques in chromatography. Techniques of cellular fractionation.

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. Assessment of purity and quality using appropriate standard tests for the following ;
 - 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 Liebermann-Burchard method.

PSNTP204

- Students must submit a Report of the Industrial Visits and a Field Note Book of their Visits.
- 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, Biosynthetic pathways for nutraceuticals, mutation and genetics for strain improvement), Sterilization methods physical, chemical methods and use of antibiotics,

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-I: (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 - II: Product Development, Packaging, label claims, consumer acceptance, future prospects

302.1 Nutraceuticals and the Future of Medical Science: (15L)

Increasing role of Nutraceuticals in management of health and diseases, development of designer foods for specific chronic diseases like diabetes, cardiovascular diseases, AIDS and degenerative diseases like Parkinson, functional foods for specific sports, oligosaccharides, dietary fibers of microbial and plant origin as Nutraceuticals of future, Role of changing food preferences and globalization on selection of Nutraceutical products.

302.2 Consumers' views on nutraceuticals: (15L)

Consumer as a layman when it comes to technical jargon, Need to look back and then forward for industry when it is nomenclature for new product, Categories of concepts, media messages and evolving communication techniques for effectively conveying the information, the Consumer view on function Nutraceuticals, What is the level of awareness of consumers today?, What are the barriers to acceptance by the consumer? - Value added? credibility? Ethical issues? What is in the best interest of consumer?

302.3 Packaging strategies for nutraceutical products: (15L)

Introduction to packaging, plastic as packaging material- structure, optical and mechanical properties of plastic, paper and paper-based packaging material, glass packaging material, concept of aseptic packaging of foods or Nutraceuticals, packaging of dairy products, cereals and snack foods. The changing scenario in food and pharma industry regarding quality standards and its compliance

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

Overview of dietary supplements labeling, 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 FDA requirements, Dietary supplements labeling issues, regulatory agencies views on label claims.

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

303.1 Scope of genetic engineering: (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. cDNA synthesis and cloning, mRNA enrichment, reverse transcription, DNA primers, linkers, adapters.

303.2 Library construction & screenings: (15L)

Cloning interacting genes, differential expression of genes. Gene with tissue specific expression, mutant complementation. Vector engineering & codon optimization, host engineering, Application of cloning in human health and Crop improvement. Brief idea about Bioremediation. In-vitro transcription & translation expression in bacteria, yeast, insects, mammalian cells & plants. Antisense technology and ribozyme technology.

303.3 Animal Biotechnology: (15L)

Evolution and development of cell lines,. 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, cell synchronization. Cell transformation, cloning & micro manipulation, cell growth phase, growth cycle, cell cycle time, measurement of viability, cytotoxicity, apoptosis, stem cell culture. *In-vitro* fertilization & embryo transfer technology and transgenic animals.

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 by-products – Fishery, poultry/animal husbandry and agriculture/dairy industries.

PSNT304: Quality Control & Assurance, 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, Label claims and their support.

304.2 Quality Assurance: (15L)

Introduction, What is QA? Requirements for implementing QA, QA concepts in Nutraceuticals and food products, Personnel Responsibilities in QA

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

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 of poor countries, Filing of patents: Criteria to be satisfied like patentability, inventiveness, non-obviousness, novelty, utility, sufficiency of disclosure, etc. Benefits of creating and / or owning patents.

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

International Agreements related to patents: Paris Convention, Budapest treaty, PCT. Patent offices and their role in patenting, Indian patent laws, Mail box provision, Exclusive marketing rights, prevention of evergreening of patents, etc. patent management including lab documentation, pre- and post-grant opposition and servicing of patents.

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

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/Lycopene.
6. Estimation of choline.

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

SEMESTER IV

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

401.1 Biological controls: (15L)

Need and packaging containers for packaging (glass, metal, plastics, molded pulp and aluminum foil), dispensing devices

401.2 Monitoring of food quality: (15L)

Microbiological quality control for Nutraceuticals.

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 Unit Operations in Manufacturing- II: (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: Product Development, Packaging, label claims, consumer acceptance, future prospects

402.1 New technologies in development of Nutraceuticals and functional foods: (15L)

Supercritical food 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 The food industry's role in promoting functional foods: (15L)

Introduction about what is considered as functional food as against ordinary food, 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?, 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.

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? Importance of sensory quality & food acceptance by consumers, the art and science of consumer persuasion.

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, biodegradable plastics, therapeutic proteins.

403.4 Bioinformatics: (15L)

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

PSNT404: Quality Control & Assurance, Regulatory Affairs and Intellectual Property Rights – II

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

Traditional Herbal Medicines for Healthcare and Management of Human Diseases, Future of Ethnobiology, Biopiracy of Medicinal plants; Importance of traditional medicine in future materia-medica of world.

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

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

404.3 Regulatory Affairs: (15L)

Regulatory aspects of functional products. Marketing issues for functional foods and 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.

404.4 Regulatory certifications: (15L)

FPO regulations, Manufacturing guidelines, Manufacturing and marketing licenses, AGMARK, Green Label certification, Organic food certifications, Certifications for GMFs. Export regulations for Nutraceuticals.

PRACTICALS

PSNTP401

1. To study the gelatinization and factors affecting them.
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

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