Syllabus Structure- M Tech. Pharmaceutical Biotechnology

Semester- I

No.	Contents	Course Code	Subjects	Hours/Week (L+T)	Marks	Credits
1.	Core I	PBT 2101	Pharmaceutical Biotechnology I	**(2+1)**	**50**	**3**
2.	Core II	PBT 2102	Advances in Recombinant DNA Technology	**(2+1)**	**50**	**3**
3.	Core III	PBT 2106	Make-up subject-1 Fundamentals of Microbiology, Molecular Biology and Chemical Engineering	**(2+1)**	**50**	**3**
4.	Elective I			**(2+1)**	**50**	**3**
5.	Elective II			**(2+1)**	**50**	**3**
6.	Seminar and Critical Review	PBT 2114	Project – I (Seminar and Critical Review)	**6**	**50**	**3**
7	Practical	PHP 2505	Laboratory I- Instrumental Methods of Analysis	**6**	**50**	**3**
8	Research I	PBT 2115	Research I	**12**	**100**	**6**
TOTAL				**39**	**450**	**3**

Semester- II

No.	Contents	Course Code	Subjects	Hours/Week (L+T)	Marks	Credits
1.	Core I	PBT 2103	Research Methodology	**(2+1)**	**50**	**3**
2.	Core II	PBT 2104	Pharmaceutical Biotechnology II	**(2+1)**	**50**	**3**
3.	Core III	PBT 2105	Advanced Analytical Tools in Biotechnology	**(2+1)**	**50**	**3**
4.	Elective III			**(2+1)**	**50**	**3**
5.	Elective IV			**(2+1)**	**50**	**3**
6.	Practical	PBL 2002	Laboratory –II (Microbiology and Molecular biology)	**6**	**50**	**3**
7.	Research II	PBT 2116	Research II	**18**	**150**	**9**
TOTAL				**39**	**450**	**27**

Semester- III

No.	Course	Hours/Week	Marks	Credits
1.	In plant training	**40 (15 Weeks)**	**450**	**30**
TOTAL		**40**	**450**	**30**

Semester- IV

No.	Course	Hours/Week	Marks	Credits
1.	Research, Thesis and Open defense	**40**	**450**	**30**
TOTAL		**40**	**450**	**30**

Sem III and Sem IV Evaluation will conducted be at end of IV semester.

List of Electives:

1. **PBT 2121 Advanced Biochemistry**
2. **PBT 2122 Advanced Bioinformatics**
3. **PBT 2123 Biostatistics**
4. **PHT 2004 Drug Metabolism**
5. **PBT 2124 Environmental Biotechnology**
6. **PBT 2125 Immunology**
7. **PBT 2129 Vaccines and Immunotherapy**
8. **PHT 2002 Intellectual Property Rights and Patent Filing**
9. **PHT 2005 Molecular Biology**
10. **PBT 2126 Protein and Nucleic Acid Formulation Development**
11. **PHT 2302 Pharmacology, Toxicology and Therapeutics**
12. **PBT 2127 Process Biotechnology**
13. **PBT 2128 Tissue Engineering and Biopolymers**
14. **PHT 2107 Targeted Drug Delivery Systems**
15. **BST 2102 Unit Operation in Bioprocesses**
16. **CEE 2003 Environmental Biotechnology**
17. **BSE 2110 Biocatalysis and Green Technology**
18. **FDT 2005 Carbohydrate Chemistry & Technology**
19. **FDT 2072 Nutritional Genomics**

Subject wise Syllabus

I. Core subjects

1. Pharmaceutical Biotechnology I

1. Biotechnology in the Pharmaceutical Industry (Pre-biotechnology products, impact of biotechnology, post-biotechnology products: biologics and biopharmaceuticals)
2. Genetic manipulation methods
3. Fermentation technology
4. Scale-up process (Inoculum: preparation and development of inoculum for industrial fermentation, optimization of the fermentation process (pH, temperature, and oxygen requirements, Determination of the optimized feeding regimen and biomass quantification
5. Improvement of selected microorganism with increased productivity of the fermented products
6. Fermentation process: Batch and continuous fermentation and fermenters, Fermentation products in Pharmaceutical industry: Antibodies, Therapeutic proteins, Vitamins, Amino acids, Monoclonal Antibodies)

2. Advances in Recombinant DNA Technology

1. Vectors: Cloning vectors: Plasmids, Lambda phages, single stranded DNA vectors (M13, fd, f1); Cosmids, Phasmids and Phagemids, YACs, BACs, PACs; Plant Transformation vectors: Introduction to Ti, Ri plasmids and BIBACs; Expression Vectors for high level protein expression
2. Cloning strategies: Vector preparation and diverse cloning strategies viz. blunt end cloning, directional cloning, TA-cloning of PCR products, linkers and adaptors based cloning methodologies
3. E. coli transformation: Chemical transformation and Electroporation

4. Selection and screening of recombinant transformants: Introduction to marker and reporter genes and selection strategies
5. Labeling and detection of nucleic acid sequences: End-Labeling (3'- and 5'-), Random priming and Nick translation using radioactive non-radioactive labeling techniques
6. Genomic DNA libraries: Procedures for Partial, Representative, Enriched, Large-insert DNA libraries, Half-arm cloning, cDNA libraries: Prominent Adapters/Linkers based directional cloning
7. Gene therapy for genetic diseases

3. Research Methodology

Research

1. Meaning of Research, Purpose of Research, Types of Research (Educational, Clinical, Experimental, Historical, Descriptive, Basic applied and Patent Oriented Research) – Objective of research-
2. Literature survey – Use of Library, Books, & Journals – Medline – Internet, getting patents and reprints of articles as sources for literature survey.
3. Selecting a problem and preparing research proposal for different types of research mentioned above.
4. Methods and tools used in Research

- Qualitative studies, Quantitative Studies
- Simple data organization, Descriptive data analysis
- Limitations and sources of Error
- Inquiries in form of Questionnaire, Opinionnaire or by interview
- Statistical analysis of data including variance, standard deviation, students 't' test and annova, correlation data and its interpretation, computer data analysis,

5. Documentation

- "How" of Documentation
- Techniques of Documentation
- Importance of Documentation
- Uses of computer packages in Documentation

6. The Research Report / Paper writing / thesis writing

- Different parts of the Research paper
- Title – Title of project with author's name
- Abstract – Statement of the problem Background list in brief and purpose and scope
- Key-words-
- Methodology-Subject, Apparatus / Instrumentation, (if necessary) and procedure
- Results – tables, Graphs, Figures, and statistical presentation
- Discussion – Support or non- support of hypothesis – practical & theoretical implications, conclusions
- Acknowledgements
- References
- Errata
- Importance of spell check for Entire project
- Use of footnotes

7. Presentation (Specially for oral)

- Importance, types, different skills
- Content of presentation, format of model, Introduction and ending
- Posture, Genstures, Eye contact, facial expressions stage fright

- Volume- pitch, speed, pauses & language
- Visual aids and seating
- Questionnaire

8. Protection of patents and trade marks, Designs and copyrights

- The patent system in India – Present status Intellectual property Rights (IPR), Future changes expected in Indian Patents
- Advantages
- The Science in Law, Turimetrics (Introduction)
- What may be patented
- Who may apply for patent
- Preparation of patent proposal
- Registration of patent in foreign countries and vice-versa

9. Sources for procurement of Research Grants
10. Industrial- Institution Interaction

- Industrial projects – Their feasibility reports
- Research in Education – Johan V. Best James V. Kahn
- Presentation skills- Michael Halton- Indian Society for Institute Education
- A Practical Introduction to copy right – Gavin Mcfarlane
- Thesis projects in Science and Engineering – Richard M. Davis
- Scientists in legal system – Ann labor science
- Thesis and Assignment writing – Jonathan Anderson
- Writing a technical paper- Donald Menzel
- Effective Business Report writing – Leland Brown
- Protection of Industrial property rights- Purushottam Das and Gokul Das
- Spelling for the million – Edna furmess
- Preparing for publication – King Edwards Hospital fund for London
- Information technology – The Hindu speaks
- Documentation – Genesis & Development 3792
- Manual for evaluation of Industrial projects – United Nations
- Manual for the preparation of Industrial feasibility studies

4. Pharmaceutical Biotechnology II

1. Animal Cell Culture: Historical Background, Importance of and progress in Animal Cell Culture, Technology, Biology of Animal Cell; Cellular Interactions, Importance of Serum and Serum Free Media, Culturing and Sub-Culturing of Animal Cells, InVitro Transformation of Animal Cells, Cell Differentiation & Cell Movement, Cloning of Animal Cells, Cell Line Preservation, Cell Line Characterization, Chromosome Spreading and Karyotype Analysis, Mycoplasma: Detection and Control, Monoclonal Antibody Production, Insect Cell Culture: An Overview
2. Plant cell culture: History and evolution, Basics of aseptic culture, In vitro propagation, use of plant growth regulators in tissue culture, plant regeneration, organogenesis, somatic embryogenesis, protoplast isolation and culture, somaclonal variation, in vitro mutagenesis, in vitro selection, secondary metabolite production and cell transformation techniques (including protoplast fusion, direct DNA uptake and plant/ bacterial co-cultivation), use of in vitro techniques for crop improvement.
3. Omics: Proteomics, Genomics and Metabolomics: Introduction to the definitions of various ‘omics’, introduction to the general field of genomics and proteomics,

introduction to some methods used in analyzing gene expression at the mRNA and protein level, basic principles of DNA/Protein microarrays and their applications.

4. Physical aspects of the genome. Construction and study of various types of genome maps and large-scale sequencing. The human genome project and the plant genome program. Structural genomics and gene discovery, isolation, localization and characterization. Developing diagnostic tests for plant, animal and human diseases. Identification of biomarkers. Finding genetic markers for plant breeding purposes. Environmental impacts on gene expression. Protein complex structures and amino acids. Protein shapes as affecting its function. Amino acid sequencing. Cellular proteome changes in response to environmental and neighbouring cells conditions. Cataloguing the proteins produced by different cells. Discovering the function of a protein. Determining three-dimensional structure of proteins. Protein crystallography.
5. Integrons and transposons
6. Regulatory aspects of biotechnology based products

5. Advanced Analytical Tools in Biotechnology

1. Diagnostic Methods - Molecular Methods: Isolation and purification of nucleic acid and protein, Electophoresis and visualisation of nucleic acid and protein, Blotting techniques, Sequencing and amplification techniques, PCR and related techniques
2. Genomic and Post-Genomic Analytical Biotechnology: Gene purification and sequencing, Protein sequencing and purification, The goal and applications of genomics and proteomics, Techniques in use for gene and protein analysis, e.g. crystallography, magnetic resonance
3. Immunological Methods: Antibody production and labeling, Immunochemical techniques for in situ analyses (ICC and IHC), Immunochemical techniques for measurement (ELISA, etc), Immunochemical techniques for separation (Immunoprecipitation, etc)
4. Introduction to Bioinformatics: organization of biological data, databases (raw and processed), quering in databases, primer designing, gene finding, motif finding, sequence alignment, protein sequence analysis

6. Fundamentals of Microbiology, Molecular Biology and Chemical Engineering

1. Fundamentals of Microbiology (10 lectures)**:** Microbes – types, size shape and arrangement of bacterial cells, Nutritional requirements – Common ingredients, culture media and types of media, Sterilization – Importance and various methods of sterilization, Cultivation and Preservation of microorganisms – Isolation, pure culture, study of cultural characteristics and methods of preservation, Measurement of microbial growth – Total count and viable count methods, Preparation of microbes for microscopic observation – Compound microscope, stains used, simple staining, differential staining and special staining techniques.
2. Fundamentals of Molecular Biology (10 lectures): The beginnings of Molecular biology, The structure of DNA, Genome organization: Prokaryotes and Eukaryotes., The Versatility of RNA: Types of RNA and their role, DNA replication: Prokaryotic and Eukaryotic, Overview of Transcription in prokaryotes and eukaryotes, From Gene to Protein: Genetic code and Translation, Recombinant DNA technology: An introduction, molecular cloning and some tools for analyzing gene expression
3. Fundamentals of Chemical Engineering (10 lectures): Transport phenomenon, Heat transfer, Mass transfer, Process and equipment design for various operations in processing of pharmaceutical biotechnology based products and discussions on scale-up of operations; Prediction of freezing, heating and drying times

III. Electives

1. Immunology

1. Immunology as a science, module overview, practical application of the module
2. Immunity: basic definitions, types of immunity, organs involved, cells of the immune system, humoral v/s cellular immunity
3. Innate immunity: meaning, cells 'producing' innate immunity, non-cellular innate immunity
4. Adaptive immunity: meaning, cells bringing about specific immunity, production of a specific response
5. Adaptive immunity 2: signaling, steps in the development of a nonself destructive cellular specific immunity, steps in the development of a nonself destructive humoral specific immunity
6. Adaptive immunity 3: cells and antibodies adcc, failure of specific immunity development
7. Antibodies & its diversity: types, development of specific antibodies in the body: vdj recombination
8. Fine balance in immunity: th1 v/s th2 response
9. Mucosal immunology: mediation of immunology on mucosal surfaces, importance
10. Immunological response to disease (example study): components of an immunological response, th1 response type disease, th2 response type disease, alternatively activated macrophages, disease with primary response
11. Immunological pathogenesis: hyper sensitivity, auto immunity, allergy
12. Disease of the immune system: Overview
13. Cells of the immune system: identification, laboratory culture, primary culture, cell lines
14. Immunological techniques: diagnostic tests, basic/classical/common, elisa/ria call types, western blot
15. Immune suppression
16. Graft Vs host diseases
17. HLA, HLA typing and applications including organ transplantation
18. Gut microbiota and Gut immunology

2. Vaccines and Immunotherapy

Syllabus to be framed

3. Protein Nucleic And Acid Formulation Development

1. Protein engineering
2. Nucleic acids and proteins: physicochemical properties and stabilization
3. Formulation aspects
4. Mechanisms of action
5. Characterization: Raman, Mass Spectrometry, Atomic Force and Scanning Electron Microscopy (AFM and SEM), Confocal microscopy, Flow cytometry, Capillary DSC, MALDI-TOF, circular dichroism
6. Biophysical techniques: pharmacokinetics/pharmacodynamics
7. In vitro studies: cellular trafficking
8. Biosimilars

4. Advanced Biochemistry

1. Proteins: Structures – primary, secondary, tertiary, motifs, structural and functional domains, protein families and macromolecular assemblies.
2. Mechanisms for regulating protein function: Protein-protein interactions, interaction with ligands, Ca¬+2 and GTP as modulators, cyclic phosphorylation and dephosphorylation, proteolytic cleavage.
3. Purification and characterization of proteins: Electrophoresis, ultracentrifugation and liquid chromatography, use of biological assays, use of radioisotopes and MS, X-ray crystallography, NMR and Homology modeling, amino acid analysis, cleavage of peptides, protein sequencing.
4. Protein biosynthesis: Translation machinery in prokaryotic and eukaryotic systems, comparison of similarities and differences.
5. DNA and nucleic acids: DNA, RNA structure, nomenclature, double helix, conformations, higher order packing and architecture of DNA, transcription and replication of DNA – mechanisms in prokaryotic and eukaryotic systems, DNA repair mechanisms.
6. Carbohydrates: Mono, di and polysaccharides and their nomenclature, stereochemistry, linkages, conjugates of carbohydrates with other molecules - glycoproteins, glycolipids, proteoglycans, lipopolysaccharides and their biological roles.
7. Lipids: Classification, nomenclature, stereochemistry, storage lipids, membrane lipids, lipids as second messengers and cofactors, biological role of lipids

5.Advanced Bioinformatics

1. Motif and cis-Regulatory Module (CRM) Modeling: learning motif models, learning models of cis-regulatory modules, Gibbs sampling, Dirichlet priors, parameter tying, heuristic search, HMM structure search, sequence entropy and mutual information, duration modeling, semi-Markov models
2. Gene Finding: the gene finding task, maximal dependence decomposition, interpolated Markov models, back-off models, pairwise HMMs, Genscan, Twinscan, SLAM
3. RNA-Seq: RNA-Seq technology, transcript quantification with RNA-Seq
4. RNA Analysis: predicting RNA secondary structure, Nussinov/energy-minimization algorithms, stochastic context free grammars, Inside/Inside-Outside/CYK algorithms, searching sequences for a given RNA secondary structure, RSEARCH, RNA gene recognition via comparative sequence analysis, microRNA gene/target prediction
5. Large-Scale and Whole-Genome Sequence Alignment: large-scale alignment, whole-genome alignment, parametric alignment, suffix trees, locality sensitive hashing, k-mer tries, sparse dynamic programming, longest increasing subsequence problem, Markov random fields, MUMmer, LAGAN/MLAGAN, Mauve, Mercator
6. Biological network inference and evolution: Network inference, models of biological network evolution, network alignment
7. Genotype Analysis: haplotype inference, genome-wide association studies (GWAS), quantitative trait loci (QTL) mapping
8. Protein Structure Prediction: secondary structure prediction, threading, branch and bound search, ROSETTA

6. Bio-statistics

1. Application of Statistics, bioinformatics and experimental design to biotech processes: Sampling procedures, populations; types of data, data organization and presentation.
2. Correlation and Regression, linear and quadratic regression Analysis of variance.

3. Correlation coefficient; regression analysis; multivariate analysis; principal component analysis. Probability. Probability distribution.
4. Testing of hypothesis. Experimental design and factorial design.
5. Concepts and use of software. RSM and ANN techniques for optimization of fermentative processes

7. Drug Metabolism

1. Introduction to the different pathways of drug metabolism: Phase I and II reactions, sites of drug metabolism, subcellular localization of drug metabolizing enzymes, cofactors required for catalytic reactions
2. Cytochrome P450 oxidative system: Catalytic cycle of P450 reactions, mechanism of P450 hydroxylation reactions, introduction to CYP450 superfamily of enzymes and their classification, human CYP450s involved in drug metabolism and their typical substrates, inhibitors and inducers.
3. Introduction to other drug metabolism enzyme isoforms/families Glucuronosyltransferases, glutathione transferases, sulfotransferases, N-acetyltransferases, FMO's.
4. Methods for studying drug metabolism: Isolated enzymes, recombinant enzymes, subcellular fractions, hepatocytes, perfused liver, in-vivo drug metabolism studies – introduction to these methods, their utility, advantages and limitations
5. Introduction to in-silico methods for predicting drug metabolism: Principles behind development of these systems, their potential and their limitations.

8. Environmental biotechnology

1. Application of biotechnology in agriculture e.g. pest control, herbicide resistance
2. GM crops and farm animals, bio-fertilizers
3. Alternative energy resources including biogas, alcohol etc.
4. Treatment of waste from domestic, industrial, agricultural etc. and bioremediation Environmental security and safety; Socio-economic aspects of GM crops

9. Intellectual property Rights and Patent Filing

1. Introduction to IP
2. Copyright, Related Rights, Trademarks, Geographical Indications, Industrial Design
3. Patents
4. WIPO Treaties
5. Unfair Competition
6. Protection of New Varieties of Plants
7. Summary and Discussion on IP Rights

10. Molecular Biology

1. Introduction to recombinant DNA technology: Introduction to DNA
   and its functions, Replication of DNA and its transcription and translation, restriction enzymes and their properties, vectors for use in rDNA technology, creation and introduction of rDNA molecules, cloning and expression of rDNA molecules, cloning and expression systems, their advantages and limitations, application of rDNA technology in production of pharmaceutical and in drug discovery and development.

2. High throughput screening: Introduction to the principles of screening and the philosophy of HTS, considerations in HTS method development, validation of HTS methodology, some examples of typical HTS assays and the principles involved therein.
3. Human Genome Initiative: Introduction to the genome, genome complexity and genome organization, basic approaches towards sequencing of genomes, the approach for sequencing the human genome, sources for obtaining human genome sequence information, data mining of the human genome sequence for information and other potential applications, introduction to bioinformatics.

11. Pharmacology, Toxicology and Therapeutics

1. Evaluation of drug activities,
2. Study models for testing,
3. Toxicity (ICH and OECD guidelines),
4. Importance of transgenic animal models/knock out mice based screening methods, overview of regulatory status-ethical/moral/professional issues in toxicity

12. Process Biotechnology

1. Selection of separation process. Chemical, physical and biochemical aspects of isolation and purification of biomolecules. Product release from a cell
2. Concentration and separation methods: membrane, ion-exchange, precipitation and extraction. Chromatographic methods of purification
3. Chemistry of adsorption, Adsorbents, Equilibria, Yield and purity, Batch adsorption, Kinetic analysis, Discrete stage analysis, Adsorption in fixed beds
4. Design and scale-up of adsorption and chromatography equipment
5. Design of downstream processing equipment. Downstream process economics

13. Tissue Engineering and Biopolymers

1. Principles of materials science and cell biology underlying the design of medical implants, artificial organs, and matrices for tissue engineering
2. Methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials
3. Molecular and cellular interactions with biomaterials are analyzed in terms of unit cell processes, such as matrix synthesis, degradation, and contraction Mechanisms underlying wound healing and tissue remodeling following implantation in various organs
4. Tissue and organ regeneration
5. Design of implants and prostheses based on control of biomaterials-tissue interactions
6. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies
7. Criteria for restoration of physiological function for tissues and organs

14. Targeted Drug Delivery Systems

1. Introduction: concept, basis, need, physicochemical and physiological basis, RES
2. Receptor mediated drug targeting
3. Colon targeting approaches
4. Targeting to brain
5. Targeting in cancer and infectious diseases
6. Ligands for targeted drug delivery: monoclonal antibodies

15.Unit Operation in Bioprocesses

1. Downstream Processing in Biotechnology, Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules, basic review of bioprocess designing.
2. Primary separation and recovery processes: Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques, flocculation and sedimentation, centrifugation and filtration methods.
3. Enrichment operations: Membrane – based separations (micro and ultrafiltration, precipitation methods, extractive separation, aqueous two-phase extraction, supercritical extraction, insitu product removal, integrated bioprocessing.
4. Product resolution / fractionation: Adsorptive chromatographic separations processes, electrophoretic separations, hybrid separation technologies (electrochromatography).
5. Product finishing: precipitation/crystallization, mixing, dialysis, distillation and drying. Ultracentrifugation as a separation technique for fractionation of cells and proteins.
6. Introduction to Process Analytical Technology (PAT) and Quality by Design (QbD). Scale down, monitoring and Validation of bioprocesses

16. Environmental Biotechnology

1. Environmental impact and control; Biosafety
2. Biological treatment: stabilization pond, aerated lagoon, activated sludge process, trickling filter anaerobic treatment
3. Biodegradation of xenobiotic organic chemicals; Biological Detoxification of Hazardous chemicals
4. Environmental Policy & Legislation; Sampling of air and water pollutants; Monitoring techniques and methodology, pH, Dissolved Oxygen (DO); Chemical oxygen demand (COD); Biological Oxygen Demand (BOD); Speculation of metals, monitoring & analysis of CO, NO2, CO2, SO2; Pesticide residue; Phenols and petrochemicals
5. Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms; Bioreactors for waste water treatments

17. Biocatalysis and Green Technology

1. Catalytic activity of biomolecules – enzymes and ribozymes; Enzyme applications: Hydrolase enzymes – lipases, esterases, proteases etc. with specific examples and mechanism, Lyases – e.g. Aspartase, tyrosine-phenol lyase; Isomerases – e.g. glucose isomerise; Transferases – e.g. aminotransferases, PLP as cofactor; Ligases; Oxidoreductases – dehydrogenases, oxidases, oxygenases, peroxidases.
2. Whole cells as catalysts; Energetically unfavourable reactions at low temperatures and in unfavourable solvents; The Michaelis-Menten model and modes of inhibition; Kinetics of enzyme catalysed reaction; Regulation mechanisms; Mechanisn of enzyme action; Multi-enzyme systems; Selection and screening of biocatalysts for activity, stability and substrate or product selectivity; Extremozymes – protein catalysts for reactions at extremes of temperature, pressure and pH.
3. Principles of green chemistry (e.g. prevention of waste, less hazardous methods, safer chemicals and solvents, energy efficiency, atom economy, use of catalysis, etc.); the design of “greener” effect chemicals, with examples from the development of crop protection agents; the design of “greener” chemical processes, with examples of the use of biocatalysts.

18. Carbohydrate chemistry and technology

1. Different carbohydrates in food products such as starch, cellulose, sugars, pectin, fibre etc. and their significance in diet
2. Their chemistry & changes in them during processing; Chemical & enzymic modification; Interactions with other food constituents and their implications
3. Special application of carbohydrates in gels, emulsions, stabilisation of food systems, simulated and low-fat foods, edible packages etc.

19. Nutritional genomics

1. Gene- environment interaction; gene- diet interaction; principals and practice behind dietary management of genetically transmitted disorders 10
2. Phenylketonuria, galactosemia; G6PD deficiency; lactose intolerance; complex traits; birth disorders; signal transduction; epigenetic mechanism 10
3. Bioactive components of food; nutraceutical; effective gene expression; epigenetic process; signal transduction. Recent developments in the field

IV. Laboratory courses

Instrumental methods of analysis

UV/Visible Spectroscopy

i. Calibration of UV spectrophotometer
ii. Study effect of solvent on wavelength maxima of drugs.
iii. Find Beer's law limit of drugs in a suitable solvent.
iv. Standard calibration curve by UV spectroscopy at
a) λ max
b) λ max + 10 nm
c) λ max – 10 nm
v. Determination of pKa by U.V. spectroscopy.
vi. Multicomponent analysis by UV-Spectrophotometry
vii. Absorbance corrected for interference method
viii. Simultaneous equation method
ix. Absorbance ratio method
x. Area under curve method
xi. First derivative spectrophotometric method

Analysis of drugs from formulations focusing on separation of drug from the formulation excipients

IR Spectroscopy

i. Calibration of IR spectrophotometer
ii. Sample preparation for I.R. spectroscopy (solid/liquids) and interpretation of IR bands for important functional groups.

DSC analysis of drugs in crystalline and amorphous forms.

Chromatography:

i. HPLC calibration of HPLC column and determination of response factor by HPLC
ii. GC Instrumental handling and few analyses of the API intermediates
iii. TLC mobile phase selection of a various combination of compounds and reaction monitoring.
iv. Preparative TLC analysis.
v. pH stability evaluation of a drug by TLC.
vi. Separation of components by column chromatography.

Structural Interpretation by Spectroscopy:

i. Basic interpretations of simple Mass spectra and NMR.
ii. Structural elucidation workshop: Interpretation of 1H NMR, 13C NMR, IR and Mass spectrometry of simple compounds (maximum 12 carbon atoms).

Microbiology & Molecular Biology Laboratory

1. Study of bacteria, yeasts, moulds, algae, viruses and other microorganisms
2. Morphology, structure, reproduction, isolation, and cultivation
3. Principles of taxonomy and classification, Mutants, Control of microorganisms
4. Laboratory experiments in use of microscopy for identification of microorganisms by morphology and staining technique. Isolation of pure culture
5. Study of growth and optimisation of conditions
6. Preparation of culture media, Sterility test
7. Basic methods in Molecular Biology, including PCR, Blotting techniques, DNA purification, DNA sequencing etc