PhD Course Work

PhD program in Biotechnology

Under
Regional Centre for Biotechnology (RCB), Faridabad

and

National Agri-Food Biotechnology Institute (NABI), Mohali

National Agri-Food Biotechnology Institute
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PhD Course Work

Rules and Regulation of PhD program are as per Regional Centre for Biotechnology (RCB) Regulation, 2017 (notified on September 15th, 2017 in The Gazette of India)

OBJECTIVES OF PhD PROGRAMME

The objective of the programme is to prepare students to conduct high quality research and disseminate it to scholarly and others and become think tanks.

GOALS OF PhD PROGRAMME

The goal of the Ph.D. programme is to train students at an advanced level in specific fields of study in order for them to assume positions of leadership in research, teaching, and service in industry, business, and government.

ADMISSION PROCESS

(i) The minimum qualification for admission to the Doctor of Philosophy programme in NABI shall be a Master's degree from a recognised institution in any area of science and technology, or a Bachelor of Medicine, Bachelor of Surgery degree, or an equivalent degree from a recognized University or institution with minimum of 55% marks. The 5% relaxation (50%) will be given to SC/ST/OBC candidates as per GOI guidelines.

(ii) In addition to the qualification specified in (i), the candidate for admission shall qualify a national level test for pursuing Doctor of Philosophy programme and such test include a doctoral fellowship or admission eligibility test conducted at the national level by the University Grants Commission, or Council for Scientific and Industrial Research, or Indian Council for Medical Research, or Department of Science and Technology, or Department of Biotechnology, or any other Government recognised agency.

(iii) The candidates, who possess qualifications specified in (i) and qualified the test specified in (ii) shall be admitted to the Doctor of Philosophy programme after an interview.

(iv) Applications will be invited through NABI's website and various newspapers during April each year. Upon receiving applications short-listed candidates will be called for an interview in July each year. Candidates who have appeared, or will be appearing, in the qualifying degree examination (final year/final semester) and whose result is still awaited may also apply. However, the admission is pursuant to satisfactory fulfilment of the aforementioned criteria/ requirements at the time of joining.

(v) The total number of PhD seats will be six in this year. The students should meet the desired criteria for selection. There shall be reservation of seats for students from the SC, ST, PD, and OBC categories as per the orders of the Govt. of India in this regard.

(vi) The selected PhD students may be allotted to any of the following six projects on the basis merit:

S. no.	Name of scientist	Number	Tentative project title
1	Prof. Ashwani Pareek, Executive Director	Two	Genome editing and genomic selection for stress tolerance and yield in rice
2	Dr. Vikas Rishi, Scientist-F	One	Mass spectrometry based thermal profiling of anti-obesity drugs: On vs Off target effects
3	Dr. Joy K Roy, Scientist-F	One	Gene discovery under QTL regions through molecular markers
4	Dr. Shrikant S. Mantri, Scientist-E	One	Discovering patterns and associations in microbiome to enhance nutrition and improve health
5	Dr. Nitin Singhal	One	Development of orally consumable Fe-polymer nanocomplex for targeted iron delivery and enhanced absorption during anemic conditions

All the academic rules will be as per the relevant RCB ordinances, statutes and regulations.

NATURE OF DOCTOR OF PHILOSOPHY PROGRAMME

The Doctor of Philosophy Programme at NABI shall consist of two components, namely:-

(a) PhD course work (six months: July to December) and

(b) Research work leading to the submission of a doctoral thesis.

ACADEMIC CALENDAR

Date/Month	Activity
April	Advertisement in newspapers and NABI's website
June	Interview of candidates
July	Commencement of PhD classes
July-December	PhD course work

Any changes in the Academic Calendar will be duly intimated to RCB and implemented following approval of the Academic Committee.

COURSE WORK

The course work for the Doctor of Philosophy degree program at NABI, Mohali shall be as per the Regional Centre for Biotechnology Regulations, 2017

Course Content

S. No.	Course	Code	Credit	Page
Compulsory courses				
1	Research methodology	NAB 401	4	5-6
2	Science Communication	NAB 402	1	7
3	Seminar	NAB 403	1	7
Elective courses (optional)				
1	Principles of Plant Biotechnology	NAB 301	3	8-9
2	Fundamentals of Molecular and Cell Biology	NAB 302	3	10
3	Fundamentals of Genomics	NAB 303	3	11-12
4	Introduction to Bioinformatics	NAB 304	3	13
5	Genome Analysis and Computational Biology	NAB 305	3	14
6	Basic Concepts of Food Science and Technology	NAB 306	3	15-16
7	Nutritional Biochemistry	NAB 307	3	17
8	Bio-organic and Biophysical Chemistry	NAB 308	3	18-19
9	Industrial Biotechnology	NAB 309	3	20

Total credits: 12

Students entering into the PhD Programme at NABI shall have to complete mandatory courses, NAB-401 (Research Methodology), NAB-402 (Science Communication) and NAB-403 (Seminar) and 02 Elective courses. Total 12 credits have to be completed in PhD course work.

NAB 401

RESEARCH METHODOLOGY

(Credit score: 4)

The course is designed to develop the theoretical and practical skills in area of research to plan, conduct, analyse, and present in oral, poster and written form a scientific assignment. It is also designed to help research scholar to learn ethics in manuscript writing. It also includes basic biostatistics and bioinformatics lectures to provide basic knowledge that can be used in data analysis. This course will provide a basic knowledge of modern analytical techniques used in genomics, metabolomics, and proteomics.

COURSE CONTENT

General Principles of Research
Importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, Interpretation of results and discussion.

Scientific Writing
Scientific writing, introduction of grammar and mechanics related to scientific writing, writing synopsis, research paper, poster preparation, oral presentations and dissertations, patent writing- protecting the innovation, Intellectual Property Right (IPR).

Principles of Good Lab Practices
Good laboratory practices, Biosafety for human health and environment. Biosafety issues for using cloned genes, biological containment and physical containment, biosafety levels, biohazard management; physical, chemical and biological hazards, Intellectual Property and regulatory Issues in Biotechnology

Research Ethics
Ethical theories, ethical considerations during research, data manipulations, plagiarism, subject consent, animal testing, animal rights

Writing Project Proposal for Grants to Funding Agencies
Designing grant proposal for funding on a given topic

Basics Principles and Application of Advance Analytical Techniques
Chromatographic techniques (gas chromatography and HPLC), mass spectrometric techniques (gas chromatography-mass spectrometry- GC-MS, Matrix Assisted Laser Desorption/Ionization-MALDI and Electrospray Ionization Mass spectrometry-ESI-MS), Thermo-analytical technique (Differential Scanning Calorimetry-DSC, Thermal Gravimetric Analysis-TGA, Isothermal Calorimetry – ITC), Spectral Techniques (Circular Dichroism-CD, Nuclear magnetic resonance-NMR, Fourier Transform Infrared spectroscopy-FTIR, Dynamic Light Scattering-DLS, UV-Visible, Fluorescence-activated cell sorting-FACS), Microscopy Techniques- Fluorescence microscope, Transmission Electron Microscope, Scanning electron microscope, Confocal Microscopy, Atomic Force Microscopy; Basic principles and methods involved in proteomics and DNA sequencing instruments

Basic Bioinformatics
Bioinformatics: general introduction to databases (protein, DNA, SRA, mirBASE), database search, basic tools for sequence analysis (e.g. BLAST); algorithms for Local and Global alignment; gene prediction and annotation, identification of repeats and primer designing; large scale transcriptome analysis: data quality assessment, filtering of data, steps and tools to analyse transcriptome data; quantitative expression analysis.

Basic Statistical Data Analysis
Importance of statistics in biotechnology; experimental design; distinguish between exploratory and conclusive research; different techniques of sampling; basic statistics techniques for variation analysis; correlation and regression; multivariate analysis and presenting schemes; central tendency and their importance and different conditions to use; Type I and type II error; multiple test correction.

Suggested Readings

1. Modern Language Association, MLA Hand Book for writers of research papers (Seventh edition), 7th edition, (2009), Modern Language Association of America, 2009.
2. Eco, Umberto. How to Write a Thesis. Cambridge (MA): MIT Press. 2015.
3. Joel Bloch, Plagiarism, Intellectual Property and the Teaching of L2 Writing. Multilingual Matters, 2018
4. J. Xiong, Essential Bioinformatics, Cambridge University Press (2009).
5. A. D. Baxevanis and B. F. F. Ouellette (eds), Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd Edn., Wiley-Interscience (2004).
6. D. E. Krane and M. L. Raymer, Fundamental concepts of Bioinformatics, 1st Edn., Pearson Education India (2003).
7. Johnson, R.A. & Bhattacharyya, G.K., Statistics: Principles and Methods, 2nd Edition. Wiley, 1992.
8. B. L. Agarwal, Basic Statistics, New Age International, 2006
9. Spectrometric Identification of Organic Compounds by Robert M. Silverstein
10. Organic Spectroscopy by William Kemp
11. Principles and Applications of Thermal Analysis by Paul Gabbott
12. Physical Principles of Electron Microscopy by Ray Egerton

NAB 402

SCIENCE COMMUNICATION
(Credit score: 1)

For a successful scientist, it is very important to effectively convey his work to both the technical and non-technical audience. This may be in the form of verbal and visual communication in the form of seminars and presentations, and written communication in the form of reports, manuscripts, and grant proposals. This course aims to encourage the students to inculcate these attributes by making presentations and writing reports.

Each student will be required to choose a recent high quality primary research publication and make a power point presentation to the class. The presentation should cover all the background literature of the chosen research area. Stress should be given to the objectives of the paper, logic of each experiment and the data analyses. In addition, they will be expected to highlight shortcomings and alternate approaches as appropriate. This endeavor would give them the exposure of what it takes to defend a scientific concept in an open audience. Additionally, students of this course will mandatorily attend all seminars conducted at NABI.

For developing the writing skills, the student will choose an area related to his research interest and write a 10-page review of the field providing a critique of the research opportunities. The area may be chosen in consultation with the guide who should help the student with the preparation of the report.

NAB 403

SEMINAR
(Credit score 1)

NAB 301

PRINCIPLES OF PLANT BIOTECHNOLOGY

(Credit score: 3)

The course aims to provide knowledge on basic and advances in biotechnological applications (such as tissue culture and genetic engineering). How plants can be genetically modified to have an altered nutrient content. The course also includes genetic techniques used in plant breeding, e.g. various molecular markers, genetic maps and even some studies of natural variation, molecular breeding work of various important crops. The social aspects of plant biotechnology will be discussed, for example, legislation of GMOs, patent legislation, risk assessment and ethical aspects of GMO plants, etc.

COURSE CONTENT

Plant Tissue Culture
History of plant tissue culture, major terminology and their description, different types of cell cultures, morphogenesis and somaclonal variation, protoplast culture and fusion, advantages and application of plant tissue culture in biotechnology.

Plant Genetic Engineering
Definition and scope, methods of plant genetic transformation, vectors for plant transformation, molecular analysis of transgenics, application of plant genetic engineering; functional analysis for plant gene, approaches to validate gene function, evolution of tools for genome editing

Genetically Modified Plants
Genesis, importance and benefits of GM plants, global commercial status of GM plants, setup required for development of GMOs; regulation of genome edited plants and their policy.

Biosafety Regulations of Plant Genetic Engineering
Containment and confined biosafety trials, type of containment facilities, application of containment trials, concerns to handling GM plants, monitoring and regulatory authorities for GM research in India, biosafety level, Status of GM plant research in India

Basics of Genetics and Molecular Breeding
Basic concept of nuclear and cytoplasmic inheritance, linkage and crossing over; allelic and non-allelic Interaction- test of allelism, complementation, and epistasis; types of mutation and chromosomal variation, chromosomal rearrangements, role of organellar genes, recombination, basic plant breeding methodologies; type and application of molecular markers; linkage maps, QTL mapping, association mapping, linkage disequilibrium mapping, population structure, genomic selection, genomics tools in breeding; marker-assisted breeding and marker assisted selection

Suggested Readings

1. Bhojwani SS, Razdan MK. Plant Tissue Culture: Theory and Practice, Volume 5. Elsevier Science, 1st edition (2003), Elsevier Science.
2. Parker & Harvey. Progress and Issues in Transgenic Plants (2015).
3. Stewart NC. Plant Biotechnology and Genetics: Principles, Techniques, and Applications: 2nd edition. (2016).
4. Watson, Ronald Ross. Genetically Modified Organisms in Food (2016). Elsevier.
5. Regulatory guidelines and SOPs for containment field trials in India.
6. http://www.dbtindia.nic.in/regulations/#
7. http://www.dbtindia.nic.in/wp-content/uploads/9.-Guidelines-_Handbook_2011.pdf
8. Singh BD. Biotechnology: Expanding Horizon, 4th Edition, Kalyani Publisher (2015).
9. Gupta PK. Elements of Biotechnology, Rastogi Publications, 2010
10. Gupta PK. Genetics. Rastogi Publications, 2009
11. Gupta PK. Cytology, Cytogenetics and Evolution, 2005
12. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell. Fifth Edition, Garland Science, NY, USA.
13. Brown TA (2007) Genomes. Third Edition, Garland Science, NY, USA.
14. Snustad DP and Simmons MJ (2012) Principles of Genetics. Sixth Edition, John Wiley & Sons, NY, USA.

NAB 302

FUNDALMENTALS OF MOLECULAR AND CELL BIOLOGY

(Credit score: 3)

Fundamental knowledge of molecular biology and cell Biology is important to understand the molecular mechanism involved in biological system. Emphasis will be given to explain the topics giving relevant examples that might help Ph.D. students in designing their experiments and interpretation of their observations.

COURSE CONTENT

Molecular Biology

Historical development of molecular biology, genome organization of prokaryotes and eukaryotes, chemistry and structure of DNA and RNA, DNA replication and recombination, source of genetic variation (natural and induced), structural and numerical alterations of chromosomes, chromosomal rearrangements – deletion, duplication, inversion and translocation; gene expression- transcription, cis-acting elements and transcription factors, RNA editing and processing; gene regulation- prokaryote and eukaryote, epigenetic gene regulation, translational and post-translational modifications, protein targeting and trafficking: protein trafficking (classical and non-classical pathways), ER and Golgi dynamics, protein sorting and trafficking, dynamics of membrane-bound proteins, mechanism of protein secretion, genetic code.

Cell Biology

Constituents of plant cell- extracellular matrix, cytoskeleton (basic elements of the cytoskeleton of a cell, mechanisms of assembly, dynamic structure and regulation of actin and microtubules, cytoskeleton based molecular motors and their varieties) and organelles – structure and function; cell cycle regulation- phases of cell cycle, restriction and check point; cell division and cell growth, cell cycle progression and regulation; enzyme function; protein turnover: biosynthesis and degradation; plant response to starvation, biotic and abiotic stresses, signal transduction mechanism, trafficking of molecules.

Suggested Readings

1. Nelson DL and Cox MM (2008) Lehninger "Principles of Biochemistry". Fifth Edition, Freeman & Co Ltd., NY, USA.
2. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell. Fifth Edition, Garland Science, NY, USA.
3. Voet D and Voet JG (2011) Biochemistry. Fourth Edition, John Wiley & Sons, NY, USA.
4. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J (2012) Molecular Cell Biology. Seventh Edition, Taylor & Francis Publishers, NY, USA.
5. Krebs JE, Goldstein ES and Kilpatrick ST (2011) Lewin's Genes X. Tenth Edition, Jones & Bartlett Publishers, MA, USA.
6. Latchman DS (2007) Gene Regulation. Fifth Edition, Taylor & Francis Publishers, NY, USA.
7. Brown TA (2007) Genomes. Third Edition, Garland Science, NY, USA.
8. Snustad DP and Simmons MJ (2012) Principles of Genetics. Sixth Edition, John Wiley & Sons, NY, USA.

NAB 303

FUNDAMENTALS OF GENOMICS
(Credit score: 3)

The main aim of this course is to familiarize students with basic knowledge and techniques for high throughput data generation and their analysis. This includes structural, functional, and comparative analysis of DNA, RNA, and protein. This also helps students to understand the latest in-silico genomics and proteomics tools and methodologies.

COURSE CONTENT

Genes, Genomes and Genomics
Basic concepts of genes and genomes, genomics and applications, physical mapping of genes and genomes, gene tagging and targeting, strategies to find gene function at genome-wide level, TILLING, Allele/gene mining

Structural Genomics
Classical sequencing methods, next generation sequencing methods and techniques, methods and tools of sequence assembly and gene annotation, gene prediction and annotation, repeat analysis and SNP/indels analysis.

Functional Genomics
Functional analysis of genes, differential gene expression profiling- methodology and analysis; microarray profiling, SAGE, yeast-two hybrid screening, gene expression and transcript profiling, lower eukaryotes as a tool for gene function, factors influencing design of vector and choice of promoters; importance and basics of virus induced gene silencing, RNA-mediated interference, genome editing tools, *in vivo* technologies for assessing gene expression, quantification of gene expression and choice of multiple internal controls; Proteomics- protein annotation, protein separation and 2D PAGE; mass spectroscopy, protein microarrays, protein interactive maps, structural proteomics including protein structure determination, prediction and threading.

Comparative Genomics
Phylogeny, synteny and comparative genomics, gene evolution, speciation and segmental duplication, molecular phylogenetics and applications; multiple sequence alignments and phylogenetic analysis; evolution of exon and introns, gene duplication, acquisition of new genes in non-coding regions, multigene families: neo-, pseudo-, and sub-functionalization; transposable elements and their role in genome evolution; peptide bond and structural basis of protein function; from sequence to structure and from structure to function.

Suggested Readings

1. Brown, T.A. Gene cloning and DNA analysis: an introduction, 7th edition, (2016), West Sussex: Wiley-Blackwell, NJ, USA.
2. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, (2010), Wiley-Blackwell, Hoboken, NJ, USA.
3. Somers DJ, Langridge P, Gustafson JP. Plant Genomics: Methods and Protocols, Methods in Molecular Biology, 2009 edition, Humana Press Inc., NY, USA.
4. Pevsner J. Bioinformatics and Functional Genomics, 2nd edition, (2012), Wiley-Blackwell, Hoboken, NJ, USA.
5. Brown TA. Genomes, 3rd edition, (2007), Garland Science, NY, USA.
6. Galperin MY & Koonin EV. Frontiers in Computational Genomics, (2003), Caister Academic Press, Norfolk, UK.
7. Primrose SB & Twyman R. Principles of Gene Manipulation and Genomics. 7th edition, (2006), Wiley-Blackwell, NJ, USA.
8. Xu Y. Molecular Plant Breeding, (2010), CABI International, Oxfordshire, UK.
9. Somers DJ, Langridge P & Gustafson JP. Plant Genomics: Methods and Protocols, 1st edition, (2011), Humana Press Inc., NY, USA.

NAB 304

INTRODUCTION TO BIOINFORMATICS

(Credit score: 3)

This course intends to give an introduction to information storage and processing by biological macromolecules (DNA and protein sequences) and biochemical pathways in cellular processes. This is an interdisciplinary area in modern biology evolving through the past two decades with inputs from mathematics, statistics, physical sciences, computer science and several other engineering sciences, to understand how biological systems work.

COURSE CONTENT

Biological Databases
Nucleic acid and protein databases such as ENTREZ, Genbank, PDB. File formats of nucleotide and protein sequences such as FASTA, ASN.1, Genbank flatfile, PDB.

DNA and Protein Sequence Analysis
Data storage and compression, DNA sequence composition, primer design, Motif and pattern search methods, Sequence alignments (Pairwise and multiple sequence alignment), Local and global sequence alignments, different types of scoring matrices.

Methods for Database Searching
BLAST and FASTA. Significance of alignments, E-values. BLAST programs: BLASTp, BLASTn, BLASTx, tBLASTn, tBLASTx, PSI BLAST.Serial and parallel BLAST.

Phylogenetic Analysis
Concept of phylogenetic trees-Branches, nodes, internal nodes, rooted and unrooted trees. Distance matrix methods; Maximum parsimony methods; Maximum likelihood methods.

Gene Prediction Annotation
Prokaryotes versus eukaryotes. Promoters, splice sites. RNA secondary structure prediction. miRNA prediction; gene annotation methods and interpretation of results

Structural Bioinformatics
Introduction to protein tertirary structure analysis, Protein structure visualization, Protein structure classification and databases. Ramachandran map, Protein secondary structure prediction. Tertiary structure prediction: Homology modeling, Threading/Fold recognition, ab initio protein structure prediction. RMSD.

Suggested Reading

1. J. Xiong, Essential Bioinformatics, Cambridge University Press (2009).
2. A. D. Mount, Bioinformatics: Sequence and Genome Analysis, 2nd Edn., Cold Spring Harbor Laboratory Press (2004).
3. A. D. Baxevanis and B. F. F. Ouellette (eds),Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd Edn., Wiley-Interscience (2004).
4. D. E. Krane and M. L. Raymer, Fundamental concepts of Bioinformatics, 1st Edn., Pearson Education India (2003).

NAB 305

GENOME ANALYSIS AND COMPUTATIONAL BIOLOGY

(Credit Score: 3)

This interdisciplinary course intends to give an advance understanding about information storage and processing by biological macromolecules (DNA and protein sequences) and biochemical pathways in cellular processes. It will help in understanding high throughput genome analysis using computational methods. .

COURSE CONTENT

High Throughput Genome Analysis

History and evolution of Bioinformatics and Computational Biology, Basic information theory and its application in biology, Cell as an information-processing system; data minning, prediction and association of traits with the sequence data, assembly of large genomes, genome finishing, gene ontology and its application

Interactome Analysis

Computation in network of genes, protein structure, protein-protein interactions, miRNA; Biochemical pathways and cellular processes: Models of regulation; Basics of metabolic control analysis; Network analysis of biochemical pathways; Introduction to some biological repositories of information and data mining.

Data bases, data analysis, Phylogeny

Suggested Readings

1. Ramsden J. Bioinformatics: An Introduction, 3rd edition, (2015), Springer Publishers.
2. Lesk A. Introduction to Bioinformatics, 4th edition, (2014), Oxford University Press.
3. Bower JM & Bolouri H. Computational Modeling of Genetic and Biochemical Networks, (2004), MIT Press.
4. Collado-Vides J & Hofestdt R. Gene Regulation and Metabolism, (2004), MIT Press.

NAB 306

BASIC CONCEPTS OF FOOD SCIENCE AND TECHNOLOGY

(Credit Score: 3)

This course will provide a broad knowledge of food science with emphasis on chemistry and analysis of foods. Further various aspects such as challenges associated with food production, microbiology, safety, quality, sensorial properties and health potentials of foods. This course would help to apply the knowledge obtained in manipulating the complex characteristics of foods.

COURSE CONTENT

Post-harvest Physiology and Technology
Improvement of processing, storage, preservation of agriculture and horticulture crops to retain (a) nutritional value and (b) shelf-life approaches to understand and eliminate post-harvest losses, diversification of foods and its role in nutrition, production of nutrient rich crops (for example, horticultural products, legumes, underutilized crops, and bio-fortified crops).

Food Processing, Fortification, Quality and Sensory Evaluation
Methods of food processing, Food fortification - definition, history, relevance, techniques, novel technologies associated to food fortification with reference to nanotechnology, microencapsulation, and success stories of food fortification, economics of food fortification, FAO/WHO food policies and programs, nanotechnology, Food flavors, food colors, development and marketing of nutraceuticals products: product development, packaging and safety evaluation.

Basic Concepts of Food Safety and Security
Isolation and identification of microorganisms from different types of food, source of outbreaks of food born disease and methods employed, and examples of biological interventions such as bacteriophages and their enzymes will be discussed and evaluated, biosafety issues related to genetically modified foods

Functional Foods and Beneficial Microbes
Introduction to Functional foods/ nutraceuticals, properties, structure and functions of various, Nutraceuticals, Food as remedies, Probiotics, Prebiotics, Dietary fibers, Antioxidants, food/dietary components and their health benefits.

Suggested Reading

1. Martirosyan DM. Introduction to Functional Food Science, 3rd edition, (2017), Food Science Publisher.
2. Lang M, Pistone P, Schuch J, Staringer C & Storck A. Beneficial Ownership: Recent Trends.
3. Tortora GJ, Funke BR & Case CL. Microbiology: An Introduction, 12th edition, Books a la Carte Edition.

4. Embuscado ME & Huber KC. Edible films and coatings for food applications, (2009 edition), Springer Publishers.
5. Fellows PJ. Food Processing Technology, 4th edition, (2016), Woodhead Publishing.
6. Rahman RS. Hand book of food preservation, (2016), Taylor & Francis Publisher.
7. Biliaderis CS. & Izydorczyk MS Functional food carbohydrates, 1st edition, (2006), CRC press.

NAB 307

NUTRITIONAL BIOCHEMISTRY

(Credit Score: 3)

This course will emphasize on basic understanding about biochemical components of the human nutrition. Metabolic pathways are key for developing nutrition based interventions for improving human health. This course will provide deeper insights to understand about various nutrients, their molecular interactions in the host's tissues and gut, how it modulates immune system and gut ecology while contributing for health and well-being. Furthermore, students will be immensely benefitted to undertake cutting edge research in the frontier areas of nutrition research.

COURSE CONTENT

Advanced Biochemistry and Cell Biology
Basics of biophysical chemistry and analytical techniques, Major nutrients in the human diets and dietary sources, micro nutrients, human physiology, digestion and absorption, basic concepts in endocrinology, basic concepts of animal cell, cell organelles and functions, cell cycle and signal hypothesis, basic methods used for bioavailability studies of micronutrients and proteins

Fundamentals of Human Nutrition
Metabolism of carbohydrates, proteins, lipids, nucleic acids, vitamins, micronutrients; disorders associated with their metabolism; malnutrition, effects of insufficient, balanced and excessive intake, energy balance and methods to calculate energy needs to maintain healthy weight; connection between diet and the prevention and treatment of major diseases; intestinal health through nutrition, nutrition and epigenetics, immuno nutrition, public health; animal models for nutrition studies; nutraceuticals and personalized nutrition; nutrigenomics, nutrigenetics and their application

Omics in nutrition
Understanding use and application of genomics, functional genomics, transcriptomics, proteomics, metabolomics, and lipidomics in nutrition, microbiome analysis and implications

Suggested Reading

1. Berg JM, Tymoczko JL, & Stryer L. Biochemistry. 7th edition, (2011), Freeman.
2. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D. & James Darnell J. Molecular Cell Biology , 7th edition, (2013), Freeman Publishers.
3. Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P. Molecular Biology of the Cell, 6th edition, (2014), Garland Science.
4. Gibney MJ, Lanham-New SA, Cassidy A, Vorster HH, Introduction to Human Nutrition, 2nd edition, (2009), Wiley-Blackwel.
5. Eastwood M A. Principles of Human Nutrition, 2nd edition, Springer Publisher.
6. Kuby. Immunology, 7th edition, (2013), W. H. Freeman.

NAB 308

BIO-ORGANIC AND BIOPHYSICAL CHEMISTRY

(Credit Score: 3)

The objective of this course is to introduce students to the physical and chemical basis of biochemical reactions. The course is designed to develop an advanced understanding of the structure and function of natural organic compounds. Students will explore the principals of biological systems through an examination of their structures, synthesis and kinetics and data analysis. Course envisages exploration of both organic and non-biological molecules, with stress on their use in advance research. Emphasis will be given to create and improve products for human consumption; this may include studies on nanotechnology and polymers.

COURSE CONTENT

Introduction to Bio-organic and Biophysical chemistry
Atomic and Molecular Structure, Equilibria, Acids, and Bases, Structural elucidation of macromolecules including proteins, carbohydrates, lipids and nucleic acids using advanced analytical techniques like mass spectrometry (MALDI-TOF, GC-MS, ESI-MS), HPLC, TLC, Dynamic light scattering (DLS), circular dichroism, NMR, PAGE and agarose gel electrophoresis, molecular basis of interactions between macromolecules (protein-protein, Protein-DNA/RNA, carbohydrates-proteins, lipids-proteins interactions) with emphasis on gene regulation and signal transduction.

Biochemical Energetics
Thermodynamics of biological systems, Enthalpy, entropy, free energy, .Biosynthesis of energy rich bonds, Glycolysis, TCA cycle, Gluconeogenesis, Glycogen metabolism, Pentose Phosphate Pathway, Lipid biosynthesis and catabolism, synthesis and degradation of nucleotides.

Isotopes in Biochemistry

Application of stable and radio-isotopes in primary and secondary metabolism, transcription, translation, post-translational modification, bio-transport of metals, drug metabolism. Isotopes and radioactive decay. Assays using radioactive substrate. Biological half-life (turnover). Radioisotopes used in diagnostic Imaging, medical treatments and in agriculture.

Nanoscience
Introduction to nanoscience, Characterization techniques for nanomaterials, biosafety of nanomaterials, Stability and Environmental effects of nanomaterials, application of nanoscience in agriculture, food and nutrition research.

Suggested Readings

1. Vranken DV, & Weiss GA. Introduction to Bioorganic Chemistry and Chemical Biology, 1st edition, (2012), Garland secience.
2. Segel IH. Biochemical Calculations 2nd edition, (2010), Wiley.
3. Dugas H. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, 3rd edition, (1999 edition), Springer Publishers.
4. Niemeyer CM & Mirkin CA, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley VCH.

NAB 309

INDUSTRIAL BIOTECHNOLOGY

(Credit Score: 3)

To provide insight into the industrial application of biotechnology and development of various products in mass scale for broad applications

COURSE CONTENT

Introduction
Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms, screening methods, storage at reduced temperature, storage in dehydrated form, selection of induced mutants, use of auxotrophs, resistant mutants, revertant mutants, microorganisms in extreme environments (thermophiles, psychrophiles, alkaliphiles, acidophiles, halophiles, barophiles) and biotechnological potentials.

Industrial Biotechnology Products
Primary metabolism products, production of industrial ethanol as a case study, Secondary metabolites, bacterial antibiotics and non-ribosomal peptide antibiotics. Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries. Bio-transformations, Bio-augmentation with production of vitamin C as a case study.

Bioreactors
Bioreactors, their design and types. Immobilized enzymes based bioreactors. Microencapsulation technologies for immobilization of microbial enzymes. Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein.

Bioproducts
Bio-remediation of soil. Production of eco-friendly agricultural chemicals, bio-pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc. Recombinant DNA technologies for microbial processes, recombinant products.

Metabolic Engineering of Microbes
Strategies for development of industrial microbial strains with scale up production capacities. Metabolic pathway engineering of microbes for production of novel product for industry.

Fermentation systems
Batch culture, continuous culture, Fed-batch culture, kinetics of growth and product formation; media for industrial fermentations, sterilization.

Suggested Readings

1. Flickinger MC. Encyclopedia of industrial Biotechnology, 1st edition, (2010), Wiley.
2. Demain AL, Devias JE. Manual of industrial Microbiology and Biotechnology, 3rd edition, (2010), ASM Press.
3. Winsoetaert & Vandamme EJ. Industrial Biotechnology, (2010).
4. Mousdale DM. Biofuels: Biotechnology, Chemistry, and Sustainable Development, 1st edition, (2008), CRC Press.