



Ph.D.
SYLLABUS
BIOTECHNOLOGY

CREDIT SYSTEM FOR Ph.D. STUDENTS
(In accordance with NIPER Ordinance)

1. The student who has pursued the M.S. (Pharm.) degree from NIPER shall be required to complete Doctoral courses of minimum 12 credits

2. The student with qualifications from other Institutes [i.e. other than NIPER(s)] shall be required to complete a minimum of 28 credits, out of these 16 credits shall be from specialization and remaining 12 credits shall be from Doctoral courses.

NIPER Students (Total 12 Credits)	<u>Odd Semester</u> 01 Compulsory Subject (02 Credits)	<ul style="list-style-type: none"> These credits will be obtained from Doctoral Courses.
	<u>Even Semester</u> 01 Compulsory Subject (02 Credits)	

Non - NIPER Students (Total 28 Credits)	<u>Odd Semester</u> 01 Compulsory Subject (02 Credits)	<ul style="list-style-type: none"> The student shall be required to complete a minimum of 28 credits, out of these 16 credits shall be from specialization and remaining 12 credits shall be from Doctoral courses.
	<u>Even Semester</u> 01 Compulsory Subject (02 Credits)	

GUIDELINES FOR SUBJECT SELECTION – Ph.D. PROGRAMME

<u>Compulsory Subjects for all departments (Total Credits : 04)</u>			
Total Credits for NIPER Students		04	
Total Credits for Non NIPER Students		04	
Odd Semester			
S.No.	Subject Code	Subject	Credit
1.	GE 710	Research and Publication Ethics	02
Even Semester			
S.No.	Subject Code	Subject	Credit
2.	GE 820	Research Methodology	02
NOTE: Earning credits in aforementioned subjects is mandatory and the earned credits will be counted in preparation of final result.			
<u>Doctoral Courses Offered By Various Departments</u>			
Total Credits for NIPER Students		08	
Total Credits for Non NIPER Students		24	
Medicinal Chemistry : Odd Semester			
S.No.	Subject Code	Subject	Credit
1.	MC 710	Stereo selective and Stereospecific Synthesis	02
2.	MC 720	Synthetic Strategies in the Total Synthesis of Complex Organic Molecules	02
3.	MC 730	Organometallic and Sustainable Chemistry in the Synthesis of Pharmaceuticals	02
Total Credits			06
Medicinal Chemistry : Even Semester			
S.No.	Subject Code	Subject	Credit
1.	MC 810	Principles of Peptide Chemistry	02
2.	MC 820	Carbohydrates: Occurrences, Structure, Reactions, Syntheses, Functions and Applications in Present Day Drugs	02
3.	MC 830	Advanced Topics in Drug Action and Drug Design	02
Total Credits			06

Pharmaceutics : Odd Semester			
S.No.	Subject Code	Subject	Credit
1.	PE 710	Implications of Solid State Properties in Drug Delivery	02
2.	PE 720	Advanced Polymeric Formulations	02
3.	PE 730	Advanced Delivery Approaches for Neurological Disorders	02
Total Credits			06
Pharmaceutics : Even Semester			
S.No.	Subject Code	Subject	Credit
1.	PE 810	Novel Approaches for Targeted Drug Delivery	02
2.	PE 820	Advanced Materials as Theranostics	02
3.	PE 830	Cosmeceutical Formulation Development	02
Total Credits			06
Pharmacology and Toxicology : Odd Semester			
S.No.	Subject Code	Subject	Credit
1.	PC 710	Signalling Mechanisms of Receptors and Neurotransmitters in Brain	02
2.	PC 720	Basics and Advances in Neuorscience	02
3.	PC 820	Pharmacological Interventions for Ischemic Brain Injury	02
4.	PC 830	Parasitology/Microbiology, Community & Pharmacy	02
Total Credits			08
Pharmacology and Toxicology : Even Semester			
S.No.	Subject Code	Subject	Credit
1	PC 840	Regulatory Toxicology And Drug Safety Evaluation	02
2	PC 860	Epigenetics and Diseases	02
3	PC 870	Preclinical Pharmacological Models Of Screening	02
Total Credits			06
Regulatory Toxicology : Odd Semester			
S.No.	Subject Code	Subject	Credit
1	RT 710	Recent advances in Regulatory Toxicology	02
Total Credits			02

Biotechnology : Odd Semester			
S.No.	Subject Code	Subject	Credit
1	BT 710	Interfacial Enzymology	02
2	BT 720	Therapeutic and Diagnostic approaches in Neglected Tropical Diseases	02
Total Credits			04
Biotechnology : Even Semester			
S.No.	Subject Code	Subject	Credit
1	BT 810	Protein Structure and Stability	02
2	BT 820	Host-Pathogen Interaction in Infectious Disease	02
3	BT 830	Targeting metabolic disorders by Natural Products	02
4	GE 830	Cell Based Therapies	02
5	GE 840	Cell-Based Therapies: Laboratory Experience Prerequisite: GE 830 Cell-Based Therapies	02
Total Credits			10

All the PhD Students have to complete 12 credits from the doctoral courses mentioned above. Further, the Non NIPERian students shall be required to earn 16 credits more from specialization of the concerned department. For these 16 credits, the PhD student may also refer to subjects of M.S. (Pharm.) Programme of the concerned department.

Ph.D. Biotechnology		
Course No.	Course Name	Credits
Odd Semester		
BT-710	Interfacial Enzymology	02
BT-720	Therapeutic and Diagnostic approaches in Neglected Tropical Diseases	02
GE-710	Research and Publication Ethics	02
	Total Credits	06
Even Semester		
BT-810	Protein Structure and Stability	02
BT-820	Host-Pathogen Interaction in Infectious Disease	02
BT-830	Targeting metabolic disorders by Natural Products	02
GE-820	Research methodology	02
	Total Credits	08
Elective courses offered		
^{\$} GE-830	Cell-Based Therapies	02
[#] GE-840	Cell-Based Therapies: Laboratory Experience	02
	Total Credits	04
*Common with other disciplines; ^{\$} Elective course; [#] Prerequisite: GE-830 Cell-Based Therapies		

Ph.D. Biotechnology Odd Semester

BT-710 Interfacial Enzymology (2 credits)

1.	Enzymology: fundamental, enzyme kinetics, enzyme inhibition and inhibitors, example of enzymatic reactions, regulation of enzyme.
2.	Biophysics of enzyme: lipid interaction, structural features of membrane lipids, critical micellar concentration, co-operativity of micellization, liposomes, lipoprotein particles
3.	Membrane properties modulating structure-function of enzymes: Properties of lipid bilayer phases, effect of sterols on aggregates of lipids, membrane fluidity.
4.	Interfacial and non-interfacial enzymes: issues of interfacial and non-interfacial enzymology, interfacial enzymes of lipid metabolism, phospholipase A2, interface phenomenon.
5.	Interfacial Activation: Enzyme versus substrate model, interfacial processivity, interfacial catalytic turnover, Scooting and Hopping model, interfacial allostery, inhibition and Inhibitors.
6.	Methods to study interface and interfacial enzymes: IR spectroscopy, Attenuated total reflection Fourier transform infra-red (ATR-FTIR) spectroscopy, IRE, sample preparation, use of fluorescent substrate and indicators
7.	Determination of protein secondary structure: dynamic and orientation in lipid-protein mixture, methods for ATR-FTIR spectra evaluation.
8.	Lipoproteins: Lipoproteins, different types, major components, apo-lipoproteins, reverse cholesterol transport.
9.	Lipoproteins associated enzymes: Various enzymes associated with lipoproteins, their role in physiology and pathology.
10.	Screening of enzyme inhibitors: various methods available to screen enzyme inhibitors.

Recommended books:

1.	Scientific Journals.
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BT-720 Therapeutic and Diagnostic approaches in Neglected Tropical Diseases (2Credits)	
1.	Application of biotechnology in drug discovery: Introduction, identification of sources for isolating the gene that encodes the target proteins, engineer expression system for targetprotein.
2.	Protein expression systems: Optimization of cell expression system to maximize production of target proteins; application of TAP tagging in protein-protein interaction and drugdiscovery.
3.	Identification of potential vaccine candidates: Basic concepts of vaccines, types of vaccines, techniques for identification of potential vaccine candidates, conventional vaccinology vs.reverse vaccinology.
4.	Genomics: Key role of genomics in modern vaccine and drug design for emerging infectious diseases.Genomics and diagnosis of infectious diseases.
5.	Biomarkers in infectious diseases: Introduction to biomarkers, classification of biomarkers, types of biomarkers-genes, proteins, RNA, biomarkers of infectious diseases,technologies for identification of biomarkers-PCR, Combined PCR-Elisa and other nonPCR methods.
6.	Monoclonal antibodies as therapeutic targets: Antibody structure and function, antibody classes and biological actions, monoclonal antibody and infectious diseases.
7.	Epitope mapping: Epitope mapping and its application in vaccines and protein therapeutics, advantagesof monoclonal antibodies over existing chemotherapy.
8.	Immunogenecity and immunotoxicity of Biopharmaceuticals: Biotech derived products-cytokines, plasminogen, growth factors, monoclonal antibodies and fusion proteins, preclinical and clinical levels of biopharmaceuticals, rules for regulation of synthesis and testing of biopharmaceuticals.
9.	RNA silencing technologies in drug discovery and target validation: Silencing of genes inducible and reversible RNAi mediated knockdown, antisense oligonucelotides, mechanism of action of antisense oligonucelotides, antisense oligonucelotides for neglectedtropical diseases, RNAi as an anti-infectiousagent.
10.	Generation of mutant strains for functional analysis of essential genes: Gene knock outandknock in by doubledisplacement and overexpression strategies.

Recommended books:

1. Scientific Journals.

GE-710: Research and Publication Ethics (2 credits)	
1.	Philosophy and Ethics: Ethics: definition, moral philosophy, nature of moral judgements and reactions. Scientific Conduct: Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. An overview of referencing softwares.
2.	Publication Ethics: Publication ethics: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributorship. Manipulation of data and deception of other kinds. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.
3.	<p>Open Access Publishing: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc</p> <p>Publication Misconduct:</p> <p>a. Group discussions: Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad.</p> <p>b. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.</p>
4.	<p>Databases and Research Metrics</p> <p>Database: Indexing database. Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.</p>

Recommended books:	
1.	Bird, A. (2006). Philosophy of Science. Routledge.
2.	MacIntyre, Alasdair (1967) 4 Short History of Ethics. London.
3.	P. Chaddal, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
4.	National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
5.	Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.
6.	Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
7.	Beall, I. (2012). Predatory publishers are corrupting open access. Nature, 489 (7415), 179-179. https://doi.org/10.1038/489179a
8.	Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/EthicsBook.pdf
9.	Scientific Journals

Ph.D. Biotechnology

Even Semester

BT-810 Protein Structure and Stability (2 credits)

1.	Protein structure: Diversity, Taxonomy, Higher levels of organization, Post-translational modifications.
2.	Analytical chromatographic methods: Chromatography of peptides and high molecular weight proteins.
3.	Spectroscopic techniques for protein structure analysis.
4.	Strategies for sequence determination: Enzymatic and chemical.
5.	Forces responsible for protein structure and stability: Thermodynamics.
6.	Kinetics of protein folding: Two-state and multistate kinetics, Transition states and inter-mediate.
7.	Stability of proteins: Kosmotropes and chaotropes. Denaturation and renaturation of proteins.
8.	Protein stabilization: Theories
9.	Stabilization of proteins: Role of additives.

Recommended books:

1. Scientific Journals.

BT-820 Host-Pathogen Interaction in Infectious Disease (2 credits)	
1.	Introduction Infectious Disease and relevance: Causative agents, bacterial and viral diseases, Pandemics.
2.	Fundamentals of the process of Infection: Basic concepts of Immunology & Cell Biology, Intercellular pathogens; extracellular pathogens
3.	Survival strategies of <i>Mycobacterium tuberculosis</i>: <i>Mycobacterium tuberculosis</i> - a global epidemic, reasons for resurgence, drug resistance and emergence of new diseases. Cell wall, phagocytosis, virulence factors, secretion systems in <i>M.tb</i> and other pathogens and their importance.
4.	Immunity and Resistance: Host-pathogen interaction, Invasion, adhesion, cell signaling and trafficking, manipulating host resources, extracellular matrix and cytoskeleton, fibrinolytic pathway.
5.	Iron metabolism: Iron and copper, iron metabolism, iron uptake and transport mechanisms in host and pathogen, role in infection, essential requirement of iron in tuberculosis.
6.	Multifunctional proteins: Concept of multifunctionality, role in pathogenesis, interplay and regulation of these proteins during infection.
7.	Intervention Strategies: Drugs and their limitation, targeted delivery of drugs, utilizing cell and pathogen biology to design new drugs, newer approaches for drug discovery

Recommended books:
1. Relevant research and review articles.

BT- 830: Targeting metabolic disorders by Natural Products (2 credits)

1.	Introduction: General principles of metabolic disorders and focuses on pathways, enzyme mechanisms, and diseases associated with defects in metabolism.
2.	Natural Products: Introduction, Types and classifications, therapeutic applications.
3.	Metabolic syndrome: Definition, risk factors, causes and complication. Prevention and treatment of metabolic syndrome.
4.	Type 2 diabetes and obesity: Insulin signaling and resistance, Metabolic consequences of type 2 diabetes, gestational and stress-induced diabetes, Adipose biology, Leptin signaling pathway, GLP1, Newer therapy.
5.	Cardiovascular diseases and heart failure: Energy metabolism in heart, Dyslipidemia, hypertension and associated cardiac disorder, recent therapy for cardiac disorders.
6.	Hepatic steatosis: Etiology, global prevalence, molecular pathways, recent therapy for hepatic disorders.

Recommended books:

1. Goodman & Gilman's: The Pharmacological Basis of Therapeutics, 13e
2. Paramjit S Tappia, S K Bhullar, Niranjana S Dhalla. Biochemistry of Cardiovascular Dysfunction in Obesity. Springer Nature Switzerland AG. 2020.
3. Enid Gilbert-Barnes, Lewis A. Barnes, Philip M. Farrell. Metabolic Disease: Foundations of Clinical Management, Genetics, and Pathology. (2nd Edition). IOS Press, Amsterdam.
4. Non-alcoholic Fatty Liver Disease: A 360-degree Overview, Elisabetta Bugianesi, Springer.
5. Bioactive Natural Products for Pharmaceutical Applications, Dilipkumar Pal, Amit Kumar Nayak, Springer.
6. Scientific journals

GE-820: Research Methodology (2 credits)	
1.	Concept of Research: - Meaning and importance of Research- Objectives and types, Motivation in Research
2.	Analysis of literature review: - Primary and Secondary sources, Web sources – critical literature review
3.	Hypothesis: Different types, Significance, Development of working hypothesis, Null hypothesis.
4.	Introduction to research methods/ methodology: - Selection and formulation of research problem, Research designing and development of models. Experimentation, determining the experimental and sample designs. Scientific method vs Arbitrary Method
5.	Data Collection and Statistical Analysis: Sources and types of data, Methods of Collecting Data: Observation, field investigations, Direct studies – Reports, Records or Experimental observations, Graphical representation, Descriptive Analysis, Inferential Analysis, Correlation analysis, Discussion, and interpretation of results.
6.	<p>1. Data Reporting and Scientific Writing: -</p> <p>I.Organization of the Research Report Preliminaries, Contents of Report, Bibliography, Appendices, Style Manuals, Criteria for the evaluation of the Research Report.</p> <p>II. Preparation of manuscript for Publication of Research paper, presenting a paper in scientific seminar/conference, Preparation of Project Proposal.</p>
7.	Principal of Analytical Instrumentation and their Implication: - Spectroscopic and microscopic techniques including cell and tissue imaging, Live Cell Cytometry studies, Omics techniques. Characterization and implication of API excipients and their formulations in research.

Recommended books:
1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
3. Wadehra, B.L.2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
4. Relevant research and review articles.

GE-830 Cell-Based Therapies	
1.	Introduction to therapeutic cells and potential applications: Differences between cell therapy and gene-modified cell therapy; cell-based transfer; multicellular therapies; application of cell therapy in different diseases such as neurodegenerative diseases, cancer, rheumatoid arthritis, metabolic diseases; administration and delivery of cell-based therapeutics; promises and challenges for cell-based therapeutics.
2.	Introduction to technologies for the development of cell-based therapy: Cell immortalization technologies; gene modification; viral vector-based technologies; cell plasticity and three-dimensional technologies.
3.	Stem cell technology: Different sources of stem cells, preparation, identification; biomarkers, collection methods; Cell transplantation; stem cells in reprogramming and its application as regenerative medicine; the role gene-editing methods including CRISPR/Cas9; designing of human iPS cells; stem cell-banking; current trends of stem cells therapies.
4.	Non-stem cell-based cell therapies: Different cell types; mesenchymal stromal cells (MSCs), dendritic cells (DCs) and their uses in cellular therapies; introduction to lymphatic system; Natural killer (NK) cell biology; NK cell receptors and ligands; application of NK cell-based therapy in cancer; CAR T cell therapy; structure, generations and productions of CAR T cells; advantages and limitations of CAR T cells as therapeutics; recent advances on macrophages (CAR-M) as cell-based treatments
5.	Cell-based vaccines: Types of vaccines; designing vaccine delivery system and applications; stem cell-based vaccines; dendritic cell-based vaccines; exosome-based vaccines.
6.	Translational aspects of cell-based therapies: Guidelines for understanding the best practices for working with cells.

Recommended books:	
1.	Daniel Scherman (2019). Advanced Textbook On Gene Transfer, Gene Therapy And Genetic Pharmacology: Principles, Delivery And Pharmacological And Biomedical Applications Of Nucleotide-Based Therapies: 2nd edition World scientific.
2.	Stewart Sell (2013). Stem Cells Handbook: 2nd edition Humana Press.
3.	Anthony Atala, Robert Lanza, Tony Mikos, Robert Nerem (2018). Principles of Regenerative Medicine: 3rd Edition Elsevier Academic Press.
4.	Stephen H. and George M. Church (2017). Precision Medicine, CRISPR, and Genome Engineering: Moving from Association to Biology and Therapeutics. 1 st Edition Springer.
5.	Dwayne F. Emerich, Gorka Orive (2017). Cell Therapy: Current Status and Future

Directions (Molecular and Translational Medicine): 1st Edition Humana Press.
6. Matthias Giese (2014). Molecular Vaccines: From Prophylaxis to Therapy – Volume 2. 2014th Edition Springer.
7. Daniel D. Karp, Gerald S. Falchook, JoAnn D. Lim (2022). Handbook of Targeted Cancer Therapy and Immunotherapy: 3rd edition LWW publishers.
8. Xiao-Dong Chen (2018). A Roadmap to Nonhematopoietic Stem Cell-Based
9. Therapeutics: From the Bench to the Clinic: 1st edition Academic Press.

GE-840 Cell-Based Therapies: Laboratory Experience Prerequisite: GE-830 Cell-Based Therapies (2Credits)	
1.	Designing of Primers and siRNAs.
2.	Designing target-specific gRNA for CRISPR/Cas-9.
3.	Sequence Analysis, Alignment, and retrieval for target genes.
4.	Labelling and identification of immune cells using Fluorescence Activated Cell Sorting (FACS).
5.	Immune cells isolation using Magnetic Activated Cell Sorting (MACS)
6.	Plasmid Transformation, purification, and validation.
7.	Gene manipulations in cells.
8.	CRISPR/Cas9-based Gene editing in cells.

<i>Recommended books:</i>
1.Relevant research and review articles.