SYLLABUS

PhD

Regulatory Toxicology

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)	**Odd Semester** 01 Compulsory Subject (02 Credits)	• These credits will be obtained from Doctoral Courses.
	Even Semester 01 Compulsory Subject (02 Credits)	

Non - NIPER Students (Total 28 Credits)	**Odd Semester** 01 Compulsory Subject (02 Credits)	• 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.
	Even Semester 01 Compulsory Subject (02 Credits)	

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GUIDELINES FOR SUBJECT SELECTION – Ph.D. PROGRAMME

Compulsory Subjects for all departments (Total Credits : 04)			
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.***			

Doctoral Courses Offered By Various Departments			
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 theses 16 credits, the PhD student may also refer to subjects of M.S. (Pharm.) Programme of the concerned department.

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RT-710 Recent advances in Regulatory Toxicology (2 credits) Odd Semester	
1.	**Alternate to animal testing in toxicology and chemical risk assessment:** 3R/4R Concepts & in-vitro or in-silico testing.
2.	**Importance of in-silico tools in toxicity prediction**: Test applications, the concept of (quantitative) structure-activity relationships (QSARs), Different types of models and molecular descriptors in the QSAR family.
3.	**In-silico tools e.g:** TopKat®, DEREK & SARAH, MultiCASE etc
4.	**Drug discovery and toxicity predictions**: Use of Artificial Intelligence (AI)) & Machine Learning (ML), Big data analysis.
5.	**Pharmacokinetic/pharmacodynamic** (PK/PD) models and different methods to determine the uncertainty.
6.	**Adverse outcome pathways (AOPs) framework**: Modules of the AOP knowledge base (AOP-KB), AOP development, AOP assessment, applications, and case studies of AOP.
7.	**Regulations on REACH**: Functions of REACH, Substance identification.
8.	**Regulations and toxicity testing of medical devices**: FDA regulations for medical devicesEuropean Union regulations for medical devices, Medical devices Rules 2017, use of International Standard ISO 10993-1 in biological evaluation of medical devices.
9.	**Regulatory requirements for generic Drug Development**: Impurity identification and its significance, Impurities in pharmaceutical products, Classification of impurities, Toxicological concerns of impurities, ICH & FDA recommendations for acceptable limits of impurities, current methods available for testing. Case study of impurity testing.

Recommended Books:
1.Alternatives to Animal Testing by Horst Spielmann , Troy Seidle , Hajime Kojima.
2. Computational Toxicology: Risk Assessment for Chemicals by Sean Ekins.
3. Guidance for Industry Q3A Impurities in New Drug Substances, FDA.
4. ANDAs: Impurities in Drug Substances, FDA.
5. ICH Q3A (R2) Impurities in new drug substances, EMA.
6. Use of International Standard ISO 10993-1, "Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk management process", FDA.
7. https://aopkb.oecd.org/
8. https://www.ich.org/
9. https://www.fda.gov/medical-devices
10. https://www.ema.europa.eu/en/human-regulatory/overview/medical-devices
11. https://cdsco.gov.in/opencms/opencms/en/Medical-Device-Diagnostics/Medical-Device- Diagnostics/

GE- 830 Cell Based Therapies (2 Credits) Even Semester	
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. 1st Edition Springer.
5. Dwaine 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 Therapeutics: From the Bench to the Clinic: 1st edition Academic Press.

GE-840 Cell-Based Therapies: Laboratory Experience(2Credits) Prerequisite: EC-810 Cell-Based Therapies Even Semeter	
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.