CURRICULUM & SYLLABUS

DOCTOR OF PHILOSOPHY (Ph.D.)

IN

BIOTECHNOLOGY

[w. e. f. 2025-26]

FACULTY OF SCIENCE & HUMANITIES
SRM UNIVERSITY DELHI-NCR, SONEPAT
39, Rajiv Gandhi Education City, Sonepat
Haryana-131029

Course Structure
Details of Course Ph.D. Biotechnology
Course WorkCredits:Theory

I. Course Theory-4 Subjects 4X3=12+2=14

(4 Papers)

Total 14 Credits

Doctor of Philosophy (Ph.D.) Biotechnology
Course Work

Course Code	Course Name	Total Credit (C)	Maximum Marks
RES701	Research Methodology	4	100
25RES711	Laboratory Techniques In Life Science	4	100
25PBT721	Laboratory Techniques & Advanced Research in Biotechnology	4	100
RPE100	Research Publication & Ethics	2	100
	Total	**14**	**400**

RESEARCH METHODOLOGY

RES701 **Credit 4**

Unit 1: Introduction to Research

Introduction, Philosophical Underpinnings, Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Approaches, Significance of Research, Scope of Research, Literature Review, Research Methods vs. Research Methodology, Research Process, Research and Scientific Methods, Criteria of Good Research, Research Questions, Research problem, Selecting the Problem, Necessity and Techniques of Research Problem, Qualitative & Quantitative Research, Research Proposal, Synopsis, Transdisciplinarity, Multidisciplinarity&Interdisciplinarity in Research.

Unit II: Data Collection & Sampling

Collection of Primary Data/Sources, Secondary Data/Sources, Observation Method, Interview, Libraries, Archives & Repositories, Questionnaire, Schedules, Case Study and other Innovative Methods, Research Procedure. Sampling, Steps and Criteria for selecting a Sample procedure, Characteristics of Good Sampling, Types of Sample Design, Selecting Random Samples, Complex Random Sampling Design.

Unit III: Data Analysis & Interpretation

Measures of Central Tendency, Dispersion, Correlation & Regression, Chi-Square Test: applications, Steps, Characteristics, Limitations, Analysis of Variance & Co-variance. Hypothesis: Meaning, Basic Concepts, Flow Diagram, Testing, of Means, Testing of Hypothesis testing of Correlation coefficients, Limitations of Tests of Hypothesis. Theory & Empirical approaches, Ethnographic, Comparative and Interpretative Research.

Unit IV: Research Tools & Ethics in Research

Computer Fundamentals, Basics, Data Representation, Word Processing Package, Creating & Editing a Word Document.Ethical issues related to Publishing & Plagiarism, LaTex tool for Detection& Elimination of Plagiarism, Intellectual Property Rights, Copy Rights & Patent Laws.

Unit V: Research Report & Presentations

Structure & Components of Research Report, Types of Report, Layout of Research Report, Mechanism of Writing a Research Report. Presentation: Tailoring the presentation to the target audience, Oral Presentation, Poster Presentation, Submission of Research Article, Thesis Writing, Visual& Delivery.

Text books

- Adam Pzreworsky and Frank Solomon. *On the Art of Writing Proposals*, rev. edn, New York, 1995.
- Blaxter Loraine, Hughes Christina and Tight Malcolm. *How to Research*, Open University Press, 2006.Gerard Guthrie. *Basic Research Methods*, Sage, London, 2010.

Reference books:

- Kothari, C. R. *Research Methodology: Methods and Techniques*, New Age Publishers, Delhi, 2018.
- Rand R. Wilcox, *Fundamentals of Modern Statistical Research*, Springer, New York, 2010.

Ross, Timothy J. *Fuzzy Logic with Engineering Applications,* 2nd Edn. Wiley Publications, 2005.

LABORATORY TECHNIQUES IN LIFE SCIENCES (Biotechnology/Microbiology)	
Course Code: 25RES711	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	Course Type: Theory
Prerequisite: NIL	

The course is aimed to provide an insight into critical review of literature and assessing the research trends, quality and extension potential of life science research and equip students to undertake life science research.

COURSE OBJECTIVES (CO):

1. To understand the animal cell culture & Molecular Biology Techniques
2. To understand the Microorganisms and Microbial Technology.
3. To understand the Animal Biotechnology and Immunological Techniques.
4. Understand the basic concept of Computational Biology and Computer Aided Drug Design
5. Understand the Biosafety & Bioethics, field work, seminars & other academic activities

COURSE LEARNING OUTCOMES (CLO):

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Explain the details of maintenance animal cell culture and molecular biology techniques associated with research.
2. Introduction to various types of microbes, Growth of bacteria; Control of Microbes. Microbial production, purification and bio-process applications.
3. Introduction to various immunological techniques, Principles and applications, Hybridoma technology.
4. Explain the basic concepts of drug discovery and development process along with molecular modelling and virtual screening
5. Explain socio-legal aspects of ethics in medicine, biotechnology and Biosafety guidelines for research on GMOs. Learn about writing research proposal.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CO'S	**CLO'S**				
	CLO1	**CLO2**	**CLO3**	**CLO4**	**CLO5**
CO1					
CO2					
CO3					
CO4					
CO5					

Elective Units

Unit 1. Cell culture &Molecular Biology Techniques

Basic lab techniques and lab safety, Introduction of Light and fluorescence microscope, Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell counting using hemocytometers. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, preparation of human chromosome, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear extract and cytoplasmic extract.

Principles of Molecular Biology Techniques, Introduction to basic and advanced information on DNA, RNA and proteins. Isolation and purification of DNA samples from different cell types and tissues, DNA concentration techniques, Restriction Digestion and analysis, Ligation of DNA to create recombinant molecules. Southern Blotting: Agarose gel electrophoresis, DNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, X-ray film exposure, interpretation of results. Northern Blotting: Blotting of isolated and purified total and/or poly(A+) mRNA from cells and from tissues. Denaturing gel electrophoresis, RNA transfer techniques, isotopic and non-isotopic probe labeling methods, hybridization, X-ray film exposure, interpretation of results. Western Blotting, Fundamentals of PCR, primer design, PCR amplification tools and techniques, hot-start PCR, TA cloning, characterization of PCR.

2. Microbiology and Microbial Technology

The world of microbiology and development of microbiology as a scientific discipline, Methods of studying microbes: Introduction to various types of microbes, Growth of bacteria; Control of Microbes; Isolation, identification and characterization of bacteria. Prokaryotic cell structure and function, Transformation, Competent cell preparation. Microbial production, purification and bio-process applications of industrial enzymes; Production and purification of recombinant proteins on a large scale, Enzymes for industry/ medicine, Immobilized enzyme technology, Bioremediation of contaminated soil and waste land. Waste Management Strategies, Kinetics of microbial growth, Biopesticides in integrating pest management, Bio-energy, Bio-diesel: Tree borne and algal oils and Trans-esterification. Hydrogen and Electricity from microbes, Biosafety in relation to recombinant organisms.

3. Animal Biotechnology and Immunological Techniques

Routes of immunization, Types of adjuvant and their importance, Antigen- Antibodies interaction, Monoclonal and Polyclonal Antibodies, ELISA techniques, principle and applications, Immunoradiometric Assay: Principles and applications, Hybridoma technology. Gene therapy, Stem cell in therapeutics, Oncogenes, Tumor Suppressor Genes and Cancer Biology, AIDS and other Immuno-deficiency diseases.

4. Computational Biology and Computer AidedDrug Design

Sequence Alignment, PAM and BLOSUM matrices, Dot Plot, Local alignment (Smith-Waterman algorithm) and Global alignment (Needleman-Wunch algorithm), Multiple Sequence Alignment and its applications, Database searching using FASTA and BLAST, Phylogenetic Analysis, Construction and visualization of phylogenetic tree, Distance and character based tree construction methods, Molecular dynamics simulation, Structure-based drug design and Ligand-based drug design, Molecular docking and Virtual screening, in silico ADME/T prediction, QSAR modeling, Pharmacogenetics and Pharmacogenomics, Systems Biology, Networks in biology, Biological

Network Databases, Protein-protein interaction networks, Biochemical networks, Flux balance analysis.

5. Biosafety & Bioethics, field work, seminars & other academic activities would be mandatory with any of the above specialization courses.

Guidelines for Biosafety, Institutional Biosafety committee, InstitutionalAnimal ethics committee, Institutional ethics committee, Patents and Intellectual property Rights, Bioethics (Animal, Human), Human cloning

Writing research proposal, Communication skills (Writing and Oral), Seminar presentation, Design and teach one practical to the students

Text books

- Evolution of Translational Omics: Lessons Learned and the Institute of Medicine, Board on Health Sciences Policy, Board on Health Care Services · 2012
- Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Ow "Kuby Immunology" WH Freeman & Co. eight edition 2022.
- IPR, Biosafety and Bioethics, Deepa Goel, Shomini Parashar
- Molecular Biology and Genetic Engineering By P. K. Gupta · 2008
- T. A. Brown. Gene Cloning and DNA Analysis: An Introduction, 6th Edition. 2010. Blackwell
- Graham .L. Patrick. An Introduction to Medicinal Chemistry.Oxford University Press. 1995

References books

- Cell Biology (Cytology, Biomolecules and Molecular Biology),Verma P.S. & Agarwal V.K.
- Cell Biologys,Gerald Karp · 2013
- Essential Bioinformatics - Jin Xiong · 2006· 2013
- Principles of Biochemistry, Lehninger-7th Edition, 2017
- Molecular Cloning: A Laboratory Manual (Fourth Edition) Michael R. Green, Howard Hughes Medical Institute, University of Massachusetts Medical School; Joseph Sambrook, Peter MacCallumCancer Institute, Melbourne, Australia

LABORATORY TECHNIQUES AND ADVANCED RESEARCH IN BIOTECHNOLOGY	
Course Code: 25PBT721	Continuous Evaluation: 40 Marks
Credits: 4	End Semester Examination: 60 Marks
L T P : 4 0 0	Course Type: Theory
Prerequisite: Introductory courses in Biotechnology, Molecular Biology, or equivalent	

The course is providing a comprehensive framework for advanced research in biotechnology.

Course Objectives (COs):

CO1: To provide advanced knowledge in modern biotechnological research and its methodologies.
CO2: To train students to design, execute, and evaluate research projects using cutting-edge biotechnological techniques.
CO3: To develop critical thinking and the ability to analyze scientific literature and data in biotechnology.
CO4: To understand the ethical, legal, and regulatory aspects of biotechnological research.
CO5: To apply biotechnology in solving complex problems in healthcare, industry, and environmental fields.

Course Learning Outcomes (CLOs):

CLO1: Demonstrate expertise in advanced molecular biology and biotechnological techniques, such as CRISPR, proteomics, and transcriptomics.
CLO2: Develop and implement independent research projects utilizing synthetic biology, genetic engineering, and bioinformatics tools.
CLO3: Critically evaluate and interpret current research findings in biotechnology and communicate them effectively.
CLO4: Address and apply biosafety, ethical, and legal considerations in biotechnological research and innovation.
CLO5: Apply advanced biotechnology techniques in solving real-world challenges in healthcare, industry, and environmental sciences.

CO and CLO Mapping:

Course Objectives (COs)	Course Learning Outcomes (CLOs)				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content:

Unit 1: Advances in Molecular Biotechnology **12 Hr**

Applications of molecular biotechnology in health and agriculture, Gene editing technologies: CRISPR-Cas, Advanced cloning strategies and expression systems, RNA interference (RNAi) and gene silencing techniques,Case studies in microbial, plant, and animal biotechnology

Unit 2: Genomics, Transcriptomics, and Proteomics **12 Hr**

DNA Sequencing High-throughput sequencing technologies and applications (NGS), Transcriptomics and gene expression profiling, RNA-Seq analysis, Mass spectrometry and proteomics: techniques and applications, Systems biology and integration of omics data, Bioinformatics tools for genomics and proteomics

Unit 3: Synthetic Biology and Genetic Engineering **12 Hr**

Synthetic gene circuits and metabolic pathway engineering, DNA synthesis and genome assembly technologies, Engineering microbial systems for industrial applications, Applications of synthetic biology in biofuels, pharmaceuticals, and synthetic organisms, Ethical and regulatory issues in genetic engineering

Unit 4: Biotechnology in Healthcare **12 Hr**

Biotechnology in drug discovery, development, and delivery, Gene therapy, stem cell research, and regenerative medicine, Personalized medicine and pharmacogenomics, Cancer immunotherapy and advances in biopharmaceuticals, Biosafety, ethical, and regulatory considerations in healthcare biotechnology

Unit 5: Environmental and Industrial Biotechnology **12 Hr**

Biotechnology in biofuels, bioremediation, and waste management, Industrial enzymes and biocatalysts, Sustainable agriculture and food biotechnology, Fermentation technologies and bioprocess engineering, Case studies in environmental and industrial biotechnology

Textbooks:

1. **Molecular Biotechnology: Principles and Applications of Recombinant DNA** by Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, 5th Edition, ASM Press, 2017.
2. **Principles of Gene Manipulation and Genomics** by Sandy Primrose and Richard Twyman, 7th Edition, Wiley-Blackwell, 2009.
3. **Synthetic Biology: A Primer** by Paul S. Freemont and Richard I. Kitney 2nd Edition, Imperial College Press, 2015.

Reference Books:

1. **Current Protocols in Molecular Biology"** by Frederick M. Ausubel, Roger Brent, Robert E. Kingston, Wiley, updated periodically.
2. **Biotechnology: A Textbook of Industrial Microbiology"** by Wulf Crueger, Anneliese Crueger, 2nd Edition, Panima Publishing, 2005.

3. **Genomics: The Science and Technology Behind the Human Genome Project"** by Charles R. Cantor, Cassandra L. Smith, Wiley-Interscience, 1999.

Research and Publication Ethics

RPE100 **Credit 2**

OBJECTIVE:

This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity,
publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, hindex, Impact Factor, etc.) and plagiarism tools will be introduced in this course.

COURSE CONTENTS:

1. Pedagogy: Classroom teaching, guestlectures, group discussions, and practical sessions.
2. Evaluation: Continuous assessment will be done through tutorials, assignments, quizzes, and group
discussions. Weightage will be given for active participation. Final written examination will be conducted
at the end of the course.
3. Course structure: The course comprises of six modules listed in table below. Each module has 4-5
units.

MODULES UNIT TITLE TEACHING HOURS
Theory
RPE 01 Philosophy and Ethics 4
RPE 02 Scientific Conduct 4
RPE 03 Publication Ethics 7
Practice
RPE 04 Open Access Publishing 4
RPE 05 Publication Misconduct 4
RPE 06 Databases and Research Metrics 7
Total 30

SYLLABUS IN DETAIL

THEORY

 RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

 RPE 02: SCIENTIFICCONDUCT (5 hrs.)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

 RPE 03: PUBLICATION ETHICS (7 hrs.)

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

PRACTICE

 RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

 RPE 05: PUBLICATION MISCONDUCT (4hrs.)

(A) Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

(B) Software tools (2 hrs.):Use of plagiarism software like Tumitin, Urkund and other open source
software tools

 RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)

(A) Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

(B) Research Metrics (3 hrs.)

1. Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics