

Ph.D. Coursework Curriculum

Sl.No	Course Number	Course Name	Credits
1	Course I	Molecular and Analytical Techniques in Biotechnology	4
2	Course II	Course on Specific Topics	4
3	Course III	Research Methodology	4
4	Course IV	Research and Publication Ethics	2
5	Course V	Literature Review and Project Proposal Défense	4
	Total		18

Ph.D. Course I Paper

Title of the Paper: Molecular and Analytical Techniques in Biotechnology ((75 hrs)

Module I: Introduction to Biotechnology (10 hrs): Milestones in Biotechnology, a basic overview of biomolecules, genes, genome, cells (prokaryotes and eukaryotes), cell division, cell cycle, metabolic pathways, signaling mechanisms, the genetic flow of information, replication, mutation, repair, recombination, transcription, translation and genetics and epigenetics regulation of cellular events.

Module II: Bioinformatics (10hrs): Biological Databases, Tools for alignment and modelling, major web sources in Bioinformatics, algorithms in Bioinformatics, FASTA, BLAST, Nucleotide sequence analysis-tools and methods, prediction of gens and protein coding region, protein sequence analysis, molecular modelling and drug discovery, molecular dynamics.

Module III: Recombinant DNA Technology and Genomics (20 hrs): History, Overview on cloning, cloning vectors, DNA libraries, restriction enzymes, chromosomal location and gene copy number, phage display and gene expression, gene transfer techniques, genome editing and gene therapy, Model Organism, Transgenic plants and animals. PCR, Types of PCR, Nucleic acid sequencing, Microarray, blotting and hybridization techniques, miRNA screening, STR analysis/ mutation/polymorphisms analysis, genome-wide screening, whole-genome sequencing, DNA fingerprinting and Forensic analysis, Human genome project.

Module IV: Techniques in Biophysics and Cell Biology and Proteomics (25 hrs): Biochemical assays, Chromatographic techniques, HPLC, Spectroscopy methods, FTIR, mass spectrometry, LCMS, Structure elucidation of biomolecules, NMR, CD, X-ray diffraction methods, Animal cell culture, Flow cytometry (FRET, FRAP, FLIM), protein/enzyme engineering, Molecular visualization; Introduction to Microscopy, Principle of microscopy, components and types of microscopes and advanced microscopy techniques (immunofluorescence and live-cell imaging). Electrophoresis techniques, SDS PAGE, 2D-PAGE, isoelectric focusing, western blotting, Proteins as Biotechnology products; Protein identification (peptide mass fingerprinting and by MS/MS sequencing), isolation and purification strategies, databases and search engines in proteomics and applications of proteomics, quantitative proteomics, biomarker discovery.

Module V: Emerging concepts and challenges in Biotechnology (10 hrs): Systems Biology, ML/AI, Big Data Analysis, Biomanufacturing, combating bioterrorism, Therapeutic manufacturing, Bioprinting, Organoids, Tissue Engineering, Precision Medicine, Gene Editing, Gene Drives, mRNA Vaccines, Synthetic Biology, Cell-free Biosynthesis, Microfluidics, Biopolymers, Bioenergy, Biotechnological innovations against COVI 19 pandemic, Omics revolution (Metabolomics, Lipidomics, Metagenomics), Biologics, Biologically inspired inventions and innovations, Exobiology, Emerging challenges and finding solutions harnessing Biotechnological concepts, tools and methods.

References

1. Essential of Stem Cell Biology. (3rd Edition) By Robert Lanza and Anthony Atala, Elsevier Academic press; 2009
2. Molecular Cell Biology, Lodish, Baltimore et al., 8th edition, 2016, W.H.Freeman and Co.
3. Pelczer J. Chen ECS., Krieg NR (1986). *Microbiology*, MC Grow Hill Company.
4. Lodish, H., Berk, A, *et al.* (2016). *Molecular Cell Biology* (8thed.). W.H. Freeman.
5. Watson, J.D. (2007). *Molecular Biology of the Gene* (6thed.). Pearson.
6. Lewin, B., Goldstein, E.S., *et al.* (2014). *Genes–XI*. Jones and Bartlett Publishers
7. Wilson and Walker,(2018) Principles and Techniques of Biochemistry and Molecular Biology
8. Winnaker, E.L. (2003). *From Genes to Clones*. India. VCH Panima Educational Book Agency.
9. Karcher, S.J. (1995). *Molecular Biology-A Project Approach* (1sted.). Academic Press.
10. Primrose, S.B. (2006). *Principles of Gene manipulation and Genomics* (7thed.). Blackwell Scientific Publications.
11. Lodish, H., Berk, A, *et al.* (2016). *Molecular Cell Biology* (8thed.). W.H. Freeman.
12. Watson, J.D. (2007). *Molecular Biology of the Gene* (6thed.). Pearson.
13. Lewin, B., Goldstein, E.S., *et al.* (2014). *Genes–XI*. Jones and Bartlett Publishers.
14. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). *Molecular cloning: a laboratory manual* (No. Ed. 2). Cold spring harbor laboratory press.
15. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (1987). *Current protocols in molecular biology* New York. NY: Wiley.
16. Freshney, R. I. *Culture of animal cells, a manual of basic technique*.
17. Kumar, A., Garg, S., Garg N. (2012). *Biochemical Test, Principles and Protocols*. India: Viva books.
18. Sawhney, S. K., & Singh, R. (Eds.). (2000). *Introductory practical biochemistry*. Alpha Science Int'l Ltd.
19. Gradwohl, R. B. H., Sonnenwirth, A. C., & Jarett, L. (1980). *Gradwohl's clinical laboratory methods and diagnosis*. Mosby
20. *An Introduction to Microscopy*, By Suzanne Bell, Keith Morris, CRC Press Fournier, M. (1996).
21. *The fabric of life: Microscopy in the seventeenth century*. Johns Hopkins University Press

Course II Paper (Elective)

Students may take a minimum of one elective.

Which shall be handled by faculties in charge of each elective

Electives available (4 credits each)

Name of the Course	Name of Faculty
Microbial Genetics and Bioinformatics	Dr. Parvathi A
Microbial Biochemistry and Enzymology	Dr. Parvathi A
Next-Generation Sequencing and Data Analysis	Dr. Sayuj KP
Bioelectrochemical system	Dr. Rajesh PP
Neurobiology	Dr. Chakrapani B
Molecular and Cellular Pathology	Dr. Bhavya BC
Molecular Ecology and Evolution	Dr. Sreekanth PM
Cancer Biology	Dr. Ajith V
RNAi and Genome Editing	Dr. Sneha Y
Nanobiotechnology	Dr. Sreeja N

Title of the paper: Research Methodology

Unit I

Science and Research- definition – history – evolution of scientific enquiry – objectivity, facts, hypothesis, theory and concept

Goals of research – characteristics and purpose of research

Essential qualities of a researcher – scientific temperament and attitude

Methods of research – scientific method versus arbitrary method - logical scientific methods – deductive and inductive methods

Unit II

Various types of Research – descriptive, analytical, fundamental, applied, qualitative, quantitative, conceptual, empirical, surveys, correlations, experimental and quasi-experimental ex-post facto research, critical and action-oriented research, biographical, phenomenological, ethnographical, case studies.

Data and methods of data collection – observations, field investigations, direct studies, reports, records, experimental observations; type of data – categorical, nominal or ordinal, continuous or mixed, primary data, secondary data, limitations and precautions in data collection.

Steps in doing research: Review of literature, primary and secondary sources, national institutes useful in literature search – NISCAIR; Library resources – Journals/periodicals, reviews, abstracts, treatise, monographs, searching of web resources, electronic databases, critical review of literature, identification of research gaps, defining or selection or identification of a research topic or problem, formulation of a hypothesis, the significance of hypothesis, types of hypothesis, relevance and assumptions in research, developing a research plan, execution of research work, exploration, description, diagnosis, experimentation, meaning and nature of experimental research, treatments, variations and variables, sample populations

Unit III

General laboratory etiquette – DBT guidelines for research in Biotechnology (rDNA technology), Rules and regulations, Biosafety measures, physical and biological containment, environmental impact
Bioethical issues in rDNA research, ethics in publication, plagiarism
Intellectual property rights, rights of future generations, issues of commercialization, problems related to trade of biological items.

Unit IV

Statistical Applications in Research- Classification, tabulation and graphical representation of data, Theory of probability. Probability distributions: Binomial, Poisson, Normal distributions. Testing of hypothesis – standard deviation, standard error, confidence limits, confidence levels, Concept of sampling distribution: t, χ^2 and F distributions. Tests of significance based on normal, t, χ^2 and F distributions. Regression and correlations – parametric and non-parametric statistics.

Estimates of central tendencies –mean, median, mode and proportions, variance, variations, transforming of data, analysis of variance (ANOVA), co-efficient of variations, diagrammatic and graphical representations of statistical inference.

Use of Computers in research - Introduction to computer fundamentals, hardware, software, data entry, statistical, logical and financial functions, computer-aided graphical applications and data analysis, SPSS and M-star.

Experimental Design – different types of design, planning of an experiment and basic principles of design of experiments. Completely randomized design (CRD), Randomized complete block design (RCBD), Latin square design (LSD). Randomization procedure, analysis and interpretation of results. Sampling theory and techniques, steps in sampling, random and non-random sampling, sampling errors, Type I error, Type II error, sample size, advantages and limitations of sampling, control observations, merits and demerits.

Unit V

Scientific writing and presentation of scientific data: Research proposals, research papers, research reports, dissertation and thesis.

Style of scientific writing – structure and language, “Title” rules, preparation of “Abstracts”, “Introduction” rules. Rules for presenting “Materials and Methods”, rules for presenting “Results”, the concept of “Discussion” method of “Conclusion”, the concept of “Acknowledgement”, Reference styles, presentation of Tables and Figures, visual organization of data/observations, peer review, editing the final drafts, manuscript submission

Presentation Tools- creating and customizing presentations, oral and poster presentations, MS / open office ppt and pdf slides.

References

1. Latest Journal articles
2. Panneerselvam R (2004) Research Methodology, Prentice Hall of India, New Delhi
3. Jerrod H Z (1999) Biostatistical Analysis, Prentice-Hall International, London
4. Montgomery, Douglas C (2007) Design and analysis of experiments, Wiley India
5. Carlos CM (2001) Intellectual Property Rights, the WTO and Developing countries; The TRIPS Agreement and policy options, Zed Books, New York.
6. Wayne C Booth, Gregory G Colomb and Joseph M Williams (1995) The craft of Research. Chicago University of Chicago press
7. Campbell, R.A. 1974. Statistics for Biologists. Cambridge University Press.
8. Cochran, W.G. and Cox, G.M. 1957. Experimental Designs. John Wiley.
9. Cochran, W.G. 1959. Sampling Techniques. John Wiley