

Syllabus
Ph.D. Biotechnology
(w.e.f. 2017-18)



DEPARTMENT OF BIOTECHNOLOGY
CENTRAL UNIVERSITY OF HARYANA

SCHEME AND CURRICULUM

Semester	Core /Elective	Paper Code	Title of the Paper	Credit L-T-P
I	CC	SIAL 02 01 01 C	Research Methodology	4+0+0
	CC	SIAL 02 01 02 C	Advanced Analytical Techniques	4+0+0
	GEC			4+0+0
	Total			12

List of GEC offered in School of Interdisciplinary and Applied Life Sciences:

1. Advanced Immunology (Department of Microbiology)
2. Microbial Metabolism (Department of Microbiology)
3. Bioprocess Engineering (Department of Biotechnology)
4. Advances in Genetic Engineering (Department of Biotechnology)
5. Advances in Nutritional Genomics and Metabolomics (Department of Nutrition Biology)
6. Food and Nutrition Toxicology (Department of Nutrition Biology)

Course: Research Methodology

Course code: SIAL 02 01 01 C

Credit: 4

Unit 1. Identification and defining of the Research Problem:

Familiarization of research areas; Review of literature using appropriate resources – reviews, research papers, books and patents; Use of tools for searching literature through electronic databases; Defining a research problem.

Unit 2. Experimental Approaches and Methodology

Experimental designs to address the research problem; Pros and cons of different experimental strategies; Finalization of experimental design; Tools and techniques to execute experiments; Means to validate and analyze data; Use of statistical tools for analyzing the significance and interpretation of the data; Methods of recording observations and documentation

Unit 3. Ethics and Safety in Biological Research

Guidelines for Biosafety and Bioethics; Institutional Biosafety Committee – Handling of Genetically modified organisms, Institutional Human and Animal Ethics Committee - compliance, concerns and approval; Safety practices and disposal of Bio-waste in the laboratory; Radioactivity and safety precautions; Handling and disposal of flammable and hazardous chemicals.

Unit 4. Presentation, Publication and Protection of Research Data.

Skills for scientific writing and research presentation – Term paper, Research project, Research report, Thesis, Research article and Review; Organization of the research document in to different sections (Introduction, Methodology, Results, Discussion, and Summary and Conclusions, Bibliography); Use of electronic tools for bibliographic formatting and checking Plagiarism; Oral presentation skills; Patents and Intellectual property rights

Students are expected to undertake the following assignments, exercises for evaluation.

1. Identification and selection of the broad area of research
2. Review of literature, formulation of research plan and submission of term paper along with references
3. Oral presentation of research plan and experimental design

Evaluation will be based on term paper and oral presentation

SUGGESTED READINGS

1. Beauchamp T.L., Walters L., Kahn J.P. & Anna C. *Contemporary issues in Bioethics*. Wardsworth Publishers. Co. 2013. Print
2. Cross C.L. and Wayne W.D. *Biostatistics: Basic Concepts and Methodology for the Health Sciences*. 10th edition, Wiley. 2014. Print
3. Davis, G.B. and Straub D.W. *Writing the doctoral dissertation*. 3rd edition. Barron's Educational series. 2012. Print
4. Deepa Goel. *IPR, Biosafety and Bioethics*. 1st edition. Pearson Education. 2013. Print
5. Kothari C.K. *Research Methodology: Methods and Techniques*. 3rd edition. New Age International. 2013. Print
6. Krishnaswamy, K.N., Mathiranjana M., and Sivakumar, A.I. *Management Research Methodology; Integration of Principles, Methods and Techniques*. Pearson Education. 2011. Print
7. Kumar R. *Research Methodology: A Step-by-Step Guide for Beginners*. 2nd edition, Pearson Education. 2005. Print
8. Montgomery, Douglas C. *Design and Analysis of Experiments*. 8th edition. Wiley. 2013. Print
9. Rao S and Richard J. *Introduction to Biostatistics and Research Methods*. 5th edition. Prentice Hall India Learning Private Limited. 2012. Print
10. Gastel, Barbara, and Robert A. Day. *How to write and publish a scientific paper*. ABC-CLIO, 2016.

Course: Advanced Analytical Techniques

Course code: SIAL 02 01 02 C

Credit: 4

Unit 1. Recombinant DNA techniques and Genomics

Use of Restriction and modification enzymes in cloning; Plasmid vector; Transformation and Plasmid isolation; PCR; DNA sequencing methods (Sanger's chain termination method, and automated DNA sequencing); Next generation sequencing (NGS); Global expression profiling; Whole genome analysis of mRNA and protein expression; Real time PCR and Microarrays and their applications

Unit 2. Proteomics

UV and fluorescence spectroscopy; Circular Dichroism; Mass spectrometry - Principles and their applications; Protein separation techniques and instrumentation (Gel filtration, Ion exchange and Affinity chromatography, 1D and 2D Polyacrylamide gel electrophoresis); Immunochemical detection of proteins

Unit 3. Microbial and Cellular Techniques

Microscopic techniques; Microbial growth and kinetics (synchronous culture, continuous and batch and fed-batch cultures, chemostat and turbidostat); Methods for identifying microbes (polyphasic approach); Cell disruption and fractionation of organelles; Isolation and purification of membrane proteins; Various methods to study cell-cell and cell-virus fusion; Flow cytometry techniques; Confocal and Atomic Force Microscopy; Types of Biosafety cabinets

Unit 4. Animal Models in Biology

Handling and maintenance of animals, Ventilated cages, Different routes of injections and collection of various biological components, Formulation of feed and design of experiment

Recap Unit

Preparation of solutions; Concepts of solution strength (concentration); Sterilization of solutions; Preparation of Buffers - Concept of pKa and Henderson-Hasselbach equation; Concept of conjugate acid and base

SUGGESTED READINGS

1. Ausubel FW. *Current Protocols in Molecular Biology*. Wiley-Blackwell. 2011. Print
2. Burgess R. and Deutcher MP. *Guide to Protein Purification*. Academic Press, San Diego, USA. 2009. Print
3. Butler, M. *Animal Cell Culture & Technology*. 1st edition. Tailor & Francis Publishers (UK). 2004. Print
4. Freshney, R.I. *Culture of Animal cells: A Manual of Basic Technique and specialized applications*. 7th edition. Wiley-Blackwell. 2016. Print
5. Green M.R. and Sambrook J. *Molecular Cloning: A Laboratory Manual. Vol. I, II, III*. 4th edition. Cold spring harbor laboratory press. 2013. Print
6. Owen J.A., Punt J., Stranford S.A. *Kuby: Immunology*. 7th edition. W.H. Freeman Publishers. 2013. Print
7. Plummer D.T. *An Introduction to Practical Biochemistry*. 3rd edition. McGraw Hill Higher Education. 2001. Print
8. Razdan, M. K. *Introduction to Plant Tissue Culture*. 2nd Edition. Oxford & IBH. 2008. Print
9. Sheehan, David. *Physical Biochemistry: Principles and Applications*. 2nd edition. Wiley. 2009. Print
10. Wilson K. and Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th edition. Cambridge University Press India Pvt. Ltd. 2010. Print

Course: Bioprocess Engineering

Course code: SIAL BT 02 01 01 GEC

Credit: 4

UNIT 1.

Sterilization of air and media; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids (examples from bioprocess fluids). Types of fermentation methods.

Gas fermentation: Overview of conversion of gasified biomass and industrial gaseous into value added chemicals, Multi-stage fermentations, mixed or co-cultures or mixotrophy, thermophiles.

UNIT 2.

Designing of various types of microbial and enzyme reactors; specialized bioreactors, Function of various parts of bioreactor (impellor, sparger, baffle, O-ring etc.) Instrumentation in bioreactors. Assembly and characterization of pH/Dissolved oxygen electrodes. Scale-up concepts. Concept of limiting nutrient and its effect on fermentation process.

UNIT 3.

Separation Processes-Solvent extraction, Biphasic separation, precipitation. Membrane based processes (Micro-filtration, Reverse osmosis, Ultra filtration and affinity ultra-filtration), concentration polarization, rejection, flux expression, Membrane modules, dead-ended and cross-flow mode, and material balance.

UNIT 4.

Combinatorial engineering for metabolic intermediates, metabolic flux analysis. Emerging separation techniques: Pervaporation, Super critical extraction, Foam based separation.

Production process of shikimic acid, monoclonal antibodies, insulin, clavulanic acid, Ethanol, Asparaginase.

SUGGESTED READINGS

1. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press
2. Unit operations of Chemical Engineering 5th ed. by W L McCabe, J C Smith and P. Harriot Mc Graw-Hill (1993).
3. Bioprocess Engineering in biotechnology by Jackson, A.T., Prentice Hall, Engelwood Cliffs.
4. Principles of Fermentation Technology by Standury R.F., and Whitaker, A., Pergamon press, Oxford.

5. Downstream processing for Biotechnology, P.A. Belter, E.L. Cussler and Wei-shou Hu, Bioseparations Wiley-Interscience, 1 edition, 1988.
6. Biochemical Engineering fundamentals, 2nd ed. By J E Bailey and D F Ollis, McGraw Hill (1986)
7. Principles of fermentation technology, by P F Stanbury and A Whitaker, Pergamon press (1984)

Course: Advances in Genetic Engineering

Course code: SIAL BT 02 02 02 GEC

Credit: 4

Unit 1.

Gene expression and transcriptomics: Use of reporter genes-enzymatic and bioluminescent reporters. S1 nuclease mapping, primer extension / 5' RACE. Transcriptome analysis by differential Display-PCR, Q-PCR, EST analysis, DNA microarrays, Serial Analysis of Gene Expression (SAGE), RNA-Seq, *in-situ* hybridization.

Unit 2.

Gene Expression and Genetic Manipulation: Use of inducible bacterial promoters for expression of various proteins including toxic and membrane proteins. Expression systems in *S. cerevisiae*, *P. pastoris*, Mammalian and plant systems.

CRISPR/Cas9 and Targeted Genome Editing, Transient Gene silencing and knockout approaches (siRNA, shRNA, microRNA)

Unit 3.

Analysis of protein-DNA and protein-protein interactions: Electrophoretic mobility shift assays, DNA footprinting by DNase I and dimethyl sulphate, ChIP- chips.

Yeast two hybrid systems. Co-immunoprecipitations and pull-downs. Use of fluorescent tags for protein localization study, Phage display. Surface Plasmon Resonance (SPR), Isothermal Calorimetry

Unit 4.

Protein engineering: Concept of protein structure, conserved residues, catalytic site. Site directed mutagenesis by conventional and PCR-based methods. Cysteine and Linker scanning mutagenesis. Genome shuffling.

Recent Case studies of pharmaceutical products based on rDNA technology.

SUGGESTED READINGS

1. Molecular Biology by David P. Clarke, 2012.
2. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 2001.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2001.
4. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick, 2007.