SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of Ph.D. Degree Programme in Biotechnology (Batch-2018-19)

Credit Structure

Category	Credits
Departmental Major Subjects	6
Minor Subject	2
Total	8

Course Structure: Ph. D. Degree (2018-19)

(Departmental Major Subjects)

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	BT-601	Fermentation Products and Processes	3	0	0	3
2	BT-602	Protein Purification and Analysis	3	0	0	3
3	BT-603	Bioinstrumentation	3	0	0	3
4	BT-604	Recombinant DNA Technology	3	0	0	3
5	BT-605	Proteomics, Protein Array and Biochips	3	0	0	3
6	BT-606	Bioproducts and Bioseparation	3	0	0	3

Note: The student has to select the courses of minimum 6 credits from the department and one minor course of minimum 2 credits from any other department of the SOE/SOM in a semester as per the requirement.

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(Departmental Major Subjects)

BT-601 L-T-P-C
Fermentation Products and Processes 3-0-0-3

Objective: *This course intends to provide the knowledge of fermentation processes of various industrially important bioproducts and their related studies. This course also designed to develop research approach in the area of fermentation.*

Course Content

Fermentation process: Introduction and review of various types of fermentation processes, Screening of microbes, Fermentation Media Design Principles, Operation Modes of Fermentation Bioreactors, Plant Cell Cultures.

Citric acid fermentation: Various fermentation process used for citric acid production, Process optimization and fermentation kinetics.

Bioethanol Fermentation: Established methods of ethanol fermentation, New fermentation techniques and challenges in optimization by integration of process engineering, fermentation technology, enzyme engineering and metabolic engineering.

Streptomycin fermentation: Different fermentation processes and media used for streptomycin fermentation, effect of different fermentation parameters on fermentation process.

Enzymes production: Applications of enzymes in various industries viz. Starch Processing, Textiles, Pharmaceutical, Detergent and Leather Industries, Paper and Pulp, Food Processing, Dairy and Beverage Industry. **Lipases and Proteases fermentation**: Selection of microorganism and suitable fermentation process, kinetics of fermentation process and optimization of fermentation.

Biofuels: Biohydrogen Production, Industrial production processes, novel approaches for biohydrogen production, Biodiesel production process: Basic production process**,**

various approaches of production, designing of an experiment for process optimization: Parameters, kinetics and correlation analysis.

Text/Reference Books

1. Principles of Fermentation Technology. Stanbury PF, Whitaker A. 2nd Ed. Butterworth-Heinemann.1995.
2. Bioprocess Engineering: Basic Concepts. Shuler ML, Kargi F. 2nd Ed. Pearson Education Limited, 2014.
3. Advanced process biotechnology. Mukhopadhyay SN. Anshan, 2006.

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BT-602 L-T-P-C
Protein Purification and Analysis 3-0-0- 3

Objective: *This course is designed to learn and understand the basic principle and procedures to purify and analyze the proteins from various sources such as plants, animal and microbes. The course will cover the all the direct and indirect approaches of protein isolation and analysis right from preparing buffers and crude sample to use advanced purification techniques.*

Course Content

An Overview of protein Purification

Aims of purification-Why do it? Where to start and where to stop? Key consideration; Sources of protein; Protein structure; Key steps in purification

Extraction of Proteins

Buffers for Protein Extraction; Effect of Temperature and Concentration on pH, Volatile Buffers; Use of Protease Inhibitors in Extraction; Use of Detergents in Extraction; Extraction and Salt Precipitation; Chemical and Mechanical Lysis for Protein Extraction; Preparation of Extracts from Prokaryotes, Yeast, Plants and Membranes;

Detection and Estimation of Proteins

Ultraviolet Absorption Methods, Determination of Extinction Coefficient at 280 nm; Colorimetric Methods; Immunological detection of proteins; Fluorescent Methods; Fluorescamine Protein Assay, o-Phthalaldehyde Protein Assay, CBQCA Protein Assay, NanoOrange® Protein Assay

Electrophoretic Analyses of Proteins

Driving Force of Electrophoresis; Polyacrylamide Gel Electrophoresis; PAGE under Denaturing Conditions (SDS-PAGE), SDS-Urea PAGE, Gradient Gels, Non-Denaturing

PAGE, Tricine-PAGE, Non-Urea SDS-PAGE for Separation of Peptides, Acid Urea PAGE, CTAB PAGE; Isoelectric focusing; Two-Dimensional (2D) Gel Electrophoresis; Western Blotting; Capillary Electrophoresis

Purification of Proteins

Purification Strategy; Non-Chromatographic Purification of Proteins; Fractionation, Membrane Ultrafiltration, Differential Centrifugation, Preparative Electrophoresis, Preparative Isoelectric Focusing

Chromatographic Purification of Proteins; Gel Filtration (Size Exclusion) Chromatography, Ion-Exchange Chromatography, Chromatofocusing, Hydrophobic Interaction Chromatography, Reversed-Phase Chromatography, Affinity Chromatography, Covalent Chromatography for Thiol-Containing Substances, Hydroxyapatite Chromatography, High-Performance Liquid Chromatography

Purification of small peptides from biological sources; Isolation of gunea-pig adrenocorticotropin (ACTH) from anterior pituitary extract by sequential HPLC steps,

Integral Membrane Proteins and glycoproteins; Problems of solubilization, purification and assay of membrane proteins, Purification of recombinant G-protein coupled receptors, Structural analysis of membrane proteins, Recombinant Protein Expression and Purification, Bacterial System for Production of Heterologous Proteins, Recombinant Protein Production by Transient Gene Transfer into Mammalian Cells, Tagging for protein expression

Text/Reference Books

1. Principle and Reactions of Protein Extraction, Purification, and Characterization. Ahmed H. CRC Press LLC, 2005
2. Protein Purification Techniques: The Practical Approach. Roe S. 2nd Ed. Oxford University Press. 2004.
3. A Guide to Protein Isolation. Dennison C. 2nd Ed. Springer Science+Business Meda. 2003.
4. Basic Methods for the Biochemical Lab: Springer Labor Manual. Holtzhauer M. 1st Ed. Springer-Verlag Berlin Heidelberg, 2006
5. Protein Analysis and Purification: Benchtop Techniques. Rosenberg IM. 2nd Ed. Birkhäuser. 2005.
6. Methods in Enzymology: Guide to protein purification. Richard BR, Deutscher M. Vol. 463.2nd ed. Academic Pres. 2009.

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BT-603 L-T-P-C
Bioinstrumentation 3-0-0- 3

Objective: *Research in the area of biology and biotechnology is based on various laboratory experiments. These experiments are analytical technique based and involve the use of various instruments. To achieve the absolute goal, the exact aim and result it is very important to select the proper technique and the related instrument. The present course work is designed to impart the knowledge of principle, instrumentation, operation and their applications.*

Course Content

Instrumentation, working principle and applications of different types of spectrophotometers: UV-Vis-IR spectrophotometer, Fluorescence spectrophotometer, atomic absorption and emission spectrophotometer, Mass spectrophotometer, FTIR, NMR, ELISA plate reader.

Instrumentation, working principle and applications of DNA analysers: Real Time PCR, DNA sequencers.

Instrumentation, working principle and applications of protein analysers: Protein sequencer, Automated Peptide Synthesizer, Amino acid analyser.

Instrumentation, working principle and applications of instruments used in Imaging techniques: Confocal Laser Microscope, Scanning electron Microscope, Spinning Disc Confocal Microscope, Transmission Electron Microscope, Ultra Microtome, Upright and Inverted Microscopes, Bench top High Throughput Bioimager, Flow Cytometer, Liquid Scintillation Counter, Submicron size Analyser, X-Ray diffraction, Phospher Imager, Multi Imager, Gel Documentation systems.

Instrumentation, working principle and applications of instruments used in separation techniques: Ultra Centrifuges, High speed Centrifuges, Table Top Centrifuges, Electrophoretic units, HPLC, GC.

Text/Reference Books

1. Biophysical Chemistry: Principles and Techniques. Upadhyay A, Upadhyay K and Nath NC. 2008.
2. Vogel's Text Book of Quantitative Chemical Analysis. Mendham J, Denney RC, Barnes JD, Thomas M & Sivasankar B. 6th Ed. Pearson Education. 2009.
3. Instrumental Methods of Analysis. Willard HH, Merritt DL & Dean JRJA. CBS Publishers & Distributors. 1992.

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BT-604	L-T-P-C
Recombinant DNA Technology	3-0-0-3

Objective: *The objective of this course is to acquaint students about the basic methodology as well as current progress made in the area of recombinant DNA technology. The recombinant DNA technology has tremendous applications in health care, agriculture, industries etc. Students will be familiarizing with basic principle and current updates takes place in the field through this course.*

Course Content

The concept of recombinant DNA technology: Intoduction, history and overview.

Tools for recombinant DNA Technology: Enzymes, Cloning vectors, Competent cells, Direct & indirect methods of gene transfer, Selectable markers, Reporter genes, DNA hybridization (Southern, Northern & western), Gene transfer: Indirect methods of gene transfer (Agrobacterium mediated, Virus mediated), Methods of direct gene transfer (Biolistics, Electroporation, Microinjection, Chemical mediated, Microlaser)

Special Techniques: DNA sequencing, DNA amplification, DNA fingerprinting, RFLP, RAPD, AFLP, DNA barcoding, Site-directed mutagenesis,

Cloning strategy: Genomic DNA cloning, PCR based cloning, Cloning in *E. coli*, Cloning in *Saccharomyces cerevisiae* & fungi, Gene transfer in animals, Gene transfer in plants

Application of recombinant DNA Technology:

Theme 1-Production of useful products:

Recombinant therapeutic proteins, Transgenic animals & plants as bioreactors, Alkaloid production, Enhanced production through metabolic engineering

Theme 2- Improvement of agronomic traits:

Development of pest resistant, herbicide resistant, stress resistant varities, Edible vaccines, Antibodies.

Theme 3- Diagnosis, prevention & treatment of diseases:

Stem cells, Gene therapy, DNA vaccines, DNA microarrays,

Transgenic organisms-the current & next generation, Benefits & risks of genetically modified organisms.

Text/Reference Books

1. Molecular Biotechnology. Glick BR, Pasternack JJ. 4th Ed. ASM Press. 2010.
2. From Genes to Genomes: Concepts & Applications of DNA Technology. Dale JW, Schantz MV and Plant N. 3rd Ed. Willey-Blackwell. 2012.
3. From Genes to Clones: Introduction to Gene Technology. Winnacker EL. VCH. 1987.
4. Gene Cloning & DNA Analysis: An Introduction. Brown TA. 6th Ed. Willey-Blackwell. 2010.
5. Molecular Cloning. Sambrook J, Russel D. 3rd Ed. CSHL Press. 2001.
6. Principles of Gene Manipulation and Genomics. Primrose SB, Twyman RM. 7th Ed.Blackwell Publishing. 2006.

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BT-605 L-T-P-C
Proteomics, Protein Arrays and Biochips 3-0-0- 3

Objective: *Proteomics is an interdisciplinary science that includes biology, bioinformatics, and protein chemistry. The purpose of this course is to provide an overview of the types of questions being addressed in proteomics studies and the technologies used to address those questions. These techniques includes 2D-gel electrophoresis, mass spectrometry to identify proteins, post-translational modifications of proteins, high-throughput recombinant DNA cloning methods, large-scale protein expression, functional studies such as protein-protein interactions, protein microarrays and protein chips.*

Course Content

Introduction

Proteomics and functional genomics; Protein structure, functions and properties; protein synthesis; Protein separation techniques; Protein interactions

Protein Identification and Analysis

Protein preparation and separation; Two-dimensional gel electrophoresis, Limitations of two-dimensional gel electrophoresis, Protein fractionation prior to electrophoresis

Protein Digestion Techniques, Mass Spectrometers for Protein and Peptide Analysis, Protein Identification by Peptide Mass Fingerprinting, Protein identification by mass spectrometry; Basics of mass spectrometry analysis, Ionization of biological macromolecules

Tandem mass spectrometry, Peptide Sequence Analysis by Tandem Mass Spectrometry, Protein Identification with Tandem Mass Spectrometry Data, Multidimensional liquid chromatography and tandem mass spectrometry

Identification of post-translational modifications; Identification of phosphorylated proteins

Protein chips, arrays and functional proteomics

Different types of protein chips; Antibody arrays, Antigen arrays, Broad-specificity capture chips, Functional protein chips, Manufacture of protein chips

Detecting and quantifying proteins bound to protein chips, Emerging protein chip technologies; Bead and particle arrays in solution, Cell and tissue arrays

Applications of proteomics

Medical proteomics in disease diagnosis; Biomarkers, Biomarker discovery using 2DGE and mass spectrometry, Biomarker discovery and pattern profiling using protein chips

Pharmaceutical proteomics in drug development; The role of proteomics in target identification, Proteomics and target validation, Proteomics in the development of lead compounds, Proteomics and clinical development

Proteomics and plant biotechnology; Proteomics in plant breeding and genetics, Proteomics for the analysis of genetically modified plants, Proteomics and the analysis of secondary metabolism

Text/Reference Books

1. Introduction to Proteomics: Tools for the New Biology. Liebler DC. Humana Press Inc. 2002
2. Proteomics. Palzkill T. Kluwer Academic Publisher. 2002.
3. Principles of Proteomics: Advanced Text, by Twyman, Richard M**.,** Garland Science/BIOS Scientific Publishers, 2004.
4. Protein Arrays, Biochips, and Proteomics: The Next Phase of Genomic Discovery by Albala JS and Smith IH. Marcel Dekker. Inc. 2005.

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BT-606 L-T-P-C
Bioproducts and Bioseparation 3-0-0- 3

Objective: *This course deals with the knowledge and techniques involved in product recovery and purification processes concerning to the biomolecules of different kinds with some illustrations. This course also covers latest bioseparation techniques used in laboratory research.*

Course content

Introduction to bioproducts and bioseparations: Primary and secondary metabolites, special bioproducts eg. Recombinant DNA products. Importance of separation techniques in biotechnology, its scope from research to industry, chemical, physical and biochemical aspects of separation and isolation, purification of biomolecules.

Separation processes: Selection of appropriate bioseparation technique, chemical, physical and biochemical concepts in isolation and purification of biomolecules.

Product release: Intracellular and extracellular compounds. Mechanical and enzymatic methods of cell disruption: importance of cell disruption in product release, Cell disruption by homogenizer, Bead mill disruption, ultrasonication, Enzymatic cell lysis for product release, chemical permeabilization of cells for intracellular product release.

Concentration and separation operations: Concentration: Leaching, precipitation, crystallization, lyophilzation, drying. Chemistry of extraction, selection of solvent, use of solvent extraction in antibiotic separation, Separation: Basic separation techniques: sedimentation, centrifugation, ultracentrifugation, gradient centrifugation, membrane filtration systems, micro/ultra filtration, use of membranes (semi permeable) in purification, dialysis.

Advanced separation processes: Reverse osmosis, Chromatographic methods, paper chromatography, thin layer chromatography, gas chromatography, GLC, HPLC, affinity chromatography, ion exchange chromatography, reverse phase chromatography.

Examples of complete bioseparation process: Separation of secondary metabolites e.g. antibiotics, separation of Nucleic acids eg. DNA, RNA, plasmids and oligonucleotides form the different sources. Separation of small molecules.

Industrial and research applications with examples, Pharmaceutical applications of bioseparation

Text/Reference Books

1. Separation processes in Biotechnology. Asenjo JA. Marcel Dekker. 1990.
2. Separation and purification techniques in biotechnology, Dechow F, Noyes Publications. 1989.
3. Bioseparation: Downstream processing for Biotechnology. Belter PA & Cussler EL. Hu. Wiley. 1988.
4. Biosepration Engineering: Principles, practice and economics. Ladisch MR. Wiley. 2001.
5. Separation Process Principles. Henley EJ, Seader JD & Keith Roper D. Wiley. 2011.