BTPC3004 BIOPROCESS ENGINEERING -II (DOWNSTREAM PROCESSING) (3-0-0)

Module I: Introduction to Downstream Processing:
Overview of downstream processing in biotechnology, Importance and economics of downstream processing, Characteristics of bioproducts (proteins, enzymes, antibiotics, vaccines, metabolites), Sources of bioproducts: intracellular vs extracellular products, Process flow diagrams and integration with upstream processing

Module II: Cell Disruption and Solid–Liquid Separation
Cell harvesting methods: centrifugation, filtration, flocculation, Principles of cell disruption, Mechanical methods: homogenization, bead milling, ultrasonication, non-mechanical methods: chemical lysis, enzymatic lysis, osmotic shock, Solid–liquid separation techniques and scale-up considerations

Module III: Primary Purification Techniques
Precipitation methods (salt, solvent, pH-based), Liquid–liquid extraction, Adsorption and ion-exchange principles, Membrane separation processes: microfiltration, ultrafiltration, diafiltration, Process selection criteria for primary recovery

Module IV: Advanced Purification Techniques
Chromatography techniques: Ion-exchange chromatography, Affinity chromatography, Gel filtration (size-exclusion chromatography), Hydrophobic interaction chromatography
Electrophoretic methods, Process optimization and scale-up of chromatographic operations

Module V: Product Polishing, Formulation, and Quality Control
Final polishing steps and removal of contaminants, Concentration and drying techniques: lyophilization, spray drying, Product formulation and stabilization, Sterilization methods for bioproducts, Quality control, regulatory aspects, and Good Manufacturing Practices (GMP), Case studies on industrial downstream processing, Process modelling and simulation

Course Outcomes (COs)
After completing the course, the student will be able to:
1. Explain the fundamentals, significance, and economic aspects of downstream processing in biotechnology.
2. Apply appropriate cell harvesting and disruption techniques for recovery of bioproducts.
3. Analyze and select suitable primary purification methods for different biological products.
4. Compare and evaluate advanced purification techniques such as chromatography and membrane processes.
5. Understand product polishing, formulation, quality control, and GMP requirements in bioprocess industries.

Program Outcomes (POs)
On completion of the B.Tech Biotechnology program, graduates will be able to:
1. Apply knowledge of basic sciences and engineering principles to solve biotechnology-related problems.
2. Analyze and interpret complex biological and biochemical processes in bioprocessing industries
3. Design and evaluate bioprocesses and downstream operations considering safety, health, and environmental aspects.
4. Use modern biotechnology tools, techniques, and instrumentation effectively for experimentation and analysis.
5. Understand professional ethics, regulatory guidelines, quality control, and the need for lifelong learning.

Program Specific Outcomes (PSOs)
1. Apply principles of upstream and downstream bioprocessing for the production, recovery, and purification of bioproducts.
2. Select and operate appropriate bioprocess and downstream processing equipment for laboratory and industrial applications.
3. Analyze and optimize purification strategies for proteins, enzymes, and other biomolecules.
4. Implement quality control, GMP, and regulatory guidelines in biotechnology and biopharmaceutical industries.
5. Utilize modern biotechnology tools and analytical techniques for bioprocess development, research, and industrial problem solving.