

GUJARAT TECHNOLOGICAL UNIVERSITY

Syllabus for M.Sc. in Industrial Biotechnology, Semester - 2

Subject Name: Downstream Processing

Subject Code: 1320102

W.E.F 2021-22

1. Learning Outcomes

Learning Outcome Component	Learning Outcome (Learner will be able to)
Theoretical and practical understanding of downstream processing	<ul style="list-style-type: none">• Discuss cell separation, filtration and treatment of product by chemical, physical and biological means.• Various techniques involved in the purification process.
Give an insight in applicability of downstream processing in different fields of industry	<ul style="list-style-type: none">• Describe about recovery, extraction and purification of biosynthetic products in biotech industries.
Effective Communication	<ul style="list-style-type: none">• Communicate concepts and ideas effectively.
Professional & Ethical Behaviour	<ul style="list-style-type: none">• Transparency, honesty and ethical reasoning in handling biomolecules and product processing.

LO – PO Mapping: Correlation Levels:

1 = Slight (Low); 2 = Moderate (Medium); 3 = Substantial (High), “-”= no correlation

Sub Code: 1320102	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1:Theoretical and practical understanding of downstream processing	3	2	3	2	3	3	2
LO2:Give an insight in applicability of downstream processing in different fields of industry	3	3	3	2	2	3	2
LO3: Effective communication	2	3	2	2	3	3	2
LO4: Professional & Ethical Behaviour	2	2	3	2	3	2	3

2. Course Duration: The course duration is 45 sessions of 60 minutes each.

3. Course Contents:

Module No:	Module Content	No. of Sessions	70 Marks (External Evaluation)
1	<u>Screening and Design purification strategies</u> Overview of down-stream processing, Establishment of design space for biopharmaceutical process, High-throughput process development, Media selection in ion-exchange chromatography in single microplate,	9	10

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	high-throughput screening of dye- ligand for chromatography.		
2	<u>Low-resolution protein purification methods</u> Aqueous two phase partitioning systems, A platform for isolation of process related impurities from therapeutic proteins, Simultaneous purification refolding of protein by affinity precipitation and macro (Affinity ligand)-facilitated three-phase partitioning (MLFTPP), Co-expression and co-purification of antigen-antibody complexes in bacterial cytoplasm and periplasm, immunoglobulin purification by caprylic acid; Filtration, chromatography (comparison), rationale of choosing between quality and cost of different products.	9	14
3	<u>Protein purification and characterization</u> Introduction, initial recovery of proteins, removal of whole cells and cell debris, concentration and primary purification, protein inactivation and stabilization, protein characterization.	7	12
4	<u>Large scale protein purification</u> Some general principles, range and medical significance of impurities potentially present in protein based therapeutic products, labelling and packing of finished products.	5	8
5	<u>Animal based products</u> General DSP, Case studies of: monoclonal antibodies, Tissue plasminogen activator, insulin, erythropoietin.	5	10
6	<u>Plant based products</u> General DSP, Case studies of: shikonin, Protein extracts from Seed material and green tissues.	5	8
7	<u>Microbial based products</u>	5	8

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	General DSP, Case studies of: lipase, cellulose, amylase, horseradish peroxidase, subtilisin, ethanol, citric acid, xanthan gum.		
9	<u>Practicals</u> 1. Conventional filtration 2. Centrifugation in batch and continuous centrifuge 3. Cell disruption 4. Protein precipitation and its recovery 5. Ion-exchange chromatography 6. Membrane based filtration-ultra, filtration in cross flow modules and micro filtration 7. Adsorption process in batch and continuous mode.	-	(30 marks)

4. Pedagogy:

- ICT enabled Classroom teaching
- Practical / live assignment
- Interactive classroom discussions

5. Evaluation:

Students shall be evaluated on the following components:

	Internal Evaluation	(Internal Assessment – 20 Marks)
A	• Continuous Evaluation Component	10 marks
	• Class Presence	5 marks
	• Record maintenance	5 marks
B	Mid-Semester Examination	(Internal assessment-30 Marks)
C	End-Semester Examination	(External assessment-70 Marks)

6. Reference Books:

No	Author	Name of the Book	Publisher	Year of Publication / Edition
1	Nikolaos E. Labrou	Protein Downstream Processing: Design, Development and Application of High and Low Resolution Methods in Molecular Biology	Humana Press	Latest Edition

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2	Gary Walsh	Proteins: Biochemistry and Biotechnology	Wiley Blackwell	2 nd Edition
3	Desai, M.	Downstream Processing of Proteins: Methods and Protocols	Humana Press	Latest Edition

Note: Wherever the standard books are not available for the topic appropriate print and online resources, journals and books published by different authors may be prescribed.

7. List of Journals/Periodicals/Magazines/Newspapers / Web resources, etc

- <https://onlinelibrary.wiley.com/doi/full/10.1002/elsc.201600033>
- <https://www.sintef.no/en/expertise/sintef-industry/biotechnology-and-nanomedicine/downstream-processing-product-isolation-purificati/>
- <https://pubmed.ncbi.nlm.nih.gov/25922318/>
- https://fenix.tecnico.ulisboa.pt/downloadFile/563345090412611/Dissertacao_DSP%20viruses.pdf

Course Outcomes:

On completion of this course, students should be able to:

- Identify and design relevant unit operations for recovery of biological products