

**BITS PILANI, DUBAI CAMPUS**  
**ACADEMIC – UNDERGRADUATE STUDIES DIVISION**  
**II SEMESTER 2023-2024**

**Course Handout (Part II)**

Date: 5.2.2024

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

**Course No** : BIOT F344 (2 1 3)  
**Course Title** : Downstream Processing  
**Instructor-in-charge** : Dr. Neeru Sood /Singh  
**Instructors** : Dr. Sumitra Ramachandran

**Scope and objective of the course:**

The course introduces the various principles of bio separations for applications in bioproduct separation and purification. It is essential for process development, scale up and design for product recovery from complex cellular components. There is need to design new as well as to improve existing processes for economic and efficient process development associated with downstream processing for product isolation and purification.

**Course Pre/Co- requisite (if any) & Catalogue / Bulletin Description:** *Given in the Bulletin 2023 – 2024*

**Text Books [TB]:**

Bio separations: Downstream Processing for Biotechnology, P.A. Belter, E.L. Cussler And Wei-Houhu, Wiley Interscience Pub. (1988)

**Reference books [RB]:**

R1. Product Recovery in Bioprocess Technology – BIOTOL series, Butterworth Heinmann, 1992  
R2. R. Marshak, James T. Kadonaga, Richard R. Burgess, Mark W. Knuth, William A. Brennan, Jr. and Sue-Hua Lin, 1996, Strategies for Protein Purification and Characterization. Cold Spring Harbor Laboratory Press

**Course plan:**

Lec. No.	Learning objectives	Topics to be covered	Chapter No.
1-3	Bio separations, idealized processes	Introduction to bio separation technology, applications, principles of bio separations	1
4-6	Downstream processing for insoluble materials, cellular components	Filtration and Microfiltration, General theory of filtration, laboratory tests	2
7-9	Cell disruption techniques	Cell membranes, chemical methods, and mechanical disruption. -	4
10-12	Isolation methods, Extraction	Chemistry of extraction, batch, staged and differential extraction processes	5
13-15	Product purification, quality control	Adsorbents, kinetic analysis, scaling up chromatography	7
16-20	Bioproduct separation by precipitation techniques	Precipitation with solvents, salts, temperature, large scale precipitations	8
21-23	Product crystallization techniques, concepts	Basic concepts, batch crystallization, recrystallization	10
24-26	Biological products, drying methods	Biological products, basic concepts, drying, equipment, adiabatic and conduction drying methods	11
27-30	Final product formulation, finishing operations	Principles of lyophilization, final product formulation, quality control	11

\* The lectures may be slightly diverge from aforesaid plan based on students 'background & interest in the topic, which may perhaps include special lectures and discussions that would be planned and schedule notified accordingly.

**Laboratory Experiments:** (Lab protocols will be provided):

S. No.	Title	No. of Turns
1	Production of yeast and separation of biomass	1
2	Precipitation-ammonium sulfate precipitation	1
3	Citric acid production and purification	1
4	Extraction of value-added products from plants and analysis (lemon grass, rosemary oil, thyme, clove, tulsi, basil leaves etc)	1
5	Quality analysis of value-added products from plants and analysis with TLC (lemon grass, rosemary oil, thyme, clove, thulsi, basil leaves etc)	1
6	Production of Vinegar using Acetobacter aceti: Determination of Acetic acid content, and Yield from the Fermentation Broth	1
7	Production of glutamic acid using <i>Corynebacterium glutamicum</i>	1
8	Determination of Glutamic acid content, Yield and Partial Purification from the	1

	Fermentation Broth	
9	Production of Lactic acid using Lactococcus lactis: Determination of Lactic acid content, Yield and Partial Purification from the Fermentation Broth	1
10	Three Phase Partitioning for Purification of Zingibain, Protease	1

### **Course Learning Outcomes (CLOs)**

Upon successful completion of this course, students should be able to:

- **CLO1** Comprehend fundamental concepts and principles of downstream processing, including separation, purification, and recovery techniques for bioproducts. (knowledge)
- **CLO2** Explain the various components within bioprocess streams, including target biomolecules, contaminants, and media components. Details of cell disruption techniques, extraction methods. (Comprehension)
- **CLO3** Implement bioprocess streams using analytical techniques such as Filtration, extraction, chromatography, electrophoresis, spectroscopy, to assess product purity, yield, and quality. (Application)
- **CLO4** Describe different purification strategies and methods for isolating and purifying target biomolecules from complex mixtures, including batch and continuous processes, and the factors influencing process design and optimization (Comprehension)
- **CLO5** Analyze real-world case studies and examples of downstream processing applications in the biotechnology industry associated with scaling up downstream processing operations from laboratory to industrial scale, including considerations for equipment design, process optimization, and regulatory requirements. (Application)

### **Evaluation Scheme:**

EC No	Components	Nature of Component	Duration	Weightage%	Date & Time	Venue
1	Quiz 1	Closed book	20 minutes	8	11.03.24 (M9)	To be announced later
2	Mid Sem	Closed	90 minutes	25	01.04.24 (AN)	
3	Quiz 2	Closed book	20 minutes	7	30.04.24(T6)	
Lab Continuous Evaluation			-	15		
Comprehensive Lab Exam				15	13.05.24 (M4,5) 16.05.24 (Th3,4)	
5	Comprehensive Exam	Closed/ open book	3 hours	30	31.05.24 (FN)	

\* Only prescribed text book(s) and hand-written notes are permitted.

### **Mapping of CLOs, PLOs, and CECs**

CLOs	PLOs	Evaluation Components (ECs)				
		EC1	EC2	EC3	EC4	EC5
CLO1	1,2	✓	✓	✓		✓
CLO2	1,2	✓	✓	✓		✓
CLO3	1,2,3				✓	✓
CLO4	1,2		✓	✓		✓
CLO5	1,2,3,6			✓	✓	✓

**Assignment / Case Studies:** The Assignment will be given on either some or all of the above-mentioned topics. Case studies, interpretation of data and then analysis, will form a part of all evaluation components. Assignments(s) may include seminar presentation and viva. Details will be intimated through a separate notification or announced in the class and the deadlines would be indicated therein. However, all assignments/reports would be completed by 1<sup>st</sup> week of May, 2024. It is necessary that all students stick to time schedule and do not postpone submission of assignments/reports. This will prevent extra load during last two weeks of class work. No make-ups would be allowed for submission of assignments / practical reports.

**Reading Assignments:** Students are advised to read, collect additional information on the above-mentioned topics as per given schedule. In addition, awareness w.r.t. latest developments in the area would be an added advantage

**Mid-sem Grading:**

Mid-sem grading will be displayed after two evaluation components or earlier whenever about 40 % of evaluation components are completed.

**Note:** A student will be likely to get “NC”, if he / she doesn't appear / appear for the sake of appearing for the evaluation components / scoring zero in pre-compre total.

**Makeup and Attendance policies:**

**Make-ups** are not given as a routine. It is solely dependent upon the genuineness of the circumstances under which a student fails to appear in a scheduled evaluation component. In such circumstances, prior permission should be obtained from the Instructor-in-Charge (I/C). The decision of the I/C in the above matter will be final.

**Attendance:** Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfill all other tasks assigned to him/her in every course. A student should have a minimum of 60% of attendance in a course to be eligible to appear for the Comprehensive Examination in that course. For the students under the purview of Academic Counseling Board (ACB), the Board shall prescribe the minimum attendance requirement on a case-to-case basis. Attendance in the course will be a deciding factor in judging the seriousness of a student which may be directly / indirectly related to grading.

**General timings for consultation:**

M8 will be the chamber consultation hour; however, students can meet the concern faculty by prior appointment mutually convenient for both.

**General instructions:**

Students should come prepared for classes and carry the text book(s) or material(s) as prescribed by the Course Faculty to the class.

**Notices:**

All notices concerning the course will be displayed on the respective Notice Boards.

**Instructor-in-Charge**  
BIOT F344

**Instructors' Contact Details:**

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