



Department of Biotechnology		LP: BT18702 Rev. No: 00
B.E/ B.Tech /M.E/M.Tech : Biotechnology	Regulation: 2018A	Date: 27.06.2024
PG Specialisation : NA		
Sub. Code / Sub. Name : BT18702 & Downstream Processing		
Unit : I		

Unit Syllabus: Introduction to Downstream Processing (7 h)

Introduction to separation of biomolecules and its importance in biotechnology, Characteristics of fermentation broth and biomolecules. Cell disruption for product release - mechanical and non-mechanical methods. Pretreatment and stabilization of bioproducts.

Objective: It is intended to impart basic knowledge in the area of separation technologies for biomolecules.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Introduction to separation of biomolecules and its importance in biotechnology	T1 (2-10); R3 (1-12); T2 (3-39)	PPT & BB
2	Characteristics of fermentation broth and biomolecules	T1 (347-359)	PPT & BB
3	Cell disruption for product release and its types	T1 (77-78); R3 (13-17)	PPT & BB
4	Mechanical methods of cell disruption and problems	T1 (88-93); R3 (20 – 24); T1(94-95)	PPT & BB
5	Enzymatic methods of cell disruption and problems	T1 (84-88); R3 (18-21); T1 (94-95)	PPT & BB
6	Non-mechanical methods of cell disruption and problems	T1 (82-84); R3 (16-18); T1 (94-95)	PPT & BB
7	Pretreatment and stabilization of bioproducts	R2 (33-40); T1 (17-19); R4 (10-20)	PPT & BB

Content beyond syllabus covered (if any): Nil

*Session duration: 50 minutes; PPT – Power Point; BB – Black Board



Sub. Code / Sub. Name: **BT18702 & Downstream Processing**

Unit : **II**

Unit Syllabus : **Physical Methods of Separation (9 h)**

Unit operations for solid-liquid separation - Filtration, Centrifugation-based methods for separation of the cell organelles and biomolecules (DNA, RNA, Proteins and secondary metabolites).

Objective: Students would be able to understand workflow for the separation of DNA, RNA, proteins and secondary metabolites.

Session No *	Topics to be covered	Ref	Teaching Aids
8	Introduction to unit operations for solid-liquid separation	T1 (11-14)	PPT & BB
9	Introduction to filtration, Classifications of membrane processes; Pressure driven membrane processes	T1 (14-29); R3 (26-27); T2 (105-114)	PPT & BB
10	Continuous rotary filters, microfiltration, membrane modules	T1 (30-35); R3 (34-41); T2 (121,126)	PPT & BB
11	Problems related to rotary drum filters	T1 (42-45)	PPT & BB
12	Problems related to filtration	T1 (42-45)	PPT & BB
13	Introduction to centrifugation	T1 (47-48); R3 (42-45); T2 (142-149)	PPT & BB
14	Types of centrifuges used for separation of the cell organelles and biomolecules (DNA, RNA, Proteins and secondary metabolites)	T1 (53-61); R3 (45-49); T2 (149-153)	PPT & BB
15	Scale up of centrifugation, Centrifugal filtration	T1 (62-71); R3 (50)	PPT & BB
16	Problems related to centrifugation	T1 (73-75)	PPT & BB
Content beyond syllabus covered (if any): Nil			

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Sub. Code / Sub. Name: **BT18702 & Downstream Processing**

Unit : **III**

Unit Syllabus: **Isolation of Products (9 h)**

Liquid-liquid extraction-aqueous two-phase extraction, Membrane separation – Ultrafiltration, nanofiltration and reverse osmosis, dialysis, Precipitation of proteins by different methods.

Objective: To impart knowledge on various product isolation methods.

Session No *	Topics to be covered	Ref	Teaching Aids
17	Introduction to liquid-liquid extraction	T1 (99-108); R3 (67-71)	PPT & BB
18	Different types of extractions	T1 (99-140)	PPT & BB
19	Aqueous two-phase extraction	T1 (114-138); R3 (71-99)	Flipped Model Blended Learning
20	Introduction to membrane separation techniques – Ultrafiltration	T1 (237-249 & 39-41); R3 (100-110)	PPT & BB
21	Nanofiltration, reverse osmosis and problems	T1 (250-260); R2 (218-221); R3 (110-118); T1(269-270)	PPT & BB
22	Dialysis, Introduction to precipitation and its types	T1 (264-268); T1 (221-229); R2 (41-71); R3 (119-142)	PPT & BB
23	Protein Precipitation by salts	T1 (264-268); T1 (221-229) R2 (41-71); R3 (119-142)	PPT & BB
24	Protein Precipitation by solvent	T1 (264-268); T1 (221-229) R2 (41-71); R3 (119-142)	PPT & BB
25	Protein Precipitation using acids/bases, etc	T1 (264-268); T1 (221-229) R2 (41-71); R3 (119-142)	PPT & BB
Content beyond syllabus covered (if any): Nil			

*Session duration: 50 minutes; PPT – Power Point; BB – Black Board



Sub. Code / Sub. Name: **BT18702 & Downstream Processing**

Unit : **IV**

Unit Syllabus : **Product Purification (12 h)**

Basics of chromatography and its use in separation of biomolecules, size exclusion, ion-exchange, hydrophobic interaction, HPLC, bioaffinity, hydroxyapatite chromatographic techniques. Magnetic beads for bioseparation, Cell Sorting, Microfluidics based separation.

Objective: To understand the principles and types of various chromatography techniques for product purification.

Session No *	Topics to be covered	Ref	Teaching Aids
26	Basics of chromatography and its use in separation of biomolecules	R3 (143-167)	PPT & BB
27	Size exclusion chromatography	R3 (188-199)	Flipped Model Blended Learning
28	Ion exchange chromatography	R3 (175-187)	PPT & BB
29	Hydrophobic interaction chromatography	R3 (209-213); R1 (200-206)	PPT & BB
30	HPLC	R3 (163-166); T1 (185-209)	PPT & BB
31	Bioaffinity chromatography	R3 (214-225)	PPT & BB
32	Pseudo affinity chromatography	R3 (226-230)	PPT & BB
33	Hydroxyapatite chromatography	Journal Paper (R5)	PPT & BB
34	Magnetic beads for bioseparation	Journal Paper (R6)	PPT & BB
35	Magnetic beads for Cell Sorting	Internet Source (R7)	PPT & BB
36	Microfluidics based separation	Journal Paper (R8)	PPT & BB
37	Up scaling of chromatography	R3 (214-238)	PPT & BB

Content beyond syllabus covered (if any): Up scaling of chromatography

*Session duration: 50 minutes; PPT – Power Point; BB – Black Board



Sub. Code / Sub. Name: **BT18702 & Downstream Processing**

Unit : **V**

Unit Syllabus : **Final Product Formulation and Finishing Operations (8 h)**

Crystallization - Basic Concepts, Crystal size distributions, Batch crystallization, Recrystallization, Drying - Basic Concepts, Equipments and Lyophilization.

Objective: Students would be able to assimilate recent research findings, advancement and development in the subject.

Session No *	Topics to be covered	Ref	Teaching Aids
38	Introduction to polishing steps	T1 (271-273)	PPT & BB
39	Crystallization basic concepts, Crystal size distributions	T1 (273-283); R3 (255)	PPT & BB
40	Crystallization types and equipments, Recrystallization	T2 (273-287); T1 (284-299); T1 (299-302)	PPT & BB
41	Basics of drying, equipment and types	T1 (307-317); R3 (259); T2 (290-311); T1 (317-324)	PPT & BB
42	Adiabatic drying	T1 (334-330)	PPT & BB
43	Lyophilization	R3 (263)	PPT & BB
44	Problems in drying	T1 (332); T2 (315)	PPT & BB
45	Problems in Crystallisation	T1 (303-305)	PPT & BB

Content beyond syllabus covered (if any): Nil

*Session duration: 50 minutes; PPT – Power Point; BB – Black Board





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TEXT BOOKS

1. P.A. Belter, E.L. Cussler and Wei-Houhu – Bioseparations – Downstream Processing for Biotechnology, Wiley Interscience Pub. (1988).
2. Roger G.Harrison, Paul Todd- Bioseparations Science and Engineering, Oxford University Press, 2006.

REFERENCES

1. J.C. Janson and L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods and Applications, VCH Pub. 1989.
2. R.K. Scopes – Protein Purification – Principles and Practice, Narosa Pub., 1994.
3. B. Sivasanker –Bioseparations –Principles and Techniques, Prentice –Hall of India, 2005.
4. Jenkins R.O, “Product Recovery in Bioprocess Technology - Biotechnology” Open Learning Series, Butterworth-Heinemann, 1992.
5. Ubeira, F.M., González-Warleta, M., Martínez-Sernández, V. et al. Increased specificity of Fasciola hepatica excretory-secretory antigens combining negative selection on hydroxyapatite and salt precipitation. Sci Rep 14, 3897 (2024).
6. Banert, T., & Peuker, U. A. (2007). Synthesis of Magnetic Beads for Bio-Separation Using the Solution Method. Chemical Engineering Communications, 194(6), 707–719.
7. <https://www.stemcell.com/cell-separation/magnetic-cell-isolation>
8. Filipa A. Vicente, Igor Plazl, Sónia P. M. Ventura and Polona Žnidaršič-Plazl, Separation and purification of biomacromolecules based on microfluidics, Green Chemistry, 2020,22, 4391-4410.

	Prepared by	Approved by
Signature		
Name	Prof. E. Nakkeeran	Prof. E. Nakkeeran
Designation	Professor & Head	Professor & Head
Date	27.06.2024	27.06.2024
Remarks *: Yes		
Remarks *: Yes		

* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD