SRI VENKATESWARA COLLEGE OF ENGINEERING
(AUTONOMOUS)

COURSE DELIVERY PLAN - THEORY

Department of Biotechnology			LP: BY22202 Rev. No: 01 Date: 30.01.2025
B.E/B.Tech/M.E/**M.Tech** : **Biotechnology**		Regulation: **2022**	
PG Specialisation	: **Biotechnology**		
Sub. Code / Sub. Name	: **BY22202 & Advanced Bioseparation Technology**		
Unit	: **I - Bioseparation in Biotechnology**		

Unit Syllabus: Role and importance of bioseparation in biotechnological processes; Problems and requirements of bioproduct purification; Economics of bioseparation techniques in Biotechnology, cost-cutting strategies; Separation characteristics of proteins and enzymes – size, stability, properties; Flocculation and conditioning of broth; Process design criteria for various classes of bioproducts like high volume, low value products and low volume, high value products; Upstream production methods affecting purification strategies (9 h).

Objective: To understand the physicochemical properties of bioproducts and economics of bioseparation techniques.

Session No *	Topics to be covered	Ref	Teaching Aids
1.	Role and importance of bioseparation in biotechnological processes	T1 (1-9) T2 (1-12) T3 (277-280)	PPT & BB
2.	Need for Bioproduct purification and their commercial values	T1 (1-9) T2 (1-12) T3 (277-280)	PPT & BB
3.	Economics of bioseparation techniques in Biotechnology, Cost-cutting strategies	T2 (214-239)	PPT & BB
4.	Characteristics of biomolecules for separation process design – size, stability, properties	T1 (1-9) T2 (1-12)	PPT & BB
5.	Flocculation and conditioning of broth	R1 (14-17) T4 (17-27)	PPT & BB
6.	Process design criteria for bioproducts class - high volume, low value products	T2 (1-12) R3 (58-61)	PPT & BB
7.	Process design criteria for bioproducts class - low volume, high value products	T2 (1-12) R3 (58-61)	PPT & BB
8.	Upstream production methods affecting purification strategies-I	T4 (45-52) R2 (15-19)	PPT & BB
9.	Upstream production methods affecting purification strategies-II	T4 (45-52) R2 (15-19)	PPT & BB
Content beyond syllabus covered (if any): Nature inspired bioseparation process in human life.			

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

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Sub. Code / Sub. Name: **BY22202 & Advanced Bioseparation Technology**

Unit : **II - Cell Disruption and Solid-Liquid Separation**

Unit Syllabus : Physical, chemical, mechanical cell disruption methods for intracellular products; Removal of insoluble, biomass and particulate debris separation techniques – Filtration at constant pressure and at constant rate – Empirical equations for batch and continuous filtration – Types of filtration - Centrifugal and tangential-flow filtration – Types of filtration equipment – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applications (9 h).

Objective : To inculcate the importance of mechanical separation process for recovery of bioproducts.

Session No *	Topics to be covered	Ref	Teaching Aids
10.	Cell disruption methods for intracellular products - Physical, chemical, and mechanical.	T2 (13-25) R1 (63-67)	PPT & BB
11.	Removal of insoluble, biomass and particulate debris separation techniques	T2 (25-27) R1 (67-72)	PPT & BB
12.	Filtration at constant pressure and at constant rate	T4 (98-101) R1 (112-115)	PPT & BB
13.	Empirical equations for batch and continuous filtration	T3 (57-61) R2 (41-49)	PPT & BB
14.	Types of filtrations - Centrifugal flow filtration	T2 (50-52) R2 (49-54)	PPT & BB
15.	Types of filtrations - Tangential- flow filtration	T2 (53-57) R2 (55-59)	Flipped Model Blended Learning
16.	Types of filtration equipment – Centrifugation – Basic principles, design characteristics	T3 (77-81) R2 (60-66)	PPT & BB
17.	Types of centrifuges and applications-I	T2 (50-52) R4 (114-119)	PPT & BB
18.	Types of centrifuges and applications-II	T2 (50-52) R4 (114-119)	PPT & BB
Content beyond syllabus covered (if any): Industrial large scale filtration setup and aids			

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Sub. Code / Sub. Name: **BY22202 & Advanced Bioseparation Technology**

Unit : **III - Membrane Processes and Enrichment Operations**

Unit Syllabus : Theory, Design consideration and configuration of membrane processes – microfiltration, ultrafiltration, nanofiltration, reverse osmosis, dialysis – Structure and characteristics of membranes – Membrane modules; Enrichment Operations – Extraction – equipment for extraction – Aqueous two-phase extraction – Reverse micellar extraction – Protein precipitation – Methods of precipitation (9 h).

Objective : To provide the knowledge on bioproduct isolation process at laboratory and pilot scale.

Session No *	Topics to be covered	Ref	Teaching Aids
19.	Theory, Design consideration and configuration of membrane processes	T2 (100-107) R4 (189-192)	PPT & BB
20.	Microfiltration, ultrafiltration, nanofiltration, reverse osmosis	T2 (110-115) R2 (67-72)	PPT & BB
21.	Dialysis – Structure and characteristics of membranes – Membrane modules	T2 (116-117) R2 (72-77)	PPT & BB
22.	Enrichment Operations – Extraction – equipment for extraction	T2 (117-118) R2 (77-81)	PPT & BB
23.	Aqueous two-phase extraction	T2 (86-87) R5 (44-49)	Flipped Model Blended Learning
24.	Reverse micellar extraction	T2 (90-91) R5 (49-54)	PPT & BB
25.	Protein precipitation	T2 (119-120) R6 (54-57)	PPT & BB
26.	Methods of precipitation-I	T2 (119-142) R6 (57-66)	PPT & BB
27.	Methods of precipitation-II	T2 (119-142) R6 (57-66)	PPT & BB
Content beyond syllabus covered (if any): Nil			

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

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Sub. Code / Sub. Name: **BY22202 & Advanced Bioseparation Technology**

Unit : **IV - Modes of Chromatographic Separation**

Unit Syllabus : Chromatography – Classification of chromatographic techniques – General description of column chromatography – Chromatographic terms and parameters – Practice of chromatography – molecular sieve, ion exchange, hydrophobic, hydroxyapatite, partition, displacement, normal-phase, reversed-phase, affinity, chiral, supercritical fluid chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC (9 h).

Objective : To understand the chromatographic separation processes and its selection.

Session No *	Topics to be covered	Ref	Teaching Aids
28.	Chromatography – Classification of chromatographic techniques	T2 (143-145) R3 (14-17)	PPT & BB
29.	General description of column chromatography – Chromatographic terms and parameters	T2 (145-161) R3 (17-21)	PPT & BB
30.	Practice of chromatography – molecular sieve, ion exchange, hydrophobic, hydroxyapatite	T2 (145-161) R3 (24-27)	Flipped Model Blended Learning
31.	Practice of chromatography - partition, displacement, normal-phase, reversed-phase	R3 (27-34)	PPT & BB
32.	Practice of chromatography - affinity, chiral, supercritical fluid chromatography	R3 (34-37)	PPT & BB
33.	Practice of chromatography - supercritical fluid chromatography	R3 (37-39)	PPT & BB
34.	Scale-up of chromatography	T2 (166-167) R3 (40-42) R6 (89-93)	PPT & BB
35.	Process considerations in Preparative liquid chromatography-I	T2 (169-171) R3 (42-45)	PPT & BB
36.	Process considerations in Preparative liquid chromatography-II	T2 (169-171) R3 (42-45)	PPT & BB
Content beyond syllabus covered (if any): Nil			

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Sub. Code / Sub. Name: **BY22202 & Advanced Bioseparation Technology**

Unit : **V - Finishing Operations and Formulations**

Unit Syllabus : Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt, disc; Crystallization – Nucleation, crystal growth – Types of crystallizers – Tank, scrapped surface, Oslo, Circulating-magma evaporator; Freeze drying – Principle, process, applications – Case studies Penicillin, Cephalosporin, Recombinant Streptokinase, Interferon (9 h).

Objective : To enhance the knowledge on stabilization and formulation of biotechnology products.

Session No *	Topics to be covered	Ref	Teaching Aids
37.	Drying – Mechanism, methods and applications	T2 (259-261) R6 (112-117)	PPT & BB
38.	Types of dryers – Tray, spray, rotary, belt, disc	T2 (259-264) R6 (117-127)	Flex model Blended Learning
39.	Crystallization – Nucleation, crystal growth	T2 (255-256) R6 (127-134)	PPT & BB
40.	Types of crystallizers – Tank, scrapped surface, Oslo, Circulating-magma evaporator	T2 (256-258) R6 (134-138)	PPT & BB
41.	Freeze drying – Principle, process, applications	T2 (259-263) R6 (138-142)	PPT & BB
42.	Case studies Penicillin	Journal Papers (R7)	PPT & BB
43.	Case studies Cephalosporin	Journal Papers (R8)	PPT & BB
44.	Case studies Recombinant Streptokinase	Journal Papers (R9)	PPT & BB
45.	Case studies Interferon	Journal Papers (R10)	PPT & BB
Content beyond syllabus covered (if any): Purification of pigments.			

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

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Text Books

1. Belter, P.A., Gussler, E.L. and Hu, W.S., "Bio-separation: Downstream Processing for Biotechnology", John Wiley and Sons, 2011.
2. Sivasankar, B., Bioseparations: Principles and Techniques, Prentice-Hall, 2005.
3. Roger, H., "Bio-separations Science and Engineering", Oxford University Press, 2006.
4. Forciniti, D., "Industrial Bio-separation: Principles & Practice", Blackwell, 2008.

Reference Books

1. Ladisch, M.R., "Bioseparations Engineering: Principles, Practice, and Economics", John Wiley & Sons, 2001.
2. Ghosh, R., "Principles of Bio-separations Engineering", World Scientific Publishers, 2006.
3. Carta, G and Jungbauer, A., "Protein Chromatography", Wiley-VCH, 2010.
4. Stanbury, P.F., Whitaker, A. and Stephen J.H., Principles of Fermentation Technology, Aditya Books, 1997.
5. Scopes R.K. – Protein Purification – Principles and Practice, Narosa, 1994.
6. Janson J.C, & Ryden L. Protein Purification: Principles, High Resolution Methods and Applications, VCH Pub., 1989.
7. Mehran Javanbakht, Khatereh Ali Pishro, Amir Heidari Nasab, Behrouz Akbari-adergani, Extraction and purification of penicillin G from fermentation broth by water-compatible molecularly imprinted polymers, Materials Science and Engineering: C, Volume 32, Issue 8, 2012, Pages 2367-2373.
8. Fereshteh Moradi, Javad Rahbar Shahrouzi, Phase equilibrium and partitioning of cephalosporins (cephalexin, cefazolin, cefixime) in aqueous two-phase systems based on carbohydrates (glucose, fructose, sucrose, maltose) / acetonitrile, Fluid Phase Equilibria, Volume 507, 2020, 112388.
9. Ehab El-Dabaa, Hend Okasha, Safia Samir, Sami Mohamed Nasr, Hadeer Adel El-Kalamawy, Mohamed Ali Saber, Optimization of high expression and purification of recombinant streptokinase and in vitro evaluation of its thrombolytic activity, Arabian Journal of Chemistry, Volume 15, Issue 5, 2022, 103799.
10. Fakiha Bajwa, Nadeem Ahmed, Mohsin Ahmad Khan, Farhana Azam, Muhammad Akram, Saad Tahir, Ahmad Usman Zafar, Evaluating the ion exchange chromatography for matrix-assisted PEGylation and purification of consensus interferon, Volume 67, Issue 2, March/April 2020, Pages 196-205.

	Prepared by	Approved by
Signature	30/1/25 30/1/25	30/1/25
Name	Prof. E. Nakkeeran & Dr M Nareshkumar	Prof. E. Nakkeeran
Designation	Professor	Professor & Head
Date	30.01.2025	30.01.2025
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