



Department of Biotechnology	LP: BT 22025 Rev. No: 00 Date:8.07.2024
B.E/B.Tech/M.E/M.Tech : Biotechnology PG Specialisation : NA Sub. Code / Sub. Name: BT22025/ Bioreactor Considerations for Recombinant Products Unit : I	Regulation: 2022

## UNIT I GENETICALLY ENGINEERED ORGANISMS AND SAFETY

9

Different host vector systems, Guidelines for choosing Host Vector systems, Process constraints – Genetic instability, considerations in plasmid design, Regulatory constraints, principles and implementation of containment, good industrial large-scale practice (GILSP). Application of rDNA organism in the environment, Interactions with species or biological systems, effects on the environment, evaluating environmental risks of rDNA organisms released from industrial applications.

OBJECTIVE: To understand the diversity of host-vector systems and their suitability for various genetic engineering applications.

Session No *	Topics to be covered	Ref	Teaching Aids
1.	Different host-vector systems, Guidelines for choosing Host Vector systems	TB2, Pg: 340-357	BB/LCD
2.	Process constraints	TB1, Pg: 433-434	BB/LCD
3.	Genetic instability, considerations in plasmid design	TB1, Pg: 434-435	BB/LCD
4.	Regulatory constraints	TB1, Pg: 435-437 JR: 1	BB/LCD
5.	Principles and implementation of containment	TB1, Pg: 435-437	BB/LCD
6.	Good industrial large-scale practice (GILSP)	TB1, Pg: 435-437 JR: 2	BB/LCD
7.	Application of rDNA organism in the environment	TB2, Pg: 340-357 JR: 3	BB/LCD
8.	Interactions with species or biological systems, effects on the environment	TB2, Pg: 340-357	BB/LCD
9.	Evaluating environmental risks of rDNA organisms released from industrial applications.	WL:1	BB/LCD
Content beyond syllabus covered (if any):-			

\* Session duration: 50 minutes



Sub. Code / Sub. Name : BT22025/ Bioreactor Considerations for Recombinant Products  
Unit : II

**UNIT II BIOREACTORS FOR ANIMAL CELL CULTURES**

9

Structure and biochemistry of animal cells - Traditional methods used for the cultivation of animal cells - Bioreactor considerations for recombinant animal cell culture systems - Products of animal cell cultures, economics of animal cell tissue cultures.

**OBJECTIVE:** To understand the methods employed for the cultivation of animal cells, encompassing cell isolation, culture maintenance, and scale-up techniques.

Session No *	Topics to be covered	Ref	Teaching Aids
10.	Animal Cell Cultures- overview	TB1, Pg: 396	BB/LCD
11.	Structure of animal cells	TB1, Pg: 385	BB/LCD
12.	Biochemistry of animal cells	TB1, Pg: 385	BB/LCD
13.	Traditional methods used for the cultivation of animal cells	TB4, Pg: 125-140	BB/LCD
14.	Traditional methods used for the cultivation of animal cells	TB4, Pg: 125-140	BB/LCD
15.	Bioreactor considerations for recombinant animal cell culture systems	TB1, Pg: 396-400	BB/LCD
16.	Bioreactor considerations for recombinant animal cell culture systems	TB1, Pg: 396-400	BB/LCD
17.	Products of animal cell cultures	TB1, Pg: 400-402	Video lecture
18.	Products of animal cell cultures	TB1, Pg: 400-402	BB/LCD
19.	Economics of animal cell tissue cultures	WL:2	BB/LCD

Content beyond syllabus covered (if any):

\* Session duration: 50 mins



Sub. Code / Sub. Name : BT22025/ Bioreactor Considerations for Recombinant Products  
Unit : III

## UNIT III

## BIOREACTORS FOR PLANT CELL CULTURES

9

Overview of plant cell cultures - Plant cells in culture compared to microbes - Bioreactor considerations for recombinant plant cell culture systems- Bioreactors for suspension cultures - Reactors using cell immobilization - Bioreactors for organized tissues, economics of plant cell tissue cultures.

**OBJECTIVE:** To gain insight into plant cell culture techniques for recombinant product expression.

Session No *	Topics to be covered	Ref	Teaching Aids
20.	Overview of plant cell cultures	TB3, Pg: 35-40	BB/LCD
21.	Plant cells in culture compared to microbes	TB1, Pg: 405-407	BB/LCD
22.	Traditional methods used for the cultivation of plant cells	TB3, Pg: 43-45	BB/LCD
23.	Bioreactor considerations for recombinant plant cell culture systems	TB1, Pg: 411-414	BB/LCD
24.	Bioreactors for suspension cultures	TB1, Pg: 411-412	BB/LCD
25.	Reactors using cell immobilization	TB1, Pg: 412-413	Video lecture
26.	Bioreactors for organized tissues	TB1, Pg: 413-414	BB/LCD
27.	Economics of plant cell tissue cultures.	TB1, Pg: 417	BB/LCD

Content beyond syllabus covered (if any):-

\* Session duration: 50 mins



Sub. Code / Sub. Name : BT22025/ Bioreactor Considerations for Recombinant Products  
Unit : IV

## UNIT IV

## BIOREACTOR PERFORMANCE

10

Types of Bioreactors: Stirred-tank bioreactors, Air-lift bioreactors, Perfusion bioreactors, Microcarrier bioreactors, Hollow fiber bioreactors, single-use bioreactors, polybag bioreactors, controlled, Controlled environment bioreactors. Strategies for maximizing product yield, Metabolic engineering approaches, Advances in bioreactor technology, Integration of omics data in bioprocess optimization.

**OBJECTIVE:** To gain comprehensive knowledge of various types of bioreactors their working principles and design considerations.

Session No *	Topics to be covered	Ref	Teaching Aids
28.	Types of Bioreactors, Stirred-tank bioreactors	TB2, Pg: 411-414	BB/LCD
29.	Air-lift bioreactors, Perfusion bioreactors,	RB2,Pg:42-45, WL:3	BB/LCD
30.	Microcarrier bioreactors, Hollow fiber bioreactors	RB2,Pg:45-47 WL:4	BB/LCD
31.	Single-use bioreactors, polybag bioreactors	WL:4	BB/LCD
32.	Controlled environment bioreactors	JR4	BB/LCD
33.	Strategies for maximizing product yield	TB2, Pg: 277-297	BB/LCD
34.	Metabolic engineering approaches	RB3: Pg: 7-36	BB/LCD
35.	Advances in bioreactor technology	WL:5	BB/LCD
36.	Integration of omics data in bioprocess optimization.	JR5	BB/LCD
Content beyond syllabus covered (if any): -			

\* Session duration: 50 mins



Sub. Code / Sub. Name : **BT22025/ Bioreactor Considerations for Recombinant Products**  
Unit : V

**UNIT V DOWNSTREAM PROCESSING CONSIDERATIONS 9**

Release of protein from Biological Host, genetic approaches to facilitate protein purification, Solid Liquid separation, extraction of Recombinant protein, Avoidance of proteolysis from extracts, membranes for protein isolation and purification, Chromatographic techniques, Removal of detergent from protein fractions, precipitation of proteins, protein crystallization for large scale bioseparation.

**OBJECTIVE:** To understand the challenges and opportunities associated with recombinant product purification ..

Session No *	Topics to be covered	Ref	Teaching Aids
37.	Release of protein from Biological Host	TB2: Pg: 722-735	BB/LCD
38.	Genetic approaches to facilitate protein purification	TB5: Pg: 115-129	BB/LCD
39.	Solid Liquid separation	TB1: Pg: 331-340	BB/LCD
40.	Extraction of Recombinant protein	RB1: Pg: 29-35	BB/LCD
41.	Avoidance of proteolysis from extracts, membranes for protein isolation and purification	JR6	BB/LCD
42.	Chromatographic techniques	TB2: Pg: 754-765	BB/LCD
43.	Removal of detergent from protein fractions	RB1: Pg: 29-35 JR7	BB/LCD
44.	Precipitation of proteins	TB2: Pg: 744-751	BB/LCD
45.	Protein crystallization for large scale bioseparation.	TB1: Pg: 378	BB/LCD

Content beyond syllabus covered (if any): -

\* Session duration: 50 mins



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**TEXTBOOKS:**

1. Shuler, M.L., Kargi, F., De Lisa, M. Bioprocess Engineering, 3rd Edition, Prentice Hall, 2017.
2. Bailey, J.A., Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill, 2010.
3. Slater, A., Scott, N., Fowler, M. Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press, 2008.
4. Portner, R., Barradas, O.B.J.P. Animal Cell Biotechnology: Methods and Protocols, 2nd Edition, Humana, 2007.
5. Zhang, W., & Liu, J. (Eds.) Recombinant Enzymes - From Basic Science to Commercialization. Springer, 2017.

**REFERENCE BOOKS:**

1. Cutler, P. ed., "Protein Purification Protocols", Vol. 244, Springer Science & Business Media, 2004.
2. Perry, R. H., "Perry's Chemical Engineers' Handbook", 8th Edition, McGraw-Hill, 2008.
3. Villadsen, J., Michelsen, M. L., & Nielsen, J. Bioreaction Engineering Principles, 3rd ed. Springer, 2011.
4. Gomes, A. M., & Ferreira, A. P. (Eds.). Biopharmaceutical Production Technology, Vol. 1, CRC Press, 2013.

**JOURNAL REFERENCE:**

- JR1: Cripps, Y. (1981). A Legal Perspective On The Control Of The Technology Of Genetic Engineering. The Modern Law Review, 44(4), 369–387.
- JR2: Junker, B. H. (2009). Good Manufacturing Practice (GMP) and Good Industrial Large Scale Practice (GLSP). Encyclopedia of Industrial Biotechnology.
- JR3: Glick, B.R. and Skof, Y.C., 1986. Environmental implications of recombinant DNA technology. Biotechnology advances, 4(2), pp.261-277.
- JR4: Singh, J., Kaushik, N. and Biswas, S., 2014. Bioreactors–technology & design analysis. The scitech journal, 1(6), pp.28-36.
- JR5: Wan S, Liu X, Sun W, Lv B, Li C. Current advances for omics-guided process optimization of microbial manufacturing. Bioresour Bioprocess. 2023 Apr 30;10(1):30.
- JR6: Ryan BJ, Henahan GT. Avoiding Proteolysis During Protein Purification. Methods Mol Biol. 2017;1485:53-69.
- JR7: Ohlendieck, K. (n.d.). Removal of Detergent From Protein Fractions. Protein Purification Protocols, 295–300.

**WEB REFERENCE LINKS:**

WL1:[https://dbtindia.gov.in/sites/default/files/uploadfiles/Regulations\\_%26\\_Guidelines\\_for\\_Reocminant\\_DNA\\_Research\\_and\\_Biocontainment%2C2017.pdf](https://dbtindia.gov.in/sites/default/files/uploadfiles/Regulations_%26_Guidelines_for_Reocminant_DNA_Research_and_Biocontainment%2C2017.pdf)

WL2: [https://www-pub.iaea.org/mtcd/publications/pdf/te\\_1384\\_web.pdf](https://www-pub.iaea.org/mtcd/publications/pdf/te_1384_web.pdf)

WL3:<https://assets.thermofisher.com/TFS-Assets/BPD/brochures/perfusion-overview-ebook.pdf>

WL4: <https://www.bioprocessintl.com/single-use/single-use-bioreactors-and-microcarriers>

WL5:<http://nuristianah.lecture.ub.ac.id/files/2017/05/advancesinthedesignofbioreactorsystems.pdf>



## SRI VENKATESWARA COLLEGE OF ENGINEERING

## COURSE DELIVERY PLAN - THEORY

	Prepared by	Approved by
Signature		
Name	Dr. V. Sumitha	Prof. E. Nakkeeran
Designation	Professor	Professor & HOD
Date	8.07.2024	8.07.2024
Remarks *:	The Same lesson plan will be followed in the subsequent year	
Remarks *:	-	

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