BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
FIRST SEMESTER 2021-22

Dated: 21.08.21

Course Handout Part II

Course No. : BIO G513
Course Title : Microbial & Fermentation Technology
Instructor In-charge : JAYATI RAY DUTTA
Instructors : Pranay A. M., Hemanjali M. & Kalyani Sakhare

1. Course Description: Metabolic Stoichiometry- energetics, fundamentals of microbes and their morphology, Stoichiometry of cell growth and product formation, fermentation kinetics, phases of growth in batch culture, continuous culture and fed-batch cultures, kinetics of cell growth, product formation and substrate utilization-substrate and product inhibition kinetics, enzyme technology. Industrial Biotechnology- strain selection and improvement, media formulation and sterilization strategies, industrial applications, fermentation and product recovery, preparation of alcohols, antibiotics, organic acids, enzymes, bakery and dairy products, biopharmaceuticals, vaccine production..

2. Scope & Objective of the Course:
The course introduces and delineates various aspects of pure and applied microbiology. It mainly dwells upon the basic principles of Fermentation Technology and Downstream Processing, which involve various strategies for strain selection and improvement, media formulation, sterilization, inoculum development, various fermenter configurations and modes of operation, cell harvesting and product recovery, kinetics of growth and enzyme catalyzed reactions. The course also focuses on implications of r-DNA technology and the industrial applications of bioprocesses (Industrial Biotechnology) for the commercial manufacture of value-added biotechnological products like solvents, organic acids, antibiotics, enzymes, biopharmaceuticals etc.

3. Text Book (TB):
"Fermentation Microbiology and Biotechnology" Edited by E.M.T El-Mansi, C.F.A. Bryce, A.L. Demain & A.R. Allman, 3rd edition, (2012), Taylor and Francis Grp., London.

4. Reference Book (RB):
1. "Principles of Fermentation Technology" by Stanbury, Whitaker & Hall, Aditya Books (P) Ltd., New Delhi, IChemE, 3rd edition, (2017).
2. 'Bioprocess Engineering: Basic Concepts' by Michael L. Shuler & F. Kargi, 2nd edition, (2007), Prentice-Hall.
3. "Biotechnology: A Text Book of Industrial Microbiology" 2nd Edition, by W. Crueger & A. Crueger (2005) Panima Publishing Corporation, New Delhi/Bangalore.

5. Course Plan:

Lec. No.	Learning Objectives	Topic to be covered	Ref. to Chapters
1	**General Introduction**	Introduction to the course & chronological development of Biotechnology	**Chap 1** (**TB, RB I**)
2. **3.** **4.**	**Introduction to Applied Enzyme Catalysis**	Biocatalysis; comparison with synthetic catalysts, Mechanisms, Michaelis-Menten Model for Saturation kinetics. Enzyme Immobilization.	**Chap 12 (TB)** **Chap 3 (RB II)**
5. **6.**	**Media Formulation & Preparation**	Complex and synthetic media, Selection of components, buffers, precursors, pH adjustment	**Chap 4 (RB I)**
7. **8.**	**Media/Air sterilization And Death Kinetics**	Media & Air: Batch & Continuous In-situ sterilization in fermenter	**Chap 5 (RB I)**
9. **10.** **11.**	**Isolation, selection and improvement of Industrial cultures**	Enrichment culture, Screening Methods, Culture preservation, Strain improvement**:** Mutagenesis, Protoplast fusion and r-DNA technology.	**Chap 2, 3 (RB I)**
12. **13.** **14.** **15.**	**Inocula Development & Fermentation: Microbial Growth & Product Formation**	Aseptic culture transfer & incubation, inoculum age/size, studies on growth kinetics in batch, continuous & fed-batch cultures, Applications. Primary & Secondary metabolism and important biotechnological products and implications.	**Chap 2, 5** (**TB**) **Chap 5, 6 (RB I)**

16. 17. 18. 19. 20. 21. 22.	**Fermenters: Configurations & Modes of Operation**	Ideal bioreactors, Various configurations, Mechanical construction**:** various parts & accessories, Introduction to Mass & Heat Transfer: Agitation and aeration, Modes of Reactor Operations. Instrumentation and control of bioprocesses, Demonstration of various parts with the Laboratory Fermenter.	**Chap 15 (TB) Chap 7 (RB I)**
23. 24. 25. 26. 27. 28. 29.	**Downstream processing Basic Concepts on Product Recovery & Purification**	**Basic principles** of Cell Separation: Filtration and Centrifugation etc. and Cell disruption – Mechanical & Non-mechanical methods. **Fundamentals** of Cell and Filtrate Processing**:** Precipitation, Centrifugation, Filtration, Dialysis, Reverse osmosis, Chromatography, Drying, Crystallization and Product Formulation	**Chap 10 (RB I) Chap 11 (RB II)**
30. 31. 32. 33. 34. 35. 36. 37. 38.	**Industrial Biotechnology Illustrations of industrial Processes: Fermentation & Product recovery steps - with some suitable Examples using process flow chart diagrams.**	Details of the process, parameters and materials for the industrial manufacture of Antibiotics (β-lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.) Microbial Transformations, Microbial leaching.	**Chap 8, 9, 11, 13 15, 16, 18 (RB III)**
39. 40.	**Medical applications of Bioprocess engineering**	Tissue engineering, Heterologous/Therapeutic proteins.	**Chap 12 (RB I) Chap 15 (RB II)**

List of experiments:

a) To demonstrate the microbial fermentation of carbohydrates.
b) To demonstrate the liberation of ammonia from nitrogenous organic compounds.
c) To demonstrate the conversion of ammonia to nitrates by soil microorganisms.
d) To demonstrate the reduction of nitrate into gaseous nitrogen (denitrification).
e) To demonstrate the toxicity of heavy metals to bacteria.
f) To estimate the amount of indole acetic acid (IAA) in a given culture broth.
g) Estimation of L – proline in a culture filtrate of *E. coli.*
h) Bactericidal activity of drug compounds.
i) Antibiofilm study of drug compounds.
j) Antioxidant study of drug compounds.

7. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weightage (%)	Date, Time & Venue	Remarks
1.	Mid-semester	90 min	30		OB
2.	Lab practical (Evaluation components include: i. Lab quiz + attendance ii. Comprehensive quiz		20		OB
3.	Presentations/assignments		15		OB
4.	Comprehensive	120 min	35	13/12 AN	OB

8. Chamber consultation hour: To be announced in the class.
9. Notices: All notices will be displayed on Course management system.
10. Make-up policy: Make-up decisions will be considered for only genuine cases and validated by proper evidence of illness. No make-up for Lab component and assignments.
Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge
BIO G513