**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

**FIRST SEMESTER 2022-23**

Dated: 30.08.22

**Course Handout Part II**

**Course No. :BIO G513**

**Course Title :Microbial & Fermentation Technology**

**Instructor In-charge : JAYATI RAY DUTTA**

**Instructors: Jayati Ray Dutta, Abhirami&Hemanjali**

**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.

**1.Course Description**:Fermentation Technology and Downstream Processing, Fermenter configurations and modes of operation,Enzyme catalyzed reactions,Industrial Biotechnology and Commercial manufacture of value-added biotechnological products.

**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,thekinetics of growth and enzyme-catalyzed reactions. The course also focuses on the implications of rDNA 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.CoursePlan:**

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| --- | --- | --- | --- |
| **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**) |
| **2-4** | **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 fermentor | **Chap 5 (RB I)** |
| **9-11** | **Isolation, selection,& improvement of industrial cultures** | Enrichment culture, Screening methods, Culture preservation, Strain improvement**:** Mutagenesis, &rDNA technology. | **Chap 2,3(RBI)** |
| **12-16** | **Inoculum 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 & important biotechnological products & implications. | **Chap 2, 5** (**TB**)  Chap 5, 6 (RB I) |
| **17-23** | **Fermenters: Configurations &modes of operation** | Ideal bioreactors, Various configurations, Mechanical construction**:** various parts & accessories, agitation and aeration, modes of reactor operations. | Chap 15 (TB)  **Chap7 (RBI)** |
| **24-30** | Downstream processing:  **Basic concepts on**  **product recovery & purification** | **Basic principles** ofCell separation: Filtration and centrifugation etc. &  Cell disruption – Mechanical & non-mechanical methods.  **Fundamentals** of Cell & filtrate processing**:** Precipitation, centrifugation, filtration, dialysis, reverse osmosis, chromatography, drying, crystallization & product formulation | Chap 10 (RB I)  Chap 11 (RB II) |
| **31-39** | Industrial Biotechnology: **Illustrations of industrial processes: Fermentation &product recovery steps - with some suitable examples.** | Details of the process, parameters & materials  for the industrial manufacture of antibiotics (β-lactum), solvents, amino acid, organic acids (Citric acid), alcohols (Ethanol), industrial enzymes (Protease/Amylase) & biopharmaceuticals (Insulin/Interferon), microbial transformations& leaching. | **Chap 8,9,11,13 15, 16, 18 (RB III)** |
| **40-41** | **Medical applications of Bioprocess engineering** | Tissue engineering, Heterologous/Therapeutic proteins. | **Chap 12 (RB I)**  **Chap 15 (RB II)** |

**List of experiments:**

1. Carbohydrate fermentation test
2. Demonstration of ammonification
3. Demonstration of nitrification
4. Demonstration of denitrification
5. Demonstration of the oligodynamic effect of metals
6. Estimation of Indole acetic acid in a culture broth
7. Estimation of L – proline in a culture filtrate of*E. coli*

**7. Evaluation Scheme:**

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| --- | --- | --- | --- | --- | --- |
| **EC No.** | **Evaluation Component** | **Duration** | **Weightage (%)** | **Date, Time & Venue** | **Remarks** |
| 1. | Mid-semester | 90 min | 25 | 01/11 9.00 - 10.30AM | CB |
| 2. | Lab practical (Evaluation components include:  **i.**Lab quiz based on experiments conducted during class + Attendance  **ii.**Comprehensive quiz |  | 20 |  | OB |
| 3. | Presentations/assignments |  | 20 |  | OB |
| 4. | Comprehensive | 3hours | 35 | 20/12 FN | CB |

**8. Chamber consultation hour**: To be announced in the class.

**9. Notices:** All notices will be displayed onthe 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 components 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**