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**SECOND SEMESTER 2023-2024**

# Course Handout Part II

Date: 09-01-2024

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

*Course No.* : BIO F451

## Course Title : **BIOPROCESS TECHNOLOGY**

## Instructor-in-Charge : Jayati Ray Dutta

*Co-instructor* : Supratim Ghosh

**Course Description:**

The course introduces various principles of bioprocess technology, fermentation process parameters & controls, bioprocess principles, kinetics of biomass production, substrate utilization, product formation, kinetics of enzyme catalyzed reactions and applied enzyme catalysis, bioreactor design & operation, transport processes in bioreactors; novel bioreactor configurations; immobilized biocatalysts; bioconversion, bio-separations for applications in bio-product separation & purification. It is essential for process development, scale up and design for product recovery from complex cellular components. There is need to design new as well as to improve existing processes for economic and efficient process development associated with upstream and downstream processing for product isolation and purification, industrial applications of bioprocesses and bioprocess patenting & economics.

**Scope and Objective of the Course:**

Being an elective course for the first-degree students, the course exposes the students to those foundational aspects as described above. At the end of the course, the student will have developed a basic understanding of the kinetics of biomass production, upstream & downstream processing, bioconversion and industrial applications of bioprocesses.

**Textbooks:**

1. Principles of Fermentation Technology by Stanbury, Whitaker & Hall, (1997) Aditya Books (P) Ltd., IChemE, 3rd edition, copyright 2017.

**Reference books**

1. **RB1:** Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, John S. Rockey and Gary Higton. Blackwell Publishing, 2001.
2. **RB2:** Product Recovery in Bioprocess Technology – BIOTOL series, Butterworth Heinmann, 1992.
3. **RB3:** Basic Biotechnology by Colin Ratledge, Bjorn Kristiansen (2006), Cambridge University Press.
4. **RB4:** Bioprocess Engineering: Basic Concepts, Michael L. Shuler and Fikret Kargi, 2nd Edition, Prentice Hall PHI, 2007.
5. **RB5:** Practical Fermentation Technology Brian McNeil & Linda M. Harvey John Wiley and Sons 2008.

**Course Plan:**

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| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-3 | Introduction to Fermentation technology | Overview of the course; range of fermentation processes; mass and energy balances; stoichiometry; microbial biomass & growth; nutritional requirements | 1 (TB); 2, (RB1) |
| 4-8 | Microbial growth kinetics | Batch culture; continuous culture; Fed-batch culture; effects of culture parameters on microbial growth, kinetics of biomass production, substrate utilization and product formation. | 2 (TB); 2 (RB1) |
| 9-13 | Microbial fermentation parameters and controls | Solid state & submerged fermentation, industrial microbes; isolation & selection methods, media formulation; optimization of process parameters; carbon, nitrogen sources, addition of precursors & metabolic regulators to media, antifoam, pH & oxygen requirements | 3, 4 (TB); 4, 5, 6 (RB1) |
| 14-17 | Bioreactor/Fermenter design and operation | Design & configuration; control systems & transport processes in bioreactor; optimization & kinetics of enzyme catalysed reactions; immobilized enzyme/biocatalyst technology and applied enzyme catalysis. | 7, 8 (TB); 7, 24 (RB3), 2 RB5 |
| 18-21 | Product recovery & purification methods | Upstream and Downstream processing & challenges; cell disruption; chemical methods | 10 (TB); 7 (RB1); 9 (RB3) |
| 22-24 | Product development | Development; regulation; safety measures | 8 (RB1); |
| 25-27 | Industrial applications of bioprocesses & products | Industrial chemicals, fuels, bioconversion methods, microbial polysaccharides, health care products | 10, 11 (RB1); 16 (RB3) |
| 28-30 | Bioprocess applications in beverage & food industries | Alcoholic beverages, beer brewing, wine fermentation, Vinegar fermentation, dairy fermentations, cheese, food additives & supplements | 12. 13 (RB1) |
| 31-33 | Bioprocess applications of high-value proteins | Analytical enzymes, Therapeutic proteins, regulatory aspects | 21 (RB3) |
| 34-37 | Medical applications of Bioprocess engineering | Tissue-engineered skin replacements, Chondrocyte culture for cartilage replacement | 15 (RB4) |
| 38-40 | Bioprocess economics, safety, feasibility, patenting | Overall production process, fermentation steps, downstream processing steps, capital  costs, operating costs, the economic case for investment; IPR related issues | 11 (RB3); 12 (TB) |

**Evaluation Scheme:**

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| **Component** | **Duration** | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Assignment/Quiz |  | 20% (40 M) |  | OB |
| Mid-semester Examination | 90 min | 25% (50 M) | 14/03 - 2.00 - 3.30PM | CB |
| Assignment/Quiz |  | 20% (40 M) |  | OB |
| Comprehensive Examination | 180 min | 35% (70 M) | 15/05 FN | CB |

**Chamber Consultation Hour:** To be announced in the class.

**Notices:** All notices will be displayed in the Course Management System.

**Make-up Policy:** Make-up decisions will be made on a case-by-case basis and only genuine cases as determined by the team and validated by Wardens and/or Medical Officers will be considered.

**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 F451**