GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 8
Subject Name: Fermentation Technology
Subject Code: 1380401

Prerequisite: Candidates enrolling in the Integrated MSc in Industrial Biotechnology program, which includes a compulsory course in Fermentation Technology, should have a solid foundation in microbiology, biochemistry, and chemical engineering principles.

Rationale: Integrating a compulsory course in Fermentation Technology into the MSc Industrial Biotechnology curriculum is essential due to its pivotal role in the production of a wide array of bioproducts, including pharmaceuticals, biofuels, and food additives. Fermentation processes harness microorganisms to convert raw materials into valuable products, making them fundamental to industrial biotechnology.

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
4	0	8	8	70	30	30	20	150

Course Content:

Module No:	Module Content	No. of Sessions	Weightage (%)
1	**Reaction engineering** Homogeneous reactions, Basic reaction theory, calculation of reaction rates, general reaction kinetics for biological systems, yields in cell culture, cell growth kinetics, production kinetics, kinetics of cell death; Continuous stirred tank reactor as a tool for calculating kinetic parameters of growth and product formation; Concept of maintenance and calculation of maintenance coefficient.	8	14
2	Process initialization Types of sterilization, thermal death kinetics of microorganism; Heat sterilization of liquid medium in batch and continuous mode; Air sterilization; Inoculum development; Various types of fermentation, submerged and solid state fermentation, aerobic and anaerobic fermentation; Overview of biosynthetic mechanisms; Metabolic stoichiometry.	8	14
3	Reactor engineering Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor.	8	14

4	Bioprocess scale up Heat and mass transfer issues in bioreactors, Estimation of KLa, Scale up with constant parameters like oxygen transfer rate, mixing, shear stress, flow regime, Reactor volume, etc. Scale-up methods by currently used rules-of-thumb viz. constant P/V, kLa, Various approaches to scale-up including regime analysis and scale-down; Analysis of alternate bioreactor configurations including cell-recycle, air-lift and immobilized-cell bioreactors, Problems on scale-up methods.	**8**	**14**
5	Commercial product processing Bulk organics (ethanol), Biomass (Bakers Yeast), Organic acids (Citric Acid), Amino Acids (L-Lysine), Microbial Transformations (Steroids), Antibiotics (Penicillin), ExtraCellular Polysaccharides (Xanthan Gum), Nucleotides (5-GMP), Vitamins (B12), Pigments (Shikonin).	**8**	**14**
6	Process technology Production of cell biomass and some primary metabolites, e.g. ethanol, acetone-butanol, citric acid, dextran and amino acids; Microbial production of industrial enzymes-glucose isomerase, cellulase & lipases.	**7**	**10**
7	Bioconversions Applications of bioconversion, transformation of steroids and sterols; Transformation of non-steroidal compounds, antibiotics and pesticides; Bioenergy-fuel from biomass, production and economics of biofuels.	**7**	**10**
8	Biosafety and Biosecurity Biological Risk Assessment, Laboratory Biosafety Level 1 to 4, Animal Biosafety for recombinant research, Biosecurity, development of biosecurity program, Containment for biohazards.	**6**	**10**

Reference Books:

1. M. L. Schuler, F. Kargi & M. DeLisa, Bioprocess Engineering - Basic Concepts, Prentice Hall., 3rd Edition
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press., 2nd Edition
3. C. Ratledge & B. Kristiansen, Basic Biotechnology, Cambridge University Press., 3rd Edition
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Elsevier India Pvt Ltd, Latest Edition

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Describe about fermentor design, different types of fermentations and current trend of fermentation process in biotech-industry.	UN
2	Discuss about strain selection, development, media design, formulation and recovery of products.	AN
3	Gain understanding of the variety of fermentation and subsequent processing approaches available for manufacture of biological products and design and operation of these systems.	EL
4	Communicate concepts and ideas effectively.	RM
5	Transparency, honesty and ethical reasoning in handling microbes and analyses during the wine making process.	AP

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

List of Experiments:

1. Assembly of bioreactors
2. Sterilization
3. Calibration of Probes (pH and Dissolved Oxygen)
4. Understanding control
5. Controller tuning
6. Cascade control of Dissolved Oxygen
7. Growth of control
8. Batch/Fed batch with concentrated feed
9. Continuous Stirred Tank Reactor running at different dilution rates.
10. Estimation of Growth/Product formation & Substrate utilization kinetics.
11. Estimation of Kla by dynamic gasing out and gas balancing.

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