



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Science (Industrial Biotechnology)

Level: PG

Course / Subject Code: IB02001011

Course / Subject Name : Fermentation Technology

## 1. Learning Outcomes

Learning Outcome Component	Learning Outcome (Learner will be able to)
Theoretical and practical understanding of fermentation technology	<ul style="list-style-type: none"><li>Describe about fermentor design, different types of fermentations and current trend of fermentation process in biotech-industry.</li></ul>
Importance of upstream and downstream components of fermentation process	<ul style="list-style-type: none"><li>Discuss about strain selection, development, media design, formulation and recovery of products.</li></ul>
Value applications of fermentation technology in biological research as well as in biotech-industries	<ul style="list-style-type: none"><li>Gain understanding of the variety of fermentation and subsequent processing approaches available for manufacture of biological products and design and operation of these systems.</li></ul>
Effective Communication	<ul style="list-style-type: none"><li>Communicate concepts and ideas effectively.</li></ul>
Professional & Ethical Behaviour	<ul style="list-style-type: none"><li>Transparency, honesty and ethical reasoning in handling microbes and analyses during the wine making process.</li></ul>

## LO – PO Mapping: Correlation Levels:

1 = Slight (Low); 2 = Moderate (Medium); 3 = Substantial (High), “-“= no correlation

Sub Code: 1320101	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1: Theoretical and practical understanding of fermentation microbiology	2	2	3	2	2	2	2
LO2: Importance of upstream and downstream components of fermentation process	3	3	3	2	2	3	1
LO3: Value applications of fermentation technology in biological research as well as in biotech-industries	3	3	3	3	2	3	2
LO4: Effective communication	2	2	2	2	3	3	2
LO5: Professional & Ethical Behaviour	2	2	1	2	3	2	3

2. Course Duration: The course duration is 45 sessions of 60 minutes each.

## 3. Course Contents:

Module No:	Module Content	No. of Sessions	70 Marks (External Evaluation)
1	Reaction engineering	6	7



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	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.		
2	<b>Process initialization</b> 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.	6	10
3	<b>Reactor engineering</b> Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, ideal reactor operations, batch operation of a mixed reactor.	6	7
4	<b>Bioprocess scale up</b> 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, <i>etc.</i> Scale-up methods by currently used rules-of-thumb <i>viz.</i> 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.	6	7
5	<b>Commercial product processing</b> 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).	6	10



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6	<b>Process technology</b> Production of cell biomass and some primary metabolites, <i>e.g.</i> ethanol, acetone-butanol, citric acid, dextran and amino acids; Microbial production of industrial enzymes-glucose isomerase, cellulase & lipases.	5	10
7	<b>Bioconversions</b> 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.	5	10
8	<b>Biosafety and Biosecurity</b> Biological Risk Assessment, Laboratory Biosafety Level 1 to 4, Animal Biosafety for recombinant research, Biosecurity, development of biosecurity program, Containment for biohazards.	5	10
9	<b><u>Practicals</u></b> <ol style="list-style-type: none"><li>1. Assembly of bioreactors</li><li>2. Sterilization</li><li>3. Calibration of Probes (pH and Dissolved Oxygen)</li><li>4. Understanding control</li><li>5. Controller tuning</li><li>6. Cascade control of Dissolved Oxygen</li><li>7. Growth of control</li><li>8. Batch/Fed batch with concentrated feed</li><li>9. Continuous Stirred Tank Reactor running at different dilution rates.</li><li>10. Estimation of Growth/Product formation &amp; Substrate utilization kinetics.</li><li>11. Estimation of <math>K_{La}</math> by dynamic gasing out and gas balancing.</li></ol>	-	(30 marks)

#### 4. Pedagogy:

- ICT enabled Classroom teaching
- Practical / live assignment



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- Interactive classroom discussions

## 5. Evaluation:

Students shall be evaluated on the following components:

	Internal Evaluation	(Internal Assessment – 20 Marks)
A	• Continuous Evaluation Component	10 marks
	• Class Presence	5 marks
	• Record maintenance	5 marks
B	Mid-Semester Examination	(Internal assessment-30 Marks)
C	End-Semester Examination	(External assessment-70 Marks)

## 6. Reference Books:

No	Author	Name of the Book	Publisher	Year of Publication / Edition
1	M. L. Schuler, F. Kargi & M. DeLisa	Bioprocess Engineering - Basic Concepts	Prentice Hall.	3 <sup>rd</sup> Edition
2	Pauline M. Doran	Bioprocess Engineering Principles	Academic Press.	2 <sup>nd</sup> Edition
3	C. Ratledge & B. Kristiansen	Basic Biotechnology	Cambridge University Press.	3 <sup>rd</sup> Edition
4	Peter F. Stanbury, Stephen J. Hall & A. Whitaker	Principles of Fermentation Technology	Elsevier India Pvt Ltd	Latest Edition

Note: Wherever the standard books are not available for the topic appropriate print and online resources, journals and books published by different authors may be prescribed.

## 7. List of Journals/Periodicals/Magazines/Newspapers / Web resources, etc

- <https://nptel.ac.in/courses/102105058>
- <https://www.journals.elsevier.com/bioresource-technology>

## Course Outcomes:

On completion of this course, students should be able to:

- Gain understanding of a variety of fermentation and subsequent processing approaches.
- Understand design & operation of fermentation systems.
- Appreciate regulatory framework of biopharmaceutical industry.