



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Biotechnology

Subject Code: BE05004041

Subject Name: Industrial Biotechnology

w. e. f. Academic Year:	2024-2025
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	None
Rationale:	Industrial Biotechnology focuses on the application of biological systems, organisms, and processes to produce useful products and services for industry. The subject provides students with the knowledge and skills to utilize microbes, enzymes, and biochemical pathways for the sustainable manufacture of fuels, chemicals, materials, and pharmaceuticals. It bridges biology and engineering to promote innovation, sustainability, and efficiency in industrial processes.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO1	Understand the steps involved in the production of bioproducts and methods to improve productivity	35
CO2	Apply basic biotechnological principles, methods and models to understand the primary and secondary metabolites	35
CO3	Understand the methodologies and production methods for the production of r-DNA products	30

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Mark s
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
1	Introduction to Industrial Bioprocess: Biotechnology: Scope and importance, Commercial potential of Biotechnology in India. Historical overview of industrial fermentation process -traditional and modern Biotechnology. Industrial Fermentation- microorganisms, mode of operation, fermentation processes- pictorial representation.	10



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2	Production of Primary Metabolites: A brief outline of processes for the production of some commercially important organic acids (citric acid, lactic acid & acetic acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol)	15
3	Production of Secondary Metabolites: Production processes for various classes of secondary metabolites: antibiotics: (penicillin streptomycin & erythromycin), vitamins (Vit B12 and Vit B2) and steroid biotransformation.	10
4	Production of Enzymes and Other Bioproducts: Production of industrial enzymes (proteases & amylases), Production of biopesticide, Biofertilizers, bio-preservative (Nisin), biopolymers (xanthan gum & PHB), cheese, SCP.	10
5	Production of Modern Biotechnology Products: Production of recombinant proteins having therapeutic and diagnostic applications (insulin, human growth hormone), Production of recombinant vaccines (Hepatitis B vaccine, cholera vaccine), production of monoclonal antibodies.	
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	20	20	10	10

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

The syllabus of Advanced Power Electronics directly contributes to

SDG 2	Industrial biotechnology contributes to sustainable agricultural productivity through the development of biofertilizers, biopesticides, and improved food production technologies.
SDG 3	The syllabus supports the production of antibiotics, vaccines, recombinant therapeutics, enzymes, and healthcare-related bioproducts for improved disease management and public health.
SDG 7	Industrial biotechnology enables the production of renewable biofuels such as bioethanol and biobutanol, supporting sustainable and clean energy alternatives.
SDG 9	The subject promotes innovation in industrial fermentation, bioprocess engineering, recombinant product manufacturing, and industrial-scale biotechnology applications.
SDG 12	Sustainable manufacturing using microbial systems and biological processes reduces industrial waste and promotes environmentally responsible production systems.
SDG 13	Industrial biotechnology contributes to environmentally sustainable industrial processes by reducing dependence on fossil-based products and lowering environmental pollution.



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Reference Books:

1. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., Industrial Biotechnology: Products and Processes, John Wiley & Sons, 2016
2. Waites, M.J., Morgan, N.L., Rockey, J.S., Higton, G., Industrial Microbiology: An Introduction Blackwell, 2001
3. Cruger, W., Cruger, A., A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2nd Edition, 2005
4. Stanbury, P.F., A. Whitaker and S.J. Hall, Principles of Fermentation Technology, Butterworth – Heinemann (an imprint of Elsevier), 1995, 2nd Edition
5. James D. Watson, Richard M. Myers, Amy A. Caudy, and Jan A. Witkowski, Recombinant DNA: Genes and Genomes: A Short Course - W. H. Freeman, 2007
6. Prescott, S.C. and Cecil G. Dunn, Industrial Microbiology, Agrobios (India), 2005
7. Moo-Young, Murrey, Comprehensive Biotechnology, 4 Vols. Pergamon Press, (An Imprint of Elsevier), 2004
8. C. F. A Bryce and E.L. Mansi, Fermentation microbiology & Biotechnology, 1999

List of Experiments / Practical Demonstrations

1. To study the growth curve of microorganisms.
2. To determine the activity of industrially important enzymes.
3. To produce ethanol through microbial fermentation.
4. To isolate and screen industrially important microorganisms.
5. To immobilize enzymes or microbial cells and study their activity.
6. To study the operation and parameters of a laboratory-scale bioreactor.
7. To perform downstream processing using filtration and centrifugation.
8. To purify proteins using chromatography techniques.
9. To estimate microbial biomass and calculate product yield.

Major Equipment

1. Fermenter / Bioreactor
2. Autoclave
3. Laminar air flow cabinet
4. Incubator shaker
5. Spectrophotometer
6. Centrifuge

Open-Source Software / Learning Websites

1. COPASI (biochemical network simulation)
2. CellDesigner
3. Biocyc / KEGG Pathway Database
4. NCBI (National Center for Biotechnology Information)
5. UniProt
6. EMBL-EBI Tools



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List of suggested activities for Project Based Learning (PBL):

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Visit to fermentation industry / biopharmaceutical company / enzyme production unit / industrial microbiology laboratory	Visit = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Based on report submitted. Report should contain observations on fermentation processes, industrial bioproducts, microbial production systems, and downstream processing.
2	Video Based Learning	Technical video-based learning related to industrial fermentation, primary and secondary metabolites, enzyme production, recombinant products, and bioprocessing (MOOC/NPTEL Video)	Duration of video = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Report/presentation based on video learning outcomes and understanding of industrial biotechnology concepts.
3	Assignment / Technical Writing / Research Writing	Numerical and theory-based assignments related to fermentation processes, microbial growth, metabolite production, enzyme technology, and recombinant bioproducts	5 assignments of 2 hrs each Total = 10 hrs	Based on assignment submitted, technical understanding, calculations, and scientific interpretation.
4	Complex Problem-Solving targeting relevant SDGs / Mini Project	Comparative analysis and design of industrial production process for bioethanol, antibiotics, enzymes, or recombinant proteins	15 hrs	Based on problem-solving approach, industrial feasibility, process understanding, and technical depth.
5	Research Paper Review / Analysis	Discussion on research paper related to industrial fermentation, enzyme production, recombinant therapeutics, biofertilizers, or bioprocess optimization (SCOPUS Indexed / reputed Journal)	5 research papers = 20 hrs	Summarize research paper and evaluate critical scientific and industrial parameters.
6	Poster / Chart / PowerPoint	Poster/chart/power point preparation on topics such as	Duration = 6 hrs	Based on poster/chart preparation, scientific



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	Presentation	Industrial Fermentation, Bioproducts, Recombinant Therapeutics, Biopolymers, Biofertilizers, Biopesticides		understanding, technical depth, and presentation skills.
7	Mini Project	Working/non-working model of small-scale fermenter, microbial metabolite production, enzyme immobilization, or downstream processing system	10 hrs	Based on internal/external evaluation, innovation, technical relevance, and process understanding.
8	Group Discussion / Quiz / Simulation	Group discussion on emerging areas such as Synthetic Biology, Industrial Bioprocess Optimization, Sustainable Biomanufacturing, and Biorefinery Concepts	Duration = 1 hr each	Based on participation, scientific understanding, technical knowledge, and communication skills.
9	Case Study Analysis / Seminar	Real-world case study on industrial production of antibiotics, recombinant insulin, vaccines, bioethanol, or industrial enzymes	Data collection/study = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Based on in-depth scientific study, industrial analysis, fact-finding, and conclusions.
10	Other	Patent Search and Innovation Gap Identification in industrial enzymes, recombinant therapeutics, fermentation technology, or sustainable bioproducts	10 hrs (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. Mini Project – 10 Marks , Micro Project – 5 Marks
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
