GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Science (Industrial Biotechnology)

Level: PG Semester-3

Course / Subject Code: IB03001041

Course / Subject Name : Metabolic Engineering

1. Learning Outcomes

Learning Outcome Component	Learning Outcome (Learner will be able to)
Theoretical and practical understanding of Metabolic Engineering	• Identify the appropriate host and/or metabolic pathways to produce a desired product or remediate a toxin; • Compare potential metabolic engineering strategies using quantitative metabolic modelling
Value applications of Metabolic Engineering in biological research as well as in biotech-industries	• Explain new technologies for modelling approaches for improving pathway flux, engineered biosensors, automated cloning and strain development technologies
Effective Communication	• Communicate concepts and ideas effectively
Professional & Ethical Behaviour	• Transparency, honesty and ethical reasoning in handling biomolecule for product processing

LO – PO Mapping: Correlation Levels:
1 = Slight (Low); 2 = Moderate (Medium); 3 = Substantial (High), "-"= no correlation

Sub Code: 1330104	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1:Theoretical and practical understanding of Metabolic Engineering	2	3	3	2	3	3	2
LO2:Value applications of Metabolic Engineering in biological research as well as in biotech-industries	2	2	3	2	2	2	3
LO3: Effective communication	3	2	2	2	2	3	2
LO4: Professional & Ethical Behaviour	2	2	2	2	3	2	2

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	**Introduction** Stoichiometry, kinetics and thermodynamics of cellular reactions.	5	7
2	**Material balances and data consistency**	5	7

	Material balances on pathways and whole cell balances; Over and under-determined systems; Data consistency for overdetermined systems.		
3	**Regulation of metabolic pathways** Regulation of metabolic pathways; role of enzymes, substrate, product and regulatory molecules; Hierarchical control in cellular systems.	5	7
4	**Manipulation of metabolic pathways** Pathway manipulation strategies for overproduction of various metabolites, examples of ethanol overproduction, overproduction of intermediates in main glycolytic pathway and TCA cycle like pyruvate, succinate etc.; Need for multiple genomic modifications; Modulating fluxes in desired pathways; Tools for multiple genomic modifications examples- TALENS CRISPR-Cas systems as well as traditional systems of gene knock ins and knockouts and promoter engineering.	9	15
5	**Synthetic biology** Metabolic pathway synthesis; Relation with bioprocess design; BIOBRICKS approaches; Introduction to tools of synthetic biology.	6	12
6	**Metabolic flux analysis** Metabolic flux analysis; Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Using different optimizing functions to solve linear programming problem; FBA, understanding flux cone and constraints; Introducing additional constraints from thermodynamics; Brief introduction to developments in this area; MOMA (Minimization of Metabolic Adjustment), iFBA (Integrated Flux Balance Analysis) etc.	9	12
7	**Determination of metabolic flux** Experimental determination of metabolic fluxes; C^{13} labeling, NMR and GC-MS based methods for flux determination.	6	10

4. Pedagogy:

- ICT enabled Classroom teaching
- Practical / live assignment
- Interactive classroom discussions

5. Evaluation:
Students shall be evaluated on the following components:

A	**Mid-Semester Examination**	**(Internal assessment-30 Marks)**
B	**End-Semester Examination**	**(External assessment-70 Marks)**

6. Reference Books:

No	Author	Name of the Book	Publisher	Year of Publication / Edition
1	Stephanopoulos, G.N., Aristidou, A.A., Nielsen,J.	Metabolic Engineering: Principles and Methodologies.	Academic Press.	1st Edition
2	Smolke, C.S.	Metabolic Pathway Engineering Handbook: Fundamentals	CRC press	1st 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://onlinecourses.nptel.ac.in/

Course Outcomes:

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

- Identify the appropriate host and/or metabolic pathways to produce a desired product or remediate a toxin;
- Compare potential metabolic engineering strategies using quantitative metabolic modelling.