Microbial Biotechnology

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	PC	BT107107BT

[Pre Requisite- Microbiology, Biochemistry: Molecular biology]

Course Objectives

1. To learn the theory, practice, and the importance of applied microbiology.
2. To familiarize the student of the industrial application of microorganism such as enzymes, antibiotics production, bioremediation etc.

Course Content

UNIT 1

General Concept of microbial biotechnology: Principles of exploitation of microorganism, Primary and secondary metabolism. Isolation and screening of industrially and biotechnologically important microorganisms Introduction to fermentation (batch, semibatch, continuous) Primary and secondary metabolic products for commercial interest

UNIT II

Fermentation processes: Solid and submerged fermentation medium: Media formulation for fermentation products; Rheology of fermentation medium; Essential rules for fermentor design; Material of construction and Vessel Size for Fermentors; Basic Design and construction of Fermentor:; kinetics of microbial growth and product formation (growth rate, yield coefficient, efficiency), Substrate utilization kinetics; Dilution rate for continuous growth of microorganisms; Solid and Submerged fermentation products

UNIT III

Preservation and improvement of industrially important microorganisms: Strategies of strain improvement of industrial microbes. Preservation of microorganisms with advantages and disadvantages – long term and short term preservation techniques

UNIT IV

Microbial cell factory: Production of primary and secondary metabolites, Microorganisms in bioremediation, Microbial sensors, Techniques of whole cell immobilisation. Advantages and Disadvantages of Immobilized enzymes over native enzymes; Various Immobilized products of commercial interest

Course Materials

Required Text: Textbooks

1. Stanbury, P.F. and Whitaker, A., and Hall S. J. Principles of Fermentation Technology, Pergamon Press (2007)
2. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates.

Optional Materials: Reference books

1. Casida L. E. J. R., Industrial Microbiology, New Age.
2. Vogel, H.C. Todaro, C.L. and Todaro C.C., Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment, Noyes Data Corporation/ Noyes Publications.

Genomics and Proteomics

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	PE3	BT108212BT

[Pre Requisite- Recombinant DNA Tech & Biochemistry]

Course Objectives

1. Provide the students a fundamental knowledge on Genomics and Proteomics
2. Broader knowledge on the genome mapping, structural/functional genomics, the techniques involved in genomics and proteomics.

Course Content

UNIT-1: GENE AND GENOME

Intro to OMICS; Types of genomics; Gene: ORF; Exon; Intron; Prokaryotic, Eukaryotic, & Mitochondria/Chloroplast genome; Shotgun DNA sequencing; C-value & paradox; Human genome project.

UNIT-2: GENOME MAPPING AND ANALYSIS OF GENE EXPRESSION

Types of genome mapping; Techniques involved in genome mapping and gene expression analysis (RFLP, RAPD, SSCP, SSLP, STS, RT-PCR; DD-PCR, SNP, FISH, Nuclease protection assay, molecular hybridization).

UNIT-3: FUNDAMENTALS OF PROTEOMICS

Concept and components of proteome; importance of proteomics in biological functions; protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems.

UNIT-4: MASS SPECTROSCOPY ANALYSIS OF PROTEIN

Mass Spectrometry (MS)- Peptide mass finger printing, Mass accuracy, Resolution, Sensitivity; Ion sources: Electrospray ionization, Matrix assisted laser desorption and ionization; Mass analyzers: Quadrupole, Ion-trap, Time-of-flight, Orbitrap, Fourier-transform ion cyclotron resonance, Hybrid analyzers; Detectors; MS-MS; LC-MS.

Text Books:-

1. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, Third Edition (Blackwell Publishing).
2. Liebler, “Introduction to Proteomics” Humana Press
3. Conard, Edward. Genomics. Apple Academics

Reference Books :-

1.Old RW, Primrose SB, “Principles of Gene Manipulation, An Introduction To Genetic Engineering “, Blackwell Science Publications.
2.Pennington, SR, Dunn MJ, “Proteomics : Protein Sequence to Function”. Viva Books 3.Mass
Spectrometry for Biotechnology: Gary Siuzdak.

Metabolic Engineering

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE4	BT107205BT

[Pre-requisites: Biochemistry, Microbiology, R-DNA Technology]

Course Objectives

Student will learn about an emerging field of biotechnology/bioprocess engineering which aims towards purposeful modification of cellular (metabolic and gene regulatory) processes/networks to achieve desirable pharmaceutical, biochemical and biotechnological products.

Course

Content

UNIT 1

Introduction to Metabolic Engineering, Basic concepts; Scopes and Applications; Metabolism overview (Cellular Transport processes, Fueling Reactions)

UNIT 2

Regulation of microbial primary and secondary metabolism, Metabolic Flux Analysis: Flux Balance Analysis (FBA), Flux Variability Analysis, Application of metabolic Flux Analysis

UNIT 3

Strain improvement techniques for industrially significant strains: Random mutagenesis, site specific mutation, directed evolution: Error prone PCR, DNA Shuffling, recombination, Cassette mutagenesis

UNIT 4

Examples of pathway manipulations by metabolic engineering for production of primary metabolites (ethanol, amino acid, vitamins and organic acids) and secondary metabolites (Antibiotics, polymers).

Course Materials

Required Text: Text

books

1. Metabolic Engineering-Principles and Methodology, George Stephanopoulos, Aristos Aristidou, Jens Nielsen, 1st Ed, Academic Press, 1998.

2. Metabolic Engineering, Sang Yup Lee, E Terry Papoutsakis, 1st Ed, CRC Press 1999.

Optional Materials: Reference Books

1. Metabolic Regulation and Metabolic Engineering for Biofuel and Biochemical Production, Kazuyuki Shimizu, CRC Press, 2017
2. Metabolic Engineering Handbook: Tools and Applicatioms, Dr Lena Olivera, 1st Ed, Delve Publishing, 2015

Industrial Biotechnology

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE4	BT108211BT

[Pre Requisite- Microbial Technology , Enzyme Technology, Plant and Animal biotechnology]

Course Objectives

1. To understand the use of living cells to generate industrial products and processes.
2. To learn the diverse applications of biobased products.

Course Content

UNIT I

Introduction, Microbes and enzymes of industrial importance; Introduction to biosynthetic technology: strain improvement through mutation and recombination in industrial microorganisms: Microbial cell factories: Protoplast fusion: Regulation of Enzyme Activity

UNIT II

Microbes in agriculture and food industry: biofertilizers and biopesticides; biopolymers (xanthan gum, PHB etc), vitamins; nutraceuticals; Bioflavours and biopigments. Microbes in fermentation industry: Microbes for Amino Acid production: Microbes for Anaerobic fermentation – Acetone Butanol,Lactic Acid, Brewing

UNIT III

Production of enzymes and specialty chemicals: Production of industrial enzymes, whole cell biocatalysis, bio pharmaceuticals; nutraceuticals; Bioanalytical agents. Immobilized Enzymes and applications

UNIT IV

Bioenergy-fuel from biomass, production of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR). Production of Biohydrogen: Microbial Fuel Cell (MFC)

Course Materials

Required Text:

Textbooks

1. Glazer AN, Nikaido H (2007): Microbial Biotechnology: Fundamentals of Applied Microbiology
2. Wulf Cruger and Anneliese Crueger (2003), Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation.
3. Malden MA (2001): Industrial Microbiology: An introduction; Blackwell Science (2001)

Optional Materials: Reference books

1. H.W. Blanch, S. Drew, D.I.C.Wang and M. Moo-Young, Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products, Pergamon Press (1985).
2. C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications (1996).
3. P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press (1993).

Unit Operations

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE4	BT107207BT

[Pre Requisite- Knowledge of Basics of Biology and Mathematics chemistry.]

Course Objectives

1. Student will be able to understand various solids, liquids and their properties.
2. Various size reduction mechanisms can be understood.
3. Mixing and agitation aspects of the various liquids can be known.

Course Content

UNIT 1:

Characteristics of solid particles, Types of standard screen series, Screening of solid particles, screen analysis, estimation of particle size, surface area and particle population based on screen analysis, ideal and actual screens, Principle of cyclone separator, hydroclones, electrostatics and magnetic separation processes, Storage and conveying of solids.

UNIT 2:

Size reduction and enlargements, crushers, grinders, ultrafine grinders, ball mills, energy and power requirements in comminution, Crushing laws and work index, Open-circuit and closed circuit operation.

UNIT 3:

Axial and radial flow impellers, prevention of vortex and swirling, Liquid-Liquid, Liquid-Solid, Solid-solid mixing operations and equipment's required in such operation, power consumption in agitated vessels mixing index, Concept of Power Number for liquid mixing in agitated vessels, Power consumption/requirements in agitation of fermentation broth.

UNIT 4:

Sedimentation, settling velocity, flocculation, thickener, thickener design, Classifier. Filtration, filter media, filter aids, batch and continuous filtration, filtration equipment': filter press, leaf, cartridge, vacuum filter, rotary drum filters, Plate and frame filter press, Disc bowl centrifuge, Centrifugal filters, Basket centrifuge. Advanced separation processes: Dialysis, ultrafiltration, reverse osmosis and membrane separation.

Name of text books:

1. Unit operations of Chemical engineering by W.L. McCabe
2. Unit operations I by Hiramath Kulkarni
3. Unit operations I by K. A. Gavhane

Process Dynamics and Control

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE4	BT107208BT

[Pre Requisite- Concept of process dynamics and control elements in bioprocess industries.]

Course Objectives

To impart the student knowledge on process dynamics and control the process equipments in the field of biotechnology.

Course Content

UNIT I :

Concept of process control, control elements, simple system analysis, Laplace transformation and transfer functions, block diagrams, linearization, response of first order systems, transfer function, transient response, step response, impulse response, sinusoidal response, liquid level, mixing process, linearization, response of first order systems in series, non-interacting systems, interacting systems, higher order systems, second order and transportation lag, under damped systems, step response, impulse response, sinusoidal response.

UNIT II :

The control system, block diagram, servo problem and regulator problem, negative feed-back and positive feedback, controllers and final control elements, ideal transfer functions, proportional, proportional integral and proportional integral derivative controllers, on-off controllers,

UNIT III:

Stability, root locus, frequency response using Bode and Nyquist plots, control system design by frequency response, Bode stability criterion, gain and phase margins, Z-N controller settings,

UNIT IV:

Control tuning and process identification, process identification, step testing, semi-log plots for modeling control valves, control valve construction, valve sizing, valve characteristics, effective valve characteristics.

Text Books:

1. Coughanowr, D.R , Process System Analysis and Control, 2 nd Edn., McGraw Hill International Editions, 1991.
2. Seborg,D.E., Edgar,T.F and Mellichamp,DA, Process Dynamics and Control, John Wiley and Sons, 2nd ed., 2004.
3. Bequette, B.W, Process Control: Modeling, Design and Simulation, Prentice Hall, New Delhi, 2003.

Nano Biotechnology

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-1-0, (4)	OE3	BT107303BT

[Pre-requisites: Chemistry, Physics]

Course Objectives

The overriding the aim of this course is to provide basic knowledge in the interface between chemistry, physics and biology on the nano-structural level with a focus on biotechnological usage

Course Content

UNIT 1:

Various definitions and Concept of Nano-biotechnology & Historical background, Basics of biology - cell, organelles and nucleic acids as genetic material, Bio macromolecules -Carbohydrates, lipids, proteins.

UNIT 2:

Nanomaterial in biotechnology -nanoparticles, quantum dots, nanotubes and nanowires etc., Biological nanoparticles production - plants and microbial

UNIT 3:

Nanobiotechnological applications in health and disease, Nanobiotechnological applications in Environment and food - detection and mitigation, Theory for how lipid/polymer nanoparticles can be utilized as model membranes and for formulation/administration of drugs

UNIT 4:

Examples and production of various types of nanostructured materials with usage and potential within biotechnology.

Course Materials

Required Text: Text books

1. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.

2. Nanobiotechnology - II more concepts and applications.(2007) - Chad A Mirkin and Christof M. Niemeyer (Eds),Wiley VCH.

3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

Optional Materials: Reference Books

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer, Chad A. Mirkin, WILEY VCH, 2004

2. The Nanobiotechnology Handbook, Ed 1, Edited By Yubing Xie, CRC Press 2017

Biosensor Technology

[7th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE3	BT107304BT

[Pre-requisites: Biochemistry, material science]

Course Objectives

To know the different types of biosensors applied to different fields

Course Content

UNIT-1:

Introduction to biosensors, applications of biosensors, concept of transducers and biological element

UNIT-2:

Bio receptors and their immobilization, synthetic receptors and nanomaterials for biosensors

UNIT-3:

Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, various types of transducers - Optical, Potentiometric, Amperometric, Conductometric , Piezoelectric, Chemiluminiscene

UNIT-4:

Application and use: Biosensors in clinical chemistry, medicine and health care, biosensors for agriculture and food industry, biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment.

Course Materials

Required Text: Text books

1. Biosensors an Introduction , Brian R Eggins, First edition, John Wiley & Sons Publishers, 1996.
2. Biosensors Principles and Applications, Loic J Blum, Pierre R Coulet , First edition, Marcel Dekker,Inc, 1991.
3. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

Optional Materials: Reference Books

1. Biosensors, Elizabeth A Hall, First Edition, Open University, Milton Keynes, 1990.
2. Commercial Biosensors, Graham Ramsay, First edition, John Wiley & Sons, Inc. 1998.
3. Sensor Physics & Technology - Biosensors, Tran Minh Canh, First Edition, Champan & Hall, 1993.
4. Bioinstrumentation and Biosensors: Theory and Applications, . D. L. Wise, CRC Press, 1991
5. Biosensors, J. Cooper, and T. Cass, Oxford University Press, 2004

Microbial Technology Lab

[7th Semester, Forth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	0-0-2, (2)	Laboratory	BT107405BT

[Pre Requisite- Microbiology, Biochemistry]

Course Objectives

1. Microbial production of primary and secondary metabolite.
2. Microbial growth and production kinetics.

LIST OF EXPERIMENTS:

1. Isolation and screening of microbes of industrial importance
2. Production of amylase/protease using shake flask method.
3. Production of alcochol using shake flask method.
4. Production of citric/amino acid using shake flask method.
5. Determination of growth, substrate and production kinetics in batch cultivation.
6. Demonstration and operation of production of microbial metabolite in lab scale fermentor.
7. Overall Oxygen Transfer Coefficient (K_La)determination in lab scale fermentor.
8. Downstream processing of microbial product (primary metabolite).
9. Preservation techniques of microbial culture.
10. Whole cell immobilisation technique.
11. Production of Baker's Yeast in shake flask.
12. Production of Vitamin B_2 and Vitamin B_{12} in shake flask

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Course Materials

Required Text: Textbooks

1. K.R. Aneja, "Experiments in Microbiology, Plant Pathology & Biotechnology" , 4th ed., New Age International Publishers. 2007.
2. P. Gunasekharan, "Laboratory Manual in Microbiology", 1st ed., Newage International Publishers. 2005.

Optional Materials: Reference books

1. J.Jayaraman , "Laboratory Manaual in Biochemistry",1 st ed., New Age International Publications, 2007.