Membrane Technology

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE5	BT108209BT

[Pre-Requisite- Membrane synthesis & characterization, application of membrane in medical and biotechnological industries]

Course Objectives

To learn the principles of membrane technology and engineering aspects of membrane separation processes, including pervaporation, reverse osmosis, ultrafiltration, microfiltration, and dialysis.

Course Content

UNIT I:

Concept of membrane filtration, types of membrane process, membrane materials and properties, membrane modules, energy for membrane process, Membrane preparation; dense membranes, symmetric membranes, Asymmetric membranes, composite membranes, Inorganic and ceramic membranes, Hollow fiber membranes; Membrane characterization, porosity, pore size distribution, bubble point method, water permeability, perporometry, molecular weight cut-off

UNIT II:

Membrane process for liquid separation, microfiltration, ultrafiltration, nanofiltration, dead-end filtration, cross flow filtration, pervaporation, osmosis and reverse osmosis theoretical principles and their industrial applications, membrane fouling and cleaning, investigation of membrane fouling

UNIT III:

Membrane process for medical applications; concept of blood purification, dialysis, hemodialysis, electrodialysis and hemofiltration, theoretical principles and applications, membrane modules and materials of construction

UNIT IV:

Application of membranes, wastewater treatment, removal and recovery of heavy metals, oily-wastewater separation, membrane bioreactor for wastewater treatment, food industries; fruit juice clarification, aroma recovery; Biotechnology, biomass separation, separation of fungus, bacteria, virus, application to microbial fuel cell

Text Books:-

1. M. Mulder, “Basic principles of membrane technology”, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2nd Edition, 1996.
2. J.D. Seader, E. J. Henley, “Separation process principles”, John Wiley & Sons, Inc, 2 nd Edition.
3. R.W. Baker, “Member technology and applications”, John Wiley & Sons Ltd, 2 nd Edition.
4. A.K. Pabby., S.S. H. Rizvi., A. M. Sastre, “Hand book of membrane separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications”, CRC press, Taylor & Francis Group, 2009.

Stem Cell and Tissue Engineering

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE5	BT108210BT

[Pre Requisite- Cell Biology, Analytical Techniques]

Course Objectives

1.Understand the structure and organization of tissues, the construction of scaffolds and other transplant engineering biocompatible materials for tissue engineering.

2.Imparting the basic knowledge of students about stem cell, culturing, therapy, and its clinical applications

Course Content

UNIT-1: BASIC OF STEM CELLS

Introduction; Types, source, and differentiation pathway of stem cell; Potency, plasticity, characters of stem cells; Stem cell isolation, culturing, subculturing, storage; Stem cell markers & their analysis; regulation of stem cell-engineered products and ethical issues.

UNIT-2: TECHNIQUES AND ENGINEERED DISEASE MODELS

In vivo cell & tissue engineering; Design of artificial organs like- artificial skin, artificial blood vessels, artificial pancreas, artificial liver, regeneration of bone and muscle, nerve regeneration.

UNIT-3: INTRODUCTION TO TISSUE ENGINEERING:

Current scope; Use in therapeutics; Tissue appearance and component, Tissue types and properties; Tissue organization, dynamics and morphogenesis; ECM component, Mechanical measurements; Tissue repair; Stem cells in tissue engineering and regenerative medicine.

UNIT-4: BIOMATERIALS IN TISSUE ENGINEERING

Biopolymers and scaffold; Classes and properties of biomaterials; Characterization of materials; Host reactions to biomaterials; Biocompatible Materials; Microtechnology Tools; 3D Tissue Printing; Implantable devices.

Text Books:-

1. Tissue Engineering, Senior Editor Ulrich Martin , Springe.
2. Stem Cells Handbook, Editor: Stewart Sell ,Humana Press.

Reference Books :-

1. Bernard N. Kennedy (editor). New York : Nova Science Publishers, c2008.Stem cell transplantation, tissue engineering, and cancer applications.
2. Stem Cell Biology ,Editors: Daniel R. Marshak, Richard L. Gardner and David Gottlieb Cold Spring Harbor Laboratory Press, Cold Spring Harbor NY, USA

Industrial Biotechnology

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE6	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).

Metabolic Engineering

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	PE6	BT108212BT

[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

Bioreactor Design and Analysis

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biotechnology	3-0-0, (3)	OE4	BT108304BT

[Pre Requisite- The student is expected to have a basic knowledge of modelling aspects. Prerequisite courses can be Material Balances and energy balances, Biological Rate processes.]

Course Objectives

The course introduces the student to design principles of batch, fed-batch and continuous bioreactors. The student will also be able to identify suitable criterion for the scale-up of bioprocesses and characterize bioreactors. Specify design criteria for medium sterilization.

Course Content

UNIT 1:

Modelling of Microbial growth and product formation kinetics, Thermal death kinetics of microorganisms, Techniques used in sterilization, Design criterion for sterilization, Batch, continuous and air sterilization of medium. Structured and Unstructured models for microbial growth: Growth associated, Non growth associated and combined Growth associated Non growth associated product kinetics: Design of batch and continuous medium sterilization process: Methods of Air Sterilization

UNIT 2:

Fermentation Process-General requirements; Basic design and construction of fermenters and its ancillaries; Material of construction, Vessel geometry and bioreactor design considerations for plant and animal cell cultures. Ideal and non-ideal multiphase reactors. Aseptic inoculation and sampling in Bioreactors.Resi dence Time Distribution (RTD) in Bioreactors

UNIT 3:

Batch growth of microorganism: Quantifying growth kinetics: Growth patterns and Kinetics in Batch culture, Environmental factors affect to growth kinetics, Substrate limited growth, the logistic equation for the microbial growth, Using Unstructured Non-segregated Models to predict specific growth rate. Specific devices to operate continuous culture: Chemostat and turbidostat. The ideal Chemostat,: Steady state substrate, steady state biomass, steady state product formation calculation, derive Productivity (DP/DX) of a chemostat. Relationship between Specific Growth Rate and Doubling Time of microorganisms;Dilution Rate in Chemostat culture: Application of Fed Batch Culture

UNIT 4:

CSTR with recycle, CSTR in series, Oxygen rate transfer, Scale up, Scale down. Large scale production and purification of recombinant proteins. Design and operation of Novel Bioreactors: Batch Bioreactor, CSTR, Plug flow Reactor, Airlift, Packed bed, Bubble column, Fluidized bed, Tower Bioreactor, Photo bioreactor, Bioreactors for waste treatment processes, SSF bioreactors. Volumetric Oxygen Transfer Coefficient (K_La) determination by Sulphite Oxidation, Gassing out method. Scale up criteria and scale up studies based on Power consumption per unit volume of the fermentation broth of gassed and ungassed system. Membrane Bioreactors, Immobilized cell Bioreactors

Text book

1. Kargi F, Shuler ML. Bioprocess engineering: basic concepts. Prentice-Hall PTR; 1992.
2. T Panda, Bioreactors analysis and design, Tata McGraw Hill, New Delhi, New York, 2011
3. Bailey, James E., and David F. Ollis. Biochemical engineering fundamentals. McGraw-Hill, 2018.