SHIVAJI UNIVERSITY, KOLHAPUR
BRANCH: BIOTECHNOLOGY ENGINEERING
CLASS: T.E. (Biotechnology Engineering)
Revised syllabus of T.E (Biotechnology Engineering)
(To be implemented from Academic Year 2015-16)

SEMESTER (V)

Name of the Subject	Teaching Scheme (Hours/week)				Examination Scheme (Marks)				
	L	T	P	Total	Theory	TW	POE	OE	Total
1.Bioprocess Calculations	3	-	-	3	100	25	-	-	125
2. Biological Thermodynamics	3	-	-	3	100	-	-	-	100
3. Fermentation Technology-1	3	-	2	5	100	25	-	-	125
4. Genetic Engineering	3	-	4	7	100	25	25	-	150
5. Bioinformatics	3	-	2	5	100	25	-	-	125
6. Immunology	3	-	2	5	100	25	25	-	150
7. Basics of Cell Culture	-	-	2	2	-	25	-	-	25
Total	**18**	**-**	**12**	**30**	**600**	**150**	**50**	**-**	**800**

L: Lecture, T: Tutorial, P: Practical, TW: Term Work, POE: Practical Oral Exam, OE:Oral exam

SEMESTER (VI)

Name of the Subject	Teaching Scheme (Hours/week)				Examination Scheme (Marks)				
	L	T	P	Total	Theory	TW	POE	OE	Total
1.Bioprocess Equipment Design	3	-	2	5	100	25	-	-	125
2. Fermentation Technology-2	4	-	-	4	100	25	-	-	125
3. Bioseparation Processes	4	-	2	6	100	25	25	-	150
4. Analytical Techniques inBiotechnology	4	-	2	6	100	25	25	-	150
5. Drug Development and Gene Therapy	3	-	-	3	100	-	-	-	100
6.Plant Biotechnology	3	-	-	3	100	-	-	-	100
7.Seminar $	-	-	2	2	-	25	-	-	25
8. Industrial Visit	-	-	1	1	-	25	-	-	25
Total	**21**	**-**	**9**	**30**	**600**	**150**	**50**	**-**	**800**

L: Lecture, T: Tutorial, P: Practical, TW: Term Work, POE: Practical Oral Exam, OE: Oral Exam
Note : Industrial training is compulsory.

EQUIVALENCE OF OLD AND NEW SYLLABI (T.E.)

Old Examination	Sr. No.	Subject under old syllabus	New Examination	Equivalent subject under new syllabus
T.E.(Biotech. Engg) Sem- V	1	Nil	T.E.(Biotech.Engg) Sem- V	Bioprocess Calculations
	2	Biological Thermodynamics	T.E.(Biotech.Engg) Sem- V	Biological Thermodynamics
	3	Immunology	T.E.(Biotech.Engg) Sem- V	Immunology
	4	Fermentation Technology	T.E.(Biotech.Engg) Sem- V	Fermentation Technology - 1
	5	Genetic Engineering	T.E.(Biotech.Engg) Sem- V	Genetic Engineering
	6	Bioinformatics	T.E.(Biotech.Engg) Sem- V	Bioinformatics
	7	Basics of cell culture	T.E.(Biotech.Engg) Sem- V	Basics of cell culture
T.E.(Biotech. Engg) Sem- VI	1	Bioinstrumentation	T.E.(Biotech.Engg) Sem- VI	Analytical techniques in Biotechnology
	2	Medical Biotechnology	B.E..(Biotech.Engg) Sem- VII	Medical Biotechnology (El-1)
	3	Microbial Technology	T.E.(Biotech.Engg) Sem- VI	Fermentation Technology -2
	4	Drug Development and Gene Therapy	T.E.(Biotech.Engg) Sem- VI	Drug Development and Gene Therapy
	5	Industrial economics, management and entrepreneurship	B.E..(Biotech.Engg) Sem- VIII	Industrial organization,management and entrepreneurship
	6	Bioprocess Equipment Design and Drawing	T.E.(Biotech.Engg) Sem- VI	Bioprocess Equipment Design
	7	Nil	T.E.(Biotech.Engg) Sem- VI	Plant Biotechnology
	8	Industrial Visits	T.E.(Biotech.Engg) Sem- VI	Industrial Visits

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering : Semester – V
Paper No. 1 – Bioprocess Calculations

Teaching Scheme:
Lectures: 3 Hrs / Week

Examination Scheme:
Theory: 100 marks
Term work: 25 marks

Course Objectives:

1. Students will learn to write mass and energy balances on various process equipments with and without recycle.
2. Students will learn to write mass and energy balances for reactions with and without recycle.

Course Outcomes:

1. Students will learn to calculate mass and energy flow rates into and out of various process equipments.
2. Students will learn to calculate conversion, selectivity etc for various reactions with and without recycle.

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Section-I

Unit: 1 **(6 hrs)**

Introduction to Engineering Calculations:

Units and Conversions, , Density, Specific Gravity; specific volume , Mole Concept, chemical composition, Pressure, Temperature , std. Conditions, physical and chemical data, stoichiometry, atomic mass, molar mass, Equivalent mass, Normality, Molarity, Molality.

Unit: 2 **(6 hrs)**

Material Balances without Biochemical Reaction:

Material balances, Thermodynamic Preliminaries, Law of Conservation of Mass, Procedure for Material-Balance Calculations, Material-Balance for industrially important operations- continuous filtration, batch mixing, extraction, drying

Unit: 3 **(8 hrs)**

Material Balances with Biochemical Reaction:

Definition of terms involved, guidelines for solving problems, Material-Balance for industrially important operations: continuous acetic acid fermentation, Xanthan gum production, Material Balances With Recycle, By-Pass and Purge Streams, Stoichiometry of Growth and Product Formation

Section-II

Unit: 4 **(8 hrs)**

Energy Balance without reaction:

Basic Energy Concepts, General Energy-Balance Equations, Enthalpy Calculation Procedures, Enthalpy Change in Non-Reactive Processes, Procedure for Energy-Balance Calculations without Reaction, Energy-Balance for industrially important operations: Continuous water heater, cooling in downstream processing

Unit: 5 **(6 hrs)**

Energy Balance with reaction:

Enthalpy Change Due to Reaction, Heat of Reaction For Processes With Biomass Production, Energy-Balance Equation For Cell Culture, Energy-Balance for industrially important operations: Continuous ethanol fermentation, Citric acid production

Unit: 6 **(6 hrs)**

Unsteady state material and energy Balance:

Unsteady-State Material-Balance Equations, Unsteady-State Energy-Balance Equations, Unsteady-State Mass Balance for industrially important operations: CSTR, Unsteady-State Energy Balance for industrially important operations: solvent heater

Note- Discuss minimum 3 research papers based on above topics

Term Work: Assignments should be given based on each chapter

Nature of Question Paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and Reference Books:

1. Bioprocess Engineering Principles-, Pauline Doran. (Academic Press).
2. Stoichiometry -Bhat B.I and S.M.Vora .(Tata McGraw Hill)
3. Basic Principles and Calculations in Chemical Engineering David M.Himmelblau. (Prentice Hall of India Pvt Ltd).
4. Chemical Process Principles -A.Hougen, K.M.Watson and R.A.Ragatz. (John Wiley and Asia Publishing Co.)
5. Elementary Principles of Chemical Processes. Richard Felder and Ronald W.Rausseau. (John Wiley & Sons).
6. Bioprocess Engineering: Basic Concepts Michael Shuler and Fikret Kargi. (Prentice Hall).

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SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
Paper No. 2 – Biological Thermodynamics

Teaching Scheme: **Examination Scheme:**
Lectures: 3 Hrs / Week **Theory: 100 Marks**

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Course Objectives:

1. To introduce the basic concepts of thermodynamics like heat, enthalpy, internal energy, work, energy and power etc.
2. To study the laws of thermodynamics and their applications to biological systems.

Course Outcomes:

1. Students will be able to understand and apply the laws of thermodynamics to analyze energy flows in a biological system.
2. Students will be able to understand Gibbs free energy and calculate obtainable work for engineering and biological systems.

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Section-I

Unit: 1 **(6 hrs)**

Introduction and basic concepts

Scope and limitations of thermodynamics, Force, pressure and energy, Equilibrium state and the phase rule, Temperature and Zeroth law of thermodynamics, Heat reservoirs and heat engines, reversible and irreversible processes.

Unit: 2 **(8 hrs)**

First Law of thermodynamics and P-V-T behavior:

General Statements for first law of thermodynamics, first law for cyclic process, Internal Energy, first law for non-flow process, Enthalpy, first law for flow process, Heat Capacity, P-V-T behavior of pure fluids, Equation of state and concept of ideal gas, processes involving ideal gases- constant volume, constant pressure, constant temperature processes, adiabatic process, polytropic process

Unit: 3 **(8 hrs)**

Second Law of Thermodynamics:

Limitations of first law of Thermodynamics- direction of change, qualitative difference between heat and work, General statements of the second law of thermodynamics, Entropy- concept, difference between entropy and heat , The CARNOT principle, Entropy –A state function, statistical explanation for entropy, Mathematical statement of the second law of thermodynamics, Third law of thermodynamics

Section- II

Unit: 4 **(8 hrs)**

Thermodynamic properties of pure fluids

Classification of thermodynamic properties, Work function (Helmholtz Free Energy), Gibbs Free energy, Fundamental property relations, Maxwell's relations and its applications, Fugacity, standard state for fugacity, Fugacity coefficient , Effect of temp and pressure on fugacity, Activity, Effect of temp and pressure on activity .

Unit: 5 **(6 hrs)**

Gibbs free energy-theory

Equilibrium, Reversible processes, Phase transitions, Chemical potential, Effect of solutes on boiling points and freezing points, Ionic solutions, Equilibrium constant, Standard state in biochemistry, Effect of temperature on Keq , Acids and bases, Chemical coupling, Redox reactions.

Unit: 6 **(8 hrs)**

Gibbs free energy- application

Photosynthesis, Oxidative phosphorylation, Osmosis, Dialysis, Donnan equilibrium, Membrane transport, Enzyme-substrate interaction, Molecular pharmacology, hemoglobin, Enzyme linked immunosorbent assay, DNA, Polymerase chain reaction, Free energy of transfer of amino acids, Protein solubility, Protein stability, Protein dynamics, Non-equilibrium thermodynamics and life. Protein denaturation, Third law of thermodynamics and biology, Irreversibility and life.

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and Reference Books:

1. Biological Thermodynamics – D.T. Haynie (Cambridge University Press)
2. A textbook of Chemical Engineering Thermodynamics – K. V. Narayanan (Prentice Hall of India)
3. Introduction to Chemical Engineering Thermodynamics – Smith, Van Ness, Abbott (TMH)
4. Chemical, Biochemical and Engineering Thermodynamics – Stanley I. and Sandler (Wiley India Edition)
5. Chemical engineering thermodynamics – Y.V.C. Rao (New Age international)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
Paper no. 3-Fermentation Technology – 1

Teaching Scheme:
Lectures: 3 Hrs / Week
Practical: 2 Hrs / Week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

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Course Objectives:

1. To study different strategies for isolation and preservation of industrially important microorganisms, design of media and development of inocula for fermentations
2. To learn basics and use of fermentation control systems

Course Outcomes:

1. Students will be able to devise the isolation and improvement methods base on metabolic pathway of the product
2. Students will be able to design, formulate and sterilize the media for different inocula on large scale
3. Students will be able to understand design and operation of basic control loops with respect to fermentation process

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Section - I

Unit: 1 **(8 hrs)**

Isolation, preservation and improvement of industrial microorganisms

The isolation of industrially important microorganisms (Isolation methods utilizing selection of the desired characteristics, Isolation methods not utilizing selection of the desired characteristics)

The preservation of industrially important microorganisms

The improvement of industrial microorganisms (Selection of induced mutants synthesizing improved levels of products, Use of rDNA techniques)

Unit: 2 **(10 hrs)**

Media for industrial fermentations and sterilization

Types of media, Components and criteria of their choices (Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams), Media design and formulation based on stoichiometric calculations, Medium optimization (one factor at a time method, statistical methods)

Medium sterilization

The design and scale up of batch sterilization processes (Death kinetics, Del factor derivations)

The design of continuous sterilization processes (Del factor and nutrient quality criterion)

Filter sterilization (Design of depth filter for aseptic air inoculation)

Unit: 3 **(3 hrs)**

The development of inocula for industrial fermentations

The development of inocula for yeast and fungal processes

The development of inocula for bacterial and streptomycete processes

The aseptic inoculation of plant fermenters

Section - II

Unit: 4 **(8 hrs)**

Measurement of fermentation process variables

Methods of measuring process variables (Temperature, Pressure, Weight, Microbial biomass, Flow rate, Dissolved oxygen, Inlet and Exit gas, pH, Rate of stirring)

Unit: 5 **(8 hrs)**

Control of fermentation processes

Requirement for control

Control systems – Components of basic control loop (Sensors, Controllers and Actuators)

Basic fermentation control loops (Temp, pH, DO, Air flow rate, agitation, pressure and antifoam)

Types of sensors, Types of controllers (Manual and automatic controllers), Type of control actions (ON-OFF, P, I, PI, PD, PID), Types of actuators

Unit: 6 **(5 hrs)**

Case Studies on control of fermentation processes

Case study - monitoring and manual control of fermentation process

Case study - control of fermentation process using logic gates

Advanced fermentation control options – cascade feedback control, feed forward control, event tracking control, use of fuzzy logic and artificial neural network

Computer applications - Data logging Data analysis and Process control using systems like SCADA

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

List of Practicals: (Any 08)

1. Isolation of auxotrophic mutants of industrially important microorganisms
2. Estimation of carbohydrates from fermentation media
3. Estimation of proteins from fermentation media
4. Pretreatment , preparation of fermentation media
5. Determination of cell mass by different methods (dry weight method, density method and haemocytometer method) for inoculum development
6. Fermentation medium optimization
7. Study of growth kinetics of the organism
8. Study of substrate utilization kinetics of the organism
9. Study of product formation kinetics of the organism
10. Calculation of yield coefficients
11. Study of fermenter, accessories and preparation of fermenter
12. Production of alcoholic beverages by fermentation.
13. Production of organic acid by fermentation.
14. Production of antibiotics by fermentation.
15. Production of enzymes by fermentation
16. Production of amino acids by fermentation
17. Production of biosurfactants by fermentation
18. Production of single cell proteins by fermentation
19. Production of biofertilizers and biopesticides
20. Determination of COD and BOD of given sample

Text and Reference Books:

1. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J. (Aditya Books)
2. Fermentation Microbiology and Biotechnology – El-Mansi E.M.T. ,Bryce C.F.A, Demain A.L., Allman A.R. (CRC Press)
3. Bioprocess Engineering: Basic Concepts – Shuler M.L., Kargi F. (Prentice Hall of India)
4. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
5. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)
6. Biochemical Engineering – Aiba S., HumphreyA.E. , Millis N. F. (Academic Press)
7. Introduction to Biochemical Engineering - Rao D.G. (Tata McGraw-Hill)
8. Fundamentals of Biochemical engineering -Rajiv Dutta (SpringerPub., Ann Books India)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
Paper No. 4-Genetic Engineering

Teaching Scheme:
Lectures: 3 Hrs / Week
Practical= 4 Hrs / batch/week

Examination Scheme:
Theory: 100 marks
Term work = 25 marks
POE=25 marks

Course Objective:
To provide students with conceptual knowledge of gene cloning, polymerase chain reaction, gene transfer, expression systems, heterologous expression of genes, and construction of DNA libraries.

Course Outcome:
Students will learn basics of molecular methods in genetic engineering which will help them design and execute genetic engineering experiments.

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Section-I

Unit: 1 **(4 hrs)**

Recombinant DNA technology

The recombinant DNA concept, Important Discoveries, Principles of cloning, Biohazards; risk for human health, environment, agriculture, interaction with non-target organism and Bioethics of Genetic Engineering

Unit: 2 **(12 hrs)**

The Tools of genetic engineering:

Enzymes; Nucleases, Restriction Endonucleases Type I, II, III, star activity, isoschizomers Phosphodiesterase, Polynucleotide kinase, DNA ligase, DNA polymerase I, Reverse transcriptase, Terminal deoxynucleotidyltransferase, Poly A polymerase, Vector Systems*E coli* systems – the host cells,Plasmid Vectors, Bacteriophage vectors, Plasmid-Phage combination vectors, other Prokaryotic Host-Vector systems, Eukaryotic Host-Vector Systems: Yeast, Animals, Plants.

Unit: 3 **(7 hrs)**

The Means: Constructing, Cloning, and Selecting

Restriction Mapping, Inserts, Ligating vectors to insert, Infection, Transfection, and Cloning, Screening Cloned Populations of Recombinants, Genomic Libraries:-construction of genomic library, cDNA library: isolation of mRNA, synthesis of cDNA screening of cDNA clone

Section-II

Unit:4 **(5 hrs)**

The Products: Characterizing and Manipulating Recombinants

The fine anatomy of a DNA segment – Primary Nucleotide Sequence, Alternating Cloned Segments: Constructing Mutants, Analyzing the function of Cloned DNA Segments Synthesizing Polypeptides Encoded by Cloned Eukaryotic DNA Segments

Unit: 5 **(8 hrs)**

Molecular research procedures:

DNA sequencing techniques; Maxam and Gilbert's chemical degradation method, Sanger and Courlson's dideoxynucleotide chain termination method, PCR and its types, Blotting

Techniques; southern, northern and western blotting Gene silencing techniques, RNAi, Knockout Technology

Unit: 6 **(10 hrs)**

Heterologous protein production in cells prokaryotic and eukaryotic cells

Prokaryotic gene expression, Gene expression from strong and regulatable promoters
Fusion proteins, Translation expression vectors, *Saccharomyces cerevisiae* expression system, Insect cell expression system, Mammalian cell expression system, Plant cell expression system

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text books and Reference Books:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten (American Society for Microbiology)
2. Genes VIII – Benjamin Lewin (Benjamin Cummings)
3. Molecular Biology – David Freifelder (Jones and Bartlett Publishers International)
4. Principles of gene manipulations – Old RW and Primrose SB (Wiley-Blackwell)
5. Recombinant DNA: A short course: By J D Watson, J Tooze and D T Kurtz. Scientific American books (W H Freeman)
6. A textbook of biotechnology- R.C. Dubey (S. Chand publications)
7. Molecular biology of the Cell - Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
8. Molecular Biology of the Cell– by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (Garland Science)
9. Genes and Genomes – Singer M and Berg P (USCI books)

List of Practicals: (Any 08)

1. Restriction Enzyme cleavage of DNA
2. Size determination of DNA restriction fragments
3. The molecular biology of DNA amplification by PCR - demo
4. DNA mapping using restriction enzymes
5. Transformation of *E.coli* with plasmid pBR 322
6. Transduction
7. Southern Blotting
8. Isolation of plant DNA
9. Chromosomal Banding
10. Karyotyping

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
Paper no. 5 –Bioinformatics

Teaching Scheme: **Examination Scheme:**
Lectures: 3 Hrs / Week **Theory: 100 Marks**
Laboratory: 2 Hrs / batch/week **Term Work: 25 Marks**

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Course Objectives –

1. To understand various tools in bioinformatics
2. To apply Bioinformatics tools to solve various problems in Biotechnology.

Course Outcomes –

Students will have an idea on the general overview of different resources of Bioinformatics and Chemo informatics and its applications in Biotechnology.

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Section-I

Unit:1 **(4 hrs)**

Overview of Bioinformatics and Chemo informatics

Introduction to Bioinformatics and Chemo informatics, Scope and field of Bioinformatics, Contribution to different problems in biotechnology.

Unit: 2 **(10 hrs)**

Sequence formats

GenBank DNA Sequence Entry, EMBL, SwissProt, FASTA, NBRF/PIR, conversion of sequence formats. Multiple sequence format, Data retrieval with Entrez and DBGET/ LinkDB Data retrieval with SRS etc.

Unit: 3 **(8 hrs)**

Introduction to Bioinformatics and Chemo informatics databases

NCBI EMBL DDBJ EBI, SWISSPROT, PDB, The Institute of Genome Research (TIGR), Organism specific databases, Chem bank, Pubchem.

Section-II

Unit: 4 **(6 hrs)**

Protein Structure Predictions:

Introduction to Homology Modelling, BLAST, Types of BLAST, Sequence Analysis, Pair wise Alignment, Multiple Sequence Alignment Refinement of structure by energy minimization, Introduction and Applications.

Unit: 5 **(10 hrs)**

Protein-Protein Interaction databases

Active site prediction, Bond length and bond energy calculations, Electrostatic energy, Z score, RMSD and its relevance, HADDOCK,DIP (Database of Interacting Proteins),BIND-Bio-molecular Interaction Network Database, STRING Database, MINT- a Molecular Interactions Database, InterPreTS-protein interaction prediction through tertiary structure, Protein folding and defolding, Dynamics of folding, Molecular docking.

Unit: 6 **(4 hrs)**

Protein- DNA Interaction and Protein-Drug Interaction

Prediction of ORF's and signal Sequences (Promoters, Primers, PSplice Site, UTRs etc.), Applications, various databases for Protein-small molecules interaction, applications (Drug designing, chromatography column designing etc)

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

List of Practicals: (Any 08)

1. Exploring the integrated database system at NCBI server
2. Exploring the Literature database system and querying the PUBMED and GenBank databases using the ENTREZ search engine.
3. Exploring & querying SWISSPROT & UniProtKB
4. Pair-wise global alignments of protein and DNA sequences & interpretation of results to deduce homology between the sequences, use of scoring matrices(CLUSTAL)
5. Pair-wise local alignments of protein and DNA sequences using and interpretation of results (02)
6. Multiple sequence alignments of sets of sequences using web-based and stand-alone version of CLUSTAL.
7. Molecular visualization tools (Visualization of tertiary structures, quaternary structures, architectures and Topologies of proteins and DNA using molecular visualization software such as RasMol, Cn3D etc.)
8. Structure prediction tools and homology modelling (04) Prediction of secondary structures of proteins Prediction of tertiary structures of proteins using Homology Modelling approach: SWISSMODEL.
9. Transcription and Translation of sequences.
10. Analysis of active site by pymol
11. Protein-Drug interaction and its dynamics
12. Calculation of Bond length, bond angle using vLife

Text books and Reference Books:

1. Introduction to bioinformatics – T.K. Attwood and Parry-Smith D.J.
2. Bioinformatics: sequence and genome analysis by David Mount (cold springer harbour press)
3. Bioinformatics: Methods and Applications- Rastogi S. C., N. Mendiratta., P Rastogi (Prentice Hall of India Pvt. Ltd)
4. Developing Bioinformatics computer skills – Gibas C and Jambeck P
5. Baxevanis, A. D. and Ouellette, B, F, F.: Bioinformatics: A practical guide to the analysis of genes and Proteins. 2nd Ed..2002. John wiley and sons, Inc. publications, New York.
6. ngwar Eidhammer, Inge Jonassen, William R. Taylor: protein Bioinformatics. 2003 John Wiley And Sons L

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
Paper no. 6 –Immunology

Teaching Scheme:
Lectures: 3 Hrs /Week
Practical: 2 Hrs /batch /Week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks
POE: 25 Marks

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Course Objectives:

1. To learn the structure, component, function and mechanism of immune system. Primary emphasis of this course is to study mechanisms involved in immune system development and responsiveness.
2. To learn the fundamental concepts of immunology and the associated vocabulary.
3. To learn to apply immunological knowledge to solving new problems
4. To become proficient with the use of the major investigation tools in immunology
5. To become comfortable discussing immunological ideas with various audiences

Course Outcomes:

1. Students will be able to learn the immune System & the immunotechnology and its applications to Biotechnology.
2. Students will be able to learn the immunodiagnostics and setup a industry or diagnostic kit.
3. Students will be able to learn to innovate and patent a immunodiagnostic idea, instrument or kit
4. Students will be able to learn to work in immunology R & D Lab, Industry
5. To become comfortable discussing immunological ideas with various audiences

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Section-I

Unit: 1 **(5 hrs)**

Introduction to Immune System

Introduction immune system, Innate and Acquired immunity, Organization and structure of lymphoid organs, Cells of the immune system- stem cells, hematopoietic cell – myeloid series and lymphoid series Antigens- structure and function and super-antigens. Antibody structure and function, types of immunoglobulins. Antigen – Antibody interactions- cross reactivity, precipitation, agglutination, neutralization, opsonization etc and their application

Unit: 2 **(5 hrs)**

Major Histocompatibility Complex & Complement System

Major Histocompatibility Complex- MHC class I and II, BCR and TCR generation of diversity- structure and function of BCR and TCR Complement system- classical pathway and alternate pathway

Unit: 3 **(5 hrs)**

Cell Interaction And Antibody Generation

Cell migration and cell adhesion molecules – inflammatory response, - Regulation of immune response, Antigen processing and presentation, generation of humoral mediated immune response. and cell mediated immune response. Activation of B and T lymphocytes. Cytokines and their role in immune regulation.

Section-II

Unit: 4

Transplantation, Tumor Immunity and Hybridoma (5 hrs)

Transplantation - immunological basis of graft rejection, Immunological tolerance sub- acute, acute and chronic graft rejection Tumor immunology – ADCC, natural killer cell and CTL mediated Immunity. Traditional Hybridoma technology and monoclonal antibodies. HLA and Hybridoma technology, generation of monoclonal antibodies

Unit: 5 **(5 hrs)**

Immunity to Infectious Agents

CD4+ and CD8+ mediated antibacterial immunity, intracellular parasitic immunity, antihelminthic immunity and antiviral immunity Hypersensitivity – Type I, II, III and IV Autoimmunity- introduction, general autoimmune diseases

Unit: 6 **(5 hrs)**

Primary and Secondary Immunodeficiencies

T cell mediated immunodeficiency-
B cell mediated immunodeficiency
T/ B combined cell mediated immunodeficiency
Disorders of phagocytosis
Disorders of complement

Text and Reference Books:

1. Immunology: Lydyard, P.M., Whelan,A., Fanger, M.W. , 1st Ed., Viva Books
2. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
3. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H. ,Oxford, 4th , 5th & 6th Edition.
4. Cellular and molecular Immunology – Abbas A.K., Lichtman A.H. and Pober, J.S.
5. Fundamental Immunology – Paul
6. Immunobiology 3rd ed. – Janeway Travers C. Janeway, et al., Garland Science, 2004.
7. Short Protocols in Immunology by John E. Coligan
8. Practical Immunology, 4th Edition, Frank C. Hay, Olwyn M.R. Westwood

List of Practicals: (Any 08)

1. Precipitation assay
2. To examine the cells that comprise the immune system (counts and morphology)
3. Immunization, collection of serum.
4. Immunological detection of blood group typing.(A,B, AB and O, Rh Factor)
5. Ouchterlony double diffusion
6. Radial immunodiffussion
7. Immunoelectrophoresis
8. ELISA
9. Western blotting
10. Detection of pregnancy by HCG technique
11. Purification of Immunoglobulin G with DEAE Column Chromatography
12. Immunohistochemical detection and localization of specific antigens.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – V
7- Basics of Cell Culture

Teaching Scheme **Examination scheme:**
Practical hours =2 Hrs/batch/week **Term work = 25 marks**

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Course Objective:

The major objective of this course is to acquaint students with fundamental of plant and animal cell culture.

Course Outcome:

At the end of the course students will gain knowledge of basic techniques of animal and plant cell culture.

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A. Basics of Plant cell culture techniques.

1- Glasswares and Plasticware sterilization.
2- Media Preparation.
3- Callus Culture
4- Isolation and culture of explants.
5- Embryo Culture

B. Basics of Animal Cell Culture techniques.

1. Glassware and Plasticware sterilization.
2. Media Preparation.
3. Isolation of lymphocytes from human peripheral blood.
4. Cell viability studies.
5. Cell counting
6. Cell Culture - lymphocytes

Text and reference books:

1. Basic Principles of Cell Culture by R. Ian Freshney (John Wiley & Sons, Inc.)
2. Plant Tissue Culture: Theory and Practice by S.S. Bhojwani, M.K. Razdan (Elsevier)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 1 – Bioprocess Equipment Design

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	**Theory: 100 marks**
Practical: 2 Hrs /batch/week	**Term work : 25marks**

Course Objectives:

1. To understand the basics for design as per the codes & standards for the process and mechanical design of equipments used in the bioprocess industry.
2. To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment
3. To understand content and applications of process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs)

Course Outcomes:

1. Students will demonstrate understanding of design of pressure vessels.
2. Students will demonstrate ability to design various components of process equipment like heat exchanger, fermenter and dryer.
3. Students will able to demonstrate ability to prepare and draw flow sheet of specific processes used in biotech industries.

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Section-I

Unit:1 **(6 hrs)**

Design preliminaries

Design codes, Mechanical Properties of Materials, design pressure, design temperature, design stress and factor of safety, corrosion allowance, Weld joint efficiency factor,Design Loadings.

Unit: 2 **(8 hrs)**

Pressure vessels

Classification of pressure vessels, Pressure Vessel Codes & Standards, selection of material, Design of Shell & its components, Thumb rules, process hazards and safety measures in equipment design.

Unit: 3 **(6 hrs)**

Flow sheet preparation and drawing

Sketching techniques, equipments symbols, equipment lettering ,numbering and drawing, piping and instrumentation(P&ID) , valves types.

Section-II

Unit: 4 **(7 hrs)**

Heat exchanger

Process design, mechanical design- Introduction, types of heat exchanger, Design of Shell & Tube Heat Exchanger, Material of Construction, , design pressure ,design temperature, Shell, tube, tube sheet, baffles.

Unit: 5 **(8 hrs)**

Reaction vessel- process design, mechanical design-Introduction, material of construction, Classification of Reaction Vessels ,Heating System: jackets and coils, types of agitators, flow patterns in agitated tanks, Power requirement for mixing ungassed Newtonian and non-Newtonian fluids, gassed fluids, Design of Agitator system components

Unit: 6 **(5 hrs)**

Dryer

Introduction, types, -process design , mechanical design.

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and reference books:

1. Joshi's Process Equipment Design, V.V.Mahajani & S.B.Umarji, fourth edition.(Macmillan publishers India Ltd)
2. Coulson J. M. and Richardson J. F., "Chemical Engg." Vol. 2 & 6, (Pergaman Press)
3. Process Design of Equipment ,Dr. S.D. Dawande, 1st Edition,(Central Techno Publication)
4. Fundamentals of Equipment Design ,A. K. Koker,(Gulf Publication).
5. Process Heat Transfer ,D.Q. Kern,(Tata McGraw Hill Company, New York).
6. Applied Process Design for Chemical and Petrochemical Plants ,E.E. Ludwig, Vol.I,II,III, , 3rd edition London, 1994(Gulf Publication)
7. A Guide to Chemical Engineering Process Design and Engineering G.D.Ulrich,,(John Wiley and Sons, New York).
8. Plant Design and Economics for Chemical Engineers M.S. Peters & K.D.Timmerhaus,", 5th edition, (McGraw Hill International Book Co).
9. Piping Design Handbook J. J. McKetta, (Marcel Dekker inc.(New York).
10. Chemical Engineering Kinetics, J. M. Smith,3rd edition(McGraw Hill, New York)
11. Chemical Engg .,J.M. Coulson, , Vol. VI,(Pergamon Press, Oxford).

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 2-Fermentation Technology - 2

Teaching Scheme:
Lectures: 4Hrs /Week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks

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Course Objectives:

1. To study different types of bioreactors, their accessories and design
2. To evaluate the scale up strategies for the bioreactors with respect to different parameters
3. To study different effluent treatment processes for industrial effluents

Course Outcomes:

1. Students will be able to classify, select and design bioreactors based on the applications
2. Students will be able to devise scale up strategy for bioreactors
3. Students will be able to design effluent treatment processes

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Section - I

Unit: 1 **(10 hrs)**

Classification and selection of bioreactors

Classification of reactors, peripherals and accessories

Mode of fermentation operations – batch, fed batch, continuous

Fermentation Kinetics - Microbial Growth Kinetics (Development of growth equation,Quantifying cell concentration, Growth patterns and Kinetics), Substrate consumption kinetics, Product formation kinetics

Mass transfer characterization (Determination of K_La , Factors affecting K_La values)

The balance between oxygen supply and demand

Selection of reactors

Unit: 2 **(10 hrs)**

Bioreactor Design

Design, construction and working of stirred tank reactor

Design, construction and working of bubble column reactor, air lift reactor

Design, construction and working of packed bed reactor, expanded bed reactor, fluidized bed reactor

Unit: 3 **(6 hrs)**

Scale up of bioreactor

Scale up concerns of microbial, mammalian and plant cell processes

Scale up criteria for bioreactors (Constant power per Unit volume, Constant K_La, Constant mixing quality, Constant impeller tip speed, Constant momentum factor, Constant mixing rate number, Similar drop size distribution), Selection of scale up criteria

Section - II

Unit: 4 **(12 hrs)**

Fundamentals of effluent treatment

Characterization of wastewater (sample collection, processing, Significance of Dissolved Oxygen, pH, Alkalinity, BOD, COD, Phosphorous and Nitrogen)

Classification of treatments –

Physicochemical treatments (Screening, grit removal, oil and grease removal, primary sedimentation, precipitation)

Biological treatments (aerobic oxidation, anoxic treatment, anaerobic treatment, biological nitrification and denitrification, biological phosphorus removal, acclimatization of bacteria for toxic waste)

Unit: 5 **(8 hrs)**

Aerobic effluent treatment

Fundamentals and design of -

Suspended growth processes – Activated sludge process and its modification, Aerated lagoons

Attached growth processes – Trickling filters, Rotating biological contactors

Unit: 6 **(6 hrs)**

Anaerobic effluent treatment, disinfection and disposal

Upflow Anaerobic Sludge blanket, Anaerobic digester

Combined processes (Hybrid reactors)

Disinfection methods (Chlorination, UV treatment, ozone treatment)

Disposal standards and methods

Note- Discuss minimum 3 research papers based on above topics

Nature of Question Paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and Reference Books:

1. Bioreactors in Biotechnology : A practical approach- Scragg A.H. (Ellis Horwood Pub.)
2. Bioreactor System Design – Asenjo J.A. (CRC Press)
3. Basic Bioreactor Design – Van't Riet Klass, Tramper J. (CRC Press)
4. Principles of Fermentation Technology–Stanbury P.F.,Whitaker A, Hall S.J.(Aditya Books)
5. Fermentation Microbiology and Biotechnology – El-Mansi E.M.T. ,Bryce C.F.A, Demain A.L., Allman A.R. (CRC Press)
6. Bioprocess Engineering: Basic Concepts – Shuler M.L., Kargi F. (Prentice Hall of India)
7. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
8. Process Biotechnology fundamentals – Mokhopadhyay S. N. (Anshan Publishers)
9. Biochemical Engineering – Aiba S., HumphreyA.E. , Millis N. F. (Academic Press)
10. Introduction to Biochemical Engineering - Rao D.G. (Tata McGraw-Hill)
11. Fundamentals of Biochemical engineering -Rajiv Dutta (SpringerPub.,Ann Books India)
12. Wastewater Engineering : Treatment and Reuse – Metcalf & Eddy , Tchobanoglous G.,Burton F.L., Stensel H.D. (McGraw Hill Pub.)
13. Microbiology for Sanitary Engineers – McKinney, Ross. E. (McGraw-Hill)
14. Environmental Engineering–H.S. Peavy,D.R.Rowe,G. Tchobanoglous(Tata McGraw-Hill)
15. Handbook of Water and Wastewater Microbiology – Dunkan Mara, Nigel Horn (Academic Press)
16. Theory and Practice of water and wastewater treatment – Ronald Droste (Wiley Pub.)
17. Standard Methods for the Examination of Water & Wastewater - Andrew D. Eaton, Mary Ann H. Franson (APHA, AWWA)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 3.-Bioseparation Processes

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hrs./batch/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks
POE: 25 Marks

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Course Objectives:

1. To study physico-chemical principles, working mechanism and applications of different bioseparation processes
2. To understand how to select the separation strategy to separate valuable products produced in different bioprocesses

Course Outcomes: Students will be able -

1. To understand physico-chemical principles of different bioseparation unit operations
2. To understand how to select and design the separation strategy based on biomolecular characteristics
3. To design and scale up of bioseparation equipments
4. To understand the economic aspects of bioseparation (downstreaming) strategy as a whole

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Section – I

Unit 1 **(7 hrs)**

Introduction

Classification of biotechnology products, Recovery in modern versus classical biotechnology, Characterization of fermentation broth / extract and product

Broth Pretreatments – Requirements and types (Coagulation, flocculation, filter aid usage, cell disruption for intracellular products)

Unit 2 **(12 hrs)**

Removal of insolubles

Filtration – Conventional filtration versus depth filtration, Basic theory of filtration, Types of filtration processes, Types of filtration equipments, Scale up

Centrifugation – Theory of sedimentation, Equipments for sedimentation, Relative centrifugal field, Types of centrifugation, Types of industrial centrifuges, Performance equation of centrifuges, Gyro and Sigma factor based scale up

Unit 3 **(11 hrs)**

Isolation

Extraction – Partition coefficient basis of extraction, Type of extraction processes, Type of equipments, Scale up, Special extraction types (Aqueous two phase extraction, Supercritical fluid Extraction, Reverse Miceller Extraction)

Precipitation – Chemistry of dissolution and precipitation, Difference between crystallization and precipitation, Type of Precipitation (using salts, using organic solvents, using acid/alkali, using electrolytes, using non ionic polymers), Type of equipments, Scale up

Section – II

Unit 4 : Purification **(16 hrs)**

Adsorption – Chemistry of adsorption, Adsorbents, Batch adsorption, Adsorption isotherms (Linear, Freundlich, Langmuir), Continuous adsorption (Adsorption in CSTR, Adsorption in fixed beds) , Scale up

Chromatography – Planar chromatography (paper and thin layer) , Column chromatography (Normal phase chromatography**,** Ion-exchange chromatography, Adsorption chromatography, Reverse phase chromatography**,** Hydrophobic interaction chromatography, Affinity chromatography, Gel-filtration chromatography) Analytical chromatography (HPLC,GC,HPTLC) versus preparative chromatography

Unit 5 : Membrane Separations **(6 hrs)**

Classification of membranes processes based on different driving forces (microfiltration, ultra filtration, nano filtration, reverse osmosis), Structure and preparation of membrane, Types of membrane modules, scale up

Unit 6: Finishing Operations and Stability **(4 hrs)**

Buffer exchange (diafiltration), Crystallization, Drying, Evaporation, Preparative electrophoresis Formulation, Granulation, Tableting , Stability studies

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

List of Practicals: (Any 8)

1. Flocculent screening
2. Cell disruption (mechanical method, chemical method, enzymatic method)
3. Calculation of time of filtration
4. Study of sedimentation
5. Single stage and multi stage extraction, Phyto-extraction using Soxhlet
6. Aqueous two phase extraction
7. Study of adsorption isotherm
8. Study of breakthrough curve in column adsorption
9. Isoelectric point precipitation
10. Salt precipitation
11. Organic solvent precipitation
12. Demonstration of membrane modules
13. Gel filtration chromatography
14. Ion exchange chromatography
15. Reverse phase chromatography
16. Affinity chromatography
17. Case study of purification of product from fermentation broth

Textbooks and Reference Books:

1. Bioseparations - Belter P.A., Cussler E.L., Hu Wei-Shou (Wiley Publication)
2. Bioseparation - Shivshanker B. (Prentice Hall of India)
3. Bioseparation Science and Engineering – Harrison R.G., Todd P., Rudge S.R., Petrides D.P. (Oxford University Press)
4. Product recovery in bioprocess technology – Biotol Series (Butterworth-Heinemann Ltd.)
5. Protein Purification: Principles and Practice - Scopes Robert K. (Springer – Verlag Pub.)
6. Separation processes in Biotechnology –Asenjo J.A. (Taylor and Francis Group)
7. Separation and Purification Techniques in Biotechnology – Dechow F.J. (Noyes Pub.)
8. Transport Processes and Separation Process Principles - Geankoplis Christie John (Prentice Hall of India)
9. Unit Operation of Chemical Engineering - McCabe W. L., Smith J., Harriot P.(McGraw-Hill Pub.)
10. Downstream Processing in Biotechnology – Anuj Kumar Rana (Global Vision Pub.)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E.. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 4 -Analytical Techniques in Biotechnology

Teaching Scheme:
Lectures: 4 Hrs/week
Practical's: 2 Hrs/batch/week

Examination Scheme:
Theory: 100 Marks
Term Work: 25 Marks
POE : 25 Marks

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Course Objectives:

1. To provide students with knowledge of various techniques in Biotechnology and their applications in designing new instruments.
2. To understand the working principles and mechanism of various analytical instruments used in biotechnology.
3. Be engaged in a professional career in the bioinstrumentation or other related industries, or enrolled in advanced post graduate studies.

Course Outcomes:

1. Students will gain the knowledge of designing various analytical techniques in Biotechnology.
2. Students will be able to classify, select instruments based on the working and applications for R & D.
3. Students will be able to handle various instruments used in Biotechnology.

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Section I

Unit: 1 **(6 hrs)**

Introduction

Introduction, Modern approaches in Bioanalysis and Bioassays, Need for Bioinstrumentation. Transducers- Piezoelectric transducers, Electromagnetic transducers, Optical transducers.

Unit: 2 **(10 hrs)**

Spectroscopic techniques

Absorption spectrum, instrumentation for UV-Visible spectrophotometry, radiant energy sources, wavelength selectors, detection devices, amplification and read out, double beam operation, double wavelength spectrophotometer, applications of UV-Visible spectrophotometry, quality & quantitative analysis. Theory and applications of Infrared spectrophotometry, calculation of vibrational frequencies, modes of vibration, infrared spectra of common functional groups. Infrared Spectrophotometer: Mode of operation, sampling techniques, applications. Principles, components and applications of - Flame spectrophotometry, Nuclear Magnetic Resonance spectrometry, Fluorescence spectroscopy.

Unit: 3 **(10 hrs)**

Microscopic Techniques

Light Microscopy; Principles, components and applications of - simple and compound microscopy, Fluorescence microscopy, Phase contrast microscope, Atomic forcemicroscope, Electron microscope, Scanning electronmicroscopy, Transmission electron microscope. Application ofmicroscope in analyzing biological samples.

Section II

Unit:4 **(10 hrs)**

Electrophoretic Techniques

Electrophoresis; Principle, Design of horizontal and vertical gelelectrophoresis apparatus.SDS PAGE, Discontinuous (Disc) Gel Electrophoresis, High Voltage (HVE) Electrophoresis, Isoelectric focusing, 2D Gel Electrophoresis, Pulse-Field Gel Electrophoresis.Application of electrophoresis in analyzingmacromolecules.

Unit: 5 **(10 hrs)**

Chromatographic Techniques

Plane Chromatography- Paper Chromatography, Thin Layer Chromatography. Column Chromatography- AdsorptionChromatography, Partition Chromatography, Liquid-Liquid Chromatography, Gas-Liquid Chromatography, Gel Permeation Chromatography, Ion Exchange Chromatography, Affinity Chromatography, High Performance Liquid Chromatography, GCMS, LCMS, HPTLC.

Unit: 6 **(6 hrs)**

Certain physicochemical techniques useful in Biotechnology

Geiger-Muller counter, scintillation counter, Enzyme-Linked Immunosorbent Assay (ELISA), Radio-Immunosorbent Assay (RIA), Flow cytometry

Note- Discuss minimum 3 research papers based on above topics

Nature of Question Paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and Reference Books:

1. Bioanalytical Chemistry, A. Manz, N. Pamme and D. Iossifidis, (World ScientificPublishing Company)
2. Basic Methods in Microscopy, Protocols and concepts from cells: A LaboratoryManual, D. L. Spector & R. D. Goldman (Editors.), Cold Spring Harbor Laboratory Press, 2006
3. Live Cell Imaging: A Laboratory Manual R. D. Goldman, J. R. Swedlow and D. L. (Spector Cold Spring)
4. Harbor Laboratory Press; 2nd edition, 2009.
5. Biophysical Chemistry-Principles and Techniques, A. Upadhyay, K. Upadhyay, N. Nath. (Himalaya Publishing House)
6. Bioinstrumentation, J. Webster (John Wiley and Sons Inc.,)

List of Practicals: (Any 8)

1. Demonstration of SDS PAGE / Native PAGE
2. Protein purification by IEC
3. Detection of components of mixture using absorption spectra
4. Determination of alkaline phosphatase using UV-VIS spectrophotometer
5. Demonstration of SEM/TEM microscopy
6. Study of cell by Phase contrast microscopy
7. Thin Layer Chromatography
8. Demonstration of HPLC
9. Demonstration of FTIR
10. Demonstration of GCMS
11. Demonstration of Fluorescence microscopy
12. Demonstration of HPTLC
13. Demonstration of LCMS
14. Demonstration of 2D Gel Electrophoresis.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 5 –Drug Development and Gene Therapy

Teaching Scheme: **Examination Scheme:**
Lectures: 3 Hrs /week **Theory: 100 Marks**

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Course Objectives:

1. To impart an understanding of the terms 'traditional pharmaceutical product', 'biologic' and 'biotechnological products'.
2. To provide students with a theoretical knowledge of drug targets and gene therapy.
3. To provide students with knowledge of various techniques in biotechnology and their applications in the manufacturing of biopharmaceuticals.
4. To gain knowledge in some of the physicochemical properties and formulation of commonly used biopharmaceuticals.

Course Outcomes:

At the end of the course, students will gain the knowledge of production and downstream processing of biopharmaceuticals, formulation of protein drugs and gene therapy.

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Section: I

Unit: 1 **(5 hrs)**

Introduction

Introduction to Pharmaceutical industry, pharmaceutical products, the age of biopharmaceuticals, biopharmaceuticals from plants, animals and microorganisms. Production and downstream processing of Biotech products; Expression systems, contaminants, downstream processing, issues to consider in production and purification of proteins

Unit: 2 **(8 hrs)**

Drug targets classification: DNA, RNA, post-translational processing enzymes, metabolic , enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane)proteins, ligand-gated ion channels (Oligomeric transmembrane proteins), transporters (multi-transmembrane proteins)

Unit: 3 **(8 hrs)**

Formulation of biotech products

Microbiological consideration, Excipients used in parental formulation of Biotech products, biopharmaceutical considerations, Shelf life of protein based pharmaceuticals, Routes of administration and adsorption enhancement approaches for rate controlled and target site specific by the parenteral route

Section-II

Unit: 4 **(6 hrs)**

Somatic and germ line gene therapy

Introduction, In vivo and, ex vivo gene therapy, Transgenic animal models, Gene replacement and gene addition

Unit: 5 **(8 hrs)**

Vectors for gene therapy

Viral vectors;retrovirus, Adenovirus, Adeno-associated virus , Nonviral vectors; Liposomes and lipoplexes, Naked DNA, transposon.

Unit: 6 **(8 hrs)**

Gene Therapy and diseases

Gene therapy of Cancer Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia, Severe combined immunodeficiency syndrome (SCID), Gene therapy of nonheritable disorders

Note- Discuss minimum 3 research papers based on above topics

Nature of Question Paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and reference books:

1. Industrial pharmaceutical Biotechnology by Heinrich Klefenz, (Wiley- VCH))
2. Biopharmaceutical Drug Design and Development by Susanna Wu-pong, Yongyut Rojanasakul and Joseph Robinson (Humana Press)
3. Biopharmaceuticals: Biochemistry and Biotechnology by Gary Walsh (Wiley-Blackwell)
4. Pharmaceutical Biotechnology, 2nd Ed. By Crommelin D.J.A. & Sindelar R.D (Taylor & Francis)
5.. The Development of Human Gene Therapy by Friedman T. (Cold Spring Harbor Lab. Press)).
7. Adenovirus vectors for gene therapy. In Gene Therapy Hackett NR, Crystal RG (Marcel Dekker)

SHIVAJI UNIVERSITY, KOLHAPUR
B.E.. Biotechnology Engineering
Third Year Engineering: Semester – VI
Paper no. 6-Plant Biotechnology

Teaching Scheme: **Examination Scheme:**
Lectures: 3 Hrs./week **Theory: 100 Marks**

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Course Objectives-

1. To introduce technique of plant tissue culture (PTC) practices areas of PTC and Application
2. To teach plant genetic engineering
3. To expose students to issues and challenges encountered in the area of plant biotech.

Course Outcome-

The course will provide an overview of plant biotechnology with focus on industrial applications.

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Section-I

Unit: 1 **(5 hrs)**

Plant Cell and Tissue Culture

Laboratory organization; Sterilization and preparation of media; nutrition in plant cell; Tissue and organ culture; Establishment and maintenance of callus and suspension cultures; Cellular differentiation and regulation of morphogenesis;Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell methods; Cytology of callus.

Unit: 2 **(9 hrs)**

Different Areas of PTC

Plant micropropagation: Application of micropropagatioN, Micrografting – in vitro clonal multiplication – Meristem culture and virus elimination; Shoot tip culture; Somatic embryogenesis and artificial seeds; In vitro selection of mutants –mutants for salts;Tissue culture: Haploid production - Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; In vitro pollination and fertilization; Protoplast isolation; Culture – regeneration; Somatic hybrid-cybrids.

Unit: 3 **(6 hrs)**

Tissue Culture Applications

Tissue culture applications: Improved crop varieties through somaclonal variation in in vitro cultures -- Causes- stability and utilization – genetic and epigenetic basis; Establishment of cell lines and evaluation; Secondary metabolite in cell culture; Application of tissue culture for crop improvement in medicinal plant agriculture, horticulture and forestry.

SECTION-II

Unit: 4 **(7 hrs)**

Plant Genetic Engineering

Introduction to Plant genetic Engineering:Instruments require, Bioreactor design and working; Methodology; Plant transformation with Ti plasmid of Agrobacterium tumifacians; Ti plasmid derived vector systems; Physical methods of transferring genes to plants - Microprojectile bombardment, Electroporation; Use of reporter genes in transformed plant cells; Manipulation of gene expression in plants; Production of marker free transgenic plants, promoter and reporter genes with introns, scaffold attachment, multiple gene transfer.

Unit: 5 **(6 hrs)**

Molecular Marker Aided Breeding

Molecular markers, Markers based on hybridization (RFLP Maps), Markers based on PCR Amplifications (RAPD Markers, STSs, Microsatellites, SCARs, SSCP,AFLP),Molecular Marker Assisted Selection: molecular breeding, Linkage analysis, Map-based cloning, QTL (Quantitative Trait Loci). Arid and semi arid plant biotechnology; green house and green home technology.

Unit: 6 **(7 hrs)**

Application of Plant Genetic Engineering

Herbicide resistance, Insect resistance, Disease resistance, Virus resistance. Abiotic stress tolerance; Drought, Temperature, Salt, Post-harvest losses, Long shelf life of fruits and flowers, Male sterile lines, Transgenic plants as Bio-factories, production of quality oil, Industrial enzymes, Antigens (edible vaccine),provitamins iron proteins in rice, modification of food plants test and application, yield increase in plant, wild plants- source of novalgene. Genetic manipulation of flower pigmentation.

Note- Discuss minimum 3 research papers based on above topics

Nature of Question paper:

1. There will be two sections carrying 50 marks each.
2. Each section should have three questions having internal options.

Text and reference books:

1. An introduction to plant tissue culture by Rajdan M.K. (2003) Science publisher in field USA.
2. Text book of Plant Biotechnology, by Chawala P.K. (2002) Oxford press and IBH New Delhi.
3. Plant Tissue Culture theory and practice Bhojwani, S.S. and Rajdan M.K. (1999)Elsevier publisher
4. Plant Tissue Culture Laimer and Rucker W. (2003) Springer-Verag
5. Hand book of plant biotechnology (2 Vol.) Christou P. and Klee, H.eds. (2004) Wiley Publishing U.K.
6. Plant Tissue Culture K.K. De (2008) New central book agency.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
7. Seminar

Teaching Scheme: **Examination Scheme:**
Seminar: 2 hrs./week **Term work : 25 marks**

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The student should deliver a seminar (each 15 to 20 minutes) and submit Seminar report to the department. The topic of the seminar may be chosen from different technical subjects being studied during the semester or their application.

The assessment shall be based on
1. Performance of the seminar delivery.
2. Details provided in seminar reports and
3. Performance during discussions on the seminar topic

The faculty member / s shall guide the students for:
1. Selecting the seminar topics
2. Information retrieval (literature survey)
3. Source of information i.e. names of the journals, reports books etc
4. Preparation of the seminar report as per the guidelines of department
5. Presentations on Powerpoint/OHP

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SHIVAJI UNIVERSITY, KOLHAPUR
B.E. Biotechnology Engineering
Third Year Engineering: Semester – VI
8. Industrial Visit

Teaching Scheme: **Examination Scheme:**
Practical: 1 hr /week **Term work = 25 marks**

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Minimum of 3 industries should be visited by the students and submit brief report.
The term work marks shall be given on the basis of following criteria observed and noted in the report:
1. Number of industrial visits
2. Reports
3. Orals

Report may consist the following information from the visited industry:
1. Objectives and History of the industry visited
2. Raw material
3. Process flow chart
4. Equipment details
5. Pollution control aspects
6. Production process details
7. Quality control aspects
8. Packaging and distribution practices
9. Cost of Production and profits
10. Suggestions for improvement / Consumers point of view
11. Safety Aspects

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