Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum

FOR

Third Year (T.Y.)

B.Tech. Biotechnology

(Choice Based Credit System)

(2019 Course)

(With Effect from Academic Year 2021-22)

Savitribai Phule Pune University, Pune
Syllabus For Third Year B.Tech. Bio-Technology (2019 Course)
(With effect from Academic Year 2021-22)

Semester-V

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR/OR	TUT	Total
315461	Analytical Techniques	3	-	-	30	70	-	-	-	100	3	-	-	3
315462	Material Balances and Stoichiometry	3	-	-	30	70	25	-	-	125	3	-	-	3
315463	Genetic Engineering	3	-	-	30	70	-	-	-	100	3	-	-	3
315464	Introduction to Immunology	3	-	-	30	70	-	-	-	100	3	-	-	3
315465	Elective I	3	-	-	30	70	-	-	-	100	3	-	-	3
315466	Analytical Techniques Lab	-	4	-	-	-	-	50	-	50	-	2	-	2
315467	Genetic Engineering Lab	-	4	-	-	-	-	-	50	50	-	2	-	2
315468	Elective I Lab	-	2	-	-	-	25	-	-	25	-	1	-	1
315469	Seminar	-	-	1	-	-	50	-	-	50	-	-	1	1
315470	Audit course 5	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		15	11		150	350	100	100		700	15	06		21

315465: Elective I Options

315465 (A) Enzyme Technology

315465 (B) Good Laboratory Practices and Good Manufacturing Practices

315465 (C) Agricultural Biotechnology

315470 Audit Course Options

315470 (A) Lifestyle and Nutrition

315470 (B) Essence of Indian Traditional Knowledge

Abbreviations:

TH : Theory TW : Term Work PR : Practical

OR : Oral TUT : Tutorial

Note: Students of third year (Biotechnology) can opt any one of the audit course from the list of audit courses prescribed by BoS (Biotechnology Engineering)

Savitribai Phule Pune University, Pune
Syllabus For Third Year B.Tech. Bio-Technology (2019 Course)
(With effect from Academic Year 2021-22)

Semester-VI

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR/OR	TUT	Total
315471	Fermentation Technology	3	-	-	30	70	-	-	-	100	3		-	3
315472	Mass Transfer	3	-	-	30	70	-	-	-	100	3		-	3
315473	Bioseparation Engineering	3	-	-	30	70	-	-	-	100	3		-	3
315474	Elective II	3	-	-	30	70	50	-	-	150	3	-	-	3
315475	Fermentation Technology Lab	-	4	-	-	-	-	-	50	50	-	2	-	2
315476	Mass Transfer Lab	-	2	-	-	-	50	-	-	50	-	1	-	1
315477	Bioseparation Engineering Lab	-	4	-	-	-	-	50	-	50	-	2	-	2
315478	Audit course 6	-	-	-	-	-	-	-	-	-	-		-	-
315479	**Internship****	-	-	-	-	-	100**	-	-	100		-	-	4**
	Total	12	10	-	120	280	200	100		700	12	5		21

Internship :**
Internship guidelines are provided in the course curriculum.

315474: Elective II Options

315474(A) Instrumentation and Process Control
315474(B) Food Biotechnology
315474(C) Data base management systems

315478 Audit Course Options

315478 (A) Technical Communication
315478 (B) Financial Management

Abbreviations:
TH : Theory TW : Term Work PR : Practical
OR : Oral TUT : Tutorial

Note: Students of third year (Biotechnology) can opt any one of the audit courses from the list of audit courses prescribed by BoS (Biotechnology Engineering)

Semester – V

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology (2019 Course)
315461: Analytical Techniques

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs/ Week	**03**	**In-Sem (Theory): 30 Marks** **End-Sem (Theory): 70 Marks** **Total: 100 Marks**

Prerequisite Courses, if any:

Basic knowledge of Biology, Chemistry and Mathematics

Companion Course, if any: --

Course Objectives:

1. To bring understanding of analytical methods used in biotechnology
2. To acquire knowledge of qualitative & quantitative analysis techniques for biological samples
3. To introduce the state of art methods for sample analysis

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand basic principles of Analytical Techniques and importance of sample preparation for the Analytical processes

CO2: Learn chromatography separation technique to determine the components of a mixture for qualitative & quantitative analysis of sample.

CO3: Acquire skills in state-of-art electrophoresis laboratory method for separation and analysis of macromolecules in biological samples

CO4: Understand indispensable centrifugation method as tool of modern biochemistry for subcellular studies.

CO5: Learn spectroscopy technology to detect, determine, or quantify the molecular and/or structural composition of a sample.

CO6: Learn advanced spectroscopy techniques and their applications

Course Contents

Unit I	Introduction	(8 Hrs.)

Basic principles of analytical techniques, Summary of experimental methods currently available for analysis: History and development, Introduction to modern approaches in Bioanalysis and Bioassays, Experimental Studies, Experimental Errors, Statistical Parameters for Validation of an Experiment, Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precision, measures of dispersion and central tendency, General principles of biological sample preparation for different analytical techniques

Mapping of Course Outcomes for Unit I	CO1: Attain technical knowledge of using magnification and resolution technology of various microscopes for analyzing biological samples.	
Unit II	**Chromatography**	**(8 Hrs)**
Introduction, principles- distribution coefficient, RF value Types of chromatographs a) Thin layer, HPTLC, paper chromatography b) Column chromatography – gel filtration, ion-exchange, affinity chromatography, c) adsorption chromatography, Applications in biotechnology.		
Mapping of Course Outcomes for Unit II	CO2: Learn chromatography separation technique to determine the components of a mixture for qualitative & quantitative analysis of sample.	
Unit III	**Electrophoresis & Visualization**	**(8 Hrs)**
Introduction, Theory, working principles, instrumentation and applications of gel electrophoresis, capillary electrophoresis, supporting matrices. Electrophoresis of proteins- SDS PAGE, native PAGE, Nucleic acids – Agarose, Pulse field gel electrophoresis.& Staining		
Mapping of Course Outcomes for Unit III	CO3: Acquire skills in state-of-art electrophoresis laboratory method for separation and analysis of macromolecules in biological samples	
Unit IV	**Basic Separation Techniques**	**(6 Hrs)**
Basic separation techniques: Centrifugation - Ultracentrifugation, Gradient centrifugation, Filtration – Constant pressure and volume filtration, Rate of filtration, Filter medium and filter cake resistance, specific cake resistance, Types of Filters, Washing and dewatering of filter cakes		
Mapping of Course Outcomes for Unit IV	CO4: Understand indispensable centrifugation method as tool of modern biochemistry for subcellular studies.	
Unit V	**Spectroscopy-I**	**(8 Hrs)**
Introduction, Beer-Lambert's law, Instrumentation, Principle and applications of UV-visible spectroscopy (chromophores in proteins), instrumentation (spectrophotometer and colorimeter), study of molecular extinction coefficient, Spectrofluorometry – Principle, Energy Diagram, Instrumentation, Applications, Case studies,Quantitative Spectrophotometric analysis.		
Mapping of Course Outcomes for Unit V	CO5: Learn spectroscopy technology to detect, determine, or quantify the molecular and/or structural composition of a sample**.**	
Unit VI	**Spectroscopy-II**	**(6 Hrs)**
Mass Spectrometry : Introduction of theory, ionization methods, molecule fragmentation, NMR Spectroscopy: Introduction of theory, 1H and 13C NMR, Spin-Spin Coupling, Infrared Spectroscopy: Steady-state and time- resolved Infrared spectroscopy: from overview to potential applications		
Mapping of Course Outcomes for Unit VI	CO6: Learn application of radiolabeling technique in diagnostic & research**.**	

Learning Resources

Text Books:

1. Wilson and Walker's 'Principles and Techniques of Biochemistry and Molecular Biology' Cambridge University Press 2018, Online ISBN:9781316677056; DOI:https://doi.org/10.1017/9781316677056
2. Fundamentals and Techniques of Biophysics and Molecular Biology by Pranav Kumar

   Pathfinder Publications 3rd Edition 2019.

Reference Books:

1. Bio analytics: Analytical Methods and Concepts in Biochemistry and Molecular Biology Friedrich Lottspeich (Editor), Joachim W. Engels (Editor) ISBN: 978-3-527-33919-8.
2. Analytical Biotechnology by Thomas G. M. Schalkhammer Springer ISBN-13 : 978-8181281975

MOOC / NPTEL Courses link / Any other e- resources link:

For example

1. NPTEL course Analytical Technologies in Biotechnology by Dr. Ashwani K. Sharma IIT Roorkee https://nptel.ac.in/courses/102/107/102107028/
2. NPTEL course Bioanalytical Techniques and Bioinformatics - Web course by Dr. Nitin Chaudhary Department of Biotechnology IIT Guwahati

   https://nptel.ac.in/courses/102/103/102103044/

Virtual LAB Link:

1. Biological Image Analysis Virtual Lab https://vlab.amrita.edu/?sub=3&brch=278
2. Agilent Technologies
   https://www.youtube.com/user/agilent/video

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315462: Material Balances and Stoichiometry

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs/ week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Term Work: 25 Marks** **Total Marks:-125**

Prerequisite Courses, if any: Basic concepts of fundamental and derived properties and their units.

Companion Course, if any: --

Course Objectives:

1. To introduce the concept of unit operations and unit processes and develop an ability to perform basic chemical calculations involved in bioprocesses
2. To make students conversant with different unit operations used in the process industry and formulate material balances for each step
3. Provide familiarity with energy balance calculations involved in different unit operations and unit processes
4. To make students conversant with different unit processes and chemical reactions encountered in the process industry and formulate material balances for each step
5. To develop an expertise in process design of important unit operations by combining the knowledge of material and energy balances
6. To familiarize students with different types of fuels, their properties and related combustion calculations

Course Outcomes: On completion of the course, learner will be able to –

CO1: Sort a bioprocess into different unit operations and processes and apply basic chemical calculations to them

CO2: Apply material balances to different physical steps in a process and thus efficiently design processes. CO3: Quantify heat and energy changes accompanying unit operations and unit processes

CO4: Design processes requiring physical, chemical and biochemical changes

CO5: Apply energy balances to difference processes involving chemical changes and thus efficiently design a process.

CO6: Predict efficiency of combustion and analyze the requirements and product formation in such operations for optimum use of the fuels

Course Contents		
Unit I		**(06 Hrs)**
Basic Chemical Calculations: Introduction to unit processes and operations and their symbols, process flow sheet, Basic Chemical Calculations including mole, equivalent weights, solids, liquids, solutions and their properties, properties of gases.		

Mapping of Course Outcomes for Unit I	CO1:Sort a bioprocess into different unit operations and processes and apply basic chemical calculations to them	
Unit II		**(08 Hrs)**
Material Balances without Biological/ Chemical Reactions: Concept, material balance calculations, recycling and bypassing operations, introduction to unsteady state processes.		
Mapping of Course Outcomes for Unit II	CO2: Apply material balances to different physical steps in a process and thus efficiently design processes.	
Unit III		**(08 Hrs)**
Energy Balances: Concept of conservation of energy, heat capacity of pure substances and mixtures, Phase transition: latent heats & sensible heat.		
Mapping of Course Outcomes for Unit III	CO3: Quantify heat and energy changes accompanying unit operations and unit processes	
Unit IV		**(06 Hrs)**
Material Balances involving Biological/ Chemical Reactions: Concept, material balance calculations, recycling and bypassing operations.		
Mapping of Course Outcomes for Unit IV	CO4: Design processes requiring physical, chemical and biochemical changes.	
Unit V		**(06 Hrs)**
Energy balances for a process involving chemical reaction: Standard Heat of Formation, Standard heat of reaction, Standard heat of combustion.		
Mapping of Course Outcomes for Unit V	CO5: Apply energy balances to difference processes involving chemical changes and thus efficiently design a process.	
Unit VI		**(08 Hrs)**
Combustion: Calorific values, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations.		
Mapping of Course Outcomes for Unit VI	CO6: Predict efficiency of combustion and analyze the requirements and product formation in such operations for optimum use of the fuels.	

Learning Resources

Text Books:

B. I. Bhatt, S.B. Thakore, "Stoichiometry" 5th Edition, Tata McGraw Hill Publications, New Delhi (2011)

K.A. Gavhane, "Introduction to process calculations stoichiometry", 22nd Edition, Nirali Prakashan (2009)

Reference Books:

1. David M. Himmelblau " Basic Principles and Calculations in Chemical Engineering" 6th Edition, Eastern Economy Edition, Prentice Hall of India

NPTEL Courses link.

NPTEL Course "Material and Energy Balances" https://nptel.ac.in/courses/102/106/102106069/

NPTEL Course "Basic Principles and Calculations in Chemical Engineering".

https://nptel.ac.in/courses/103/103/103103165/

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315463: Genetic Engineering

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hrs / week	**3**	**In - Sem (Theory): 30 Marks** **End - Sem (Theory): 70 Marks** **Total Marks :-100**

Prerequisite Courses, if any:

Knowledge of Genetics and Molecular Biology

Companion Course, if any: --

Course Objectives:

1. To give Introduction to various techniques used in Genetic Engineering.
2. Give an overview of recombinant DNA technology.
3. To impart knowledge of construction of various libraries.
4. To give an overview of recombinant protein production and problems associated there with.
5. To teach the various advanced techniques to transfer genes to animals and plants
6. To introduce the various applications of rDNA technology

Course Outcomes: On completion of the course, learner will be able to –

CO1: Acquire knowledge of various techniques and tools in genetic engineering and DNA sequencing methods.

CO2: Get an overview of recombinant DNA technology and learn tools and techniques in rDNA technology like DNA Manipulative enzymes, cloning vectors and isolation of gene of interest.

CO3: Acquire skills on techniques of construction of genomic DNA library and cDNA library and the screening methods.

CO4: Identify problems associated with production of recombinant proteins and protein purification and devising Strategies to overcome problems when cloning in bacteria and yeasts.

CO5: Know how to transfer genes to bacteria, animals and plants using various different methods like gene gun, electroporation, viral vectors etc.

CO6: Learn rDNA techniques for production of pest resistant plants, growth hormones, vaccines, gene therapy in expression system.

Course Contents		
Unit I		**(8Hrs)**
Techniques and tools in genetic engineering: Blotting techniques, PCR-design and optimization, PCR types- RTPCR, colony PCR, real time PCR. **DNA sequencing methods:** sequencing strategies, Sangers Sequencing, pyro sequencing, automation, base calling, applications and impact of sequencing, Human genome project, micro arrays.		

Mapping of Course Outcomes for Unit I	CO1: Acquire knowledge of various techniques and tools in genetic engineering and DNA sequencing methods.	
Unit II		**(8Hrs)**
Enzymes used in GE: Restriction enzymes, DNA ligase: adapters, linkers, homopolymer tailing **Cloning vectors:** Plasmids, basics of plasmids, lambda phage, insertional, replacement lambda vectors, in-vitro packaging, M13 vectors, phagemids, cosmids, Multiple cloning sites, selection markers, Expression Vectors, artificial chromosomes (BACs, YACs)		
Mapping of Course Outcomes for Unit II	CO2: Get an overview of recombinant DNA technology and learn tools and techniques in rDNA technology like DNA manipulative enzymes, cloning vectors and isolation of gene of interest.	
Unit III		**(8Hrs)**
Gene Cloning strategies: genomic libraries, PCR in cloning, cDNA libraries, amplification of gene libraries, strategies for screening of libraries: hybridization, colony PCR, immunological screening, blue white selection, selection based on nutrient deficiency		
Mapping of Course Outcomes for Unit III	CO3: Acquire skills on techniques of construction of genomic DNA library and cDNA library and the screening methods.	
Unit IV		**(8 Hrs)**
Cloning in bacteria, competency, broad host range plasmids, copy number significance, cloning in gram positive bacteria, Cloning in yeast and fungi: Cloning in *S. cerevisae*, problems in cloning, vectors for yeast, promoters,significance of *Pichia pastoris*, YAC's classical and circular		

Mapping of Course Outcomes for Unit IV	CO4: Identify problems associated with production of recombinant proteins and protein purification and devising strategies to overcome problems when cloning in bacteria and yeasts.	
Unit V		**(8Hrs)**
Gene transfer technologies: Transformation,, Transfection, Electroporation, Gene transfer to animal cells: bacterial vectors, Viral vectors – Adenovirus, Baculovirus, retro virus, strategies for transformation of animal cells: Pronuclear microinjection, Recombinant retroviruses, transfection of ES cells to get chimeras, Gene transfer to plants: Callus culture, protoplast transformation, strategies Agrobacterium mediated, Particle bombardment, *In planta* transformation, plant viruses		
Mapping of Course Outcomes for Unit V	CO5: Know how to transfer genes to bacteria, animals and plants using various different methods like gene gun, electroporation, viral vectors etc.	

Unit VI		(8Hrs)

Modification of bacteria and viruses: live vaccines, Animal transgenesis - Applications, Transgenic plants – Applications, Applications of rDNA technology in health and agriculture: Humulin, Hep B, factorVIII, DNA diagnostics, Bt cotton, and Golden rice. DNA markers for improvement of quality and yield of crops, Gene therapy

Mapping of Course Outcomes for Unit VI	CO6: Learn rDNA techniques for production of pest resistant plants, growth hormones, vaccines, gene therapy in expression system

Learning Resources

Text Books:

Principles of Gene manipulation and Genomics by Primrose and Twyanman (Blackwell Publishers)

From Genes to Genomes: Concepts and applications of DNA technology by J. W. Dale and M.V.Schantz (Wiely Publishers)

Reference Books:

Molecular biotechnology by Pasternack and Glick

From Genes to clones by Winnacker. PANIMA

Gene cloning and DNA Analysis: An introduction (4th edition) by T. A. Brown

Molecular Cloning: A Laboratory Manual *(Fourth Edition)* By Michael R. Green, Howard Hughes Medical Institute, University of Massachusetts Medical School; Joseph Sambrook, Peter MacCallum Cancer Institute, Melbourne, Australia

MOOC / NPTEL Courses link / Any other e- resources link:

For example

1. **NPTEL Course on** Genetic Engineering and Applications : https://nptel.ac.in/courses/102/103/102103013/
2. **NPTEL Course on** Genetic Engineering Theory and Applications https://nptel.ac.in/courses/102/103/102103074/

Virtual LAB Link:

1. Molecular Biology Virtual Lab I:- http://mbvi-au.vlabs.ac.in/
2. Molecular Biology Virtual Lab II:- https://mbvii-au.vlabs.ac.in/

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology (2019 Course)
315464 : Introduction to Immunology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks Total Marks :-100

Prerequisite Courses, if any:

Knowledge of cell biology and microbiology.

Companion Course, if any: -

Course Objectives:

1. To introduce concepts of defense mechanism in host.
2. To learn about the structural and functional features of the components of the immune system.
3. To bring understanding of the mechanisms involved in innate and adaptive, humoral and cell mediated immune responses in host.
4. To learn the basic immunological techniques for diagnostic approach in immunology.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Explain what immunology is and understand the basics of natural and adaptive, specific and nonspecific line of defense in host.

CO2: Define structural and functional role of cells, organs and tissues of immune system.

CO3: Understand the antigen-antibody concepts with cellular/molecular theories of humoral immune responses in host.

CO4: Explain the cellular and molecular processes involved in cell-mediated immunity, in state of health and disease.

CO5: Explain the hypersensitivity and autoimmunity in state of health and disease.

CO6: Develop skills in immunological diagnostic techniques

Course Contents

Unit I	Basic concepts in immunology	(6 Hrs)

Overview of immune system: Historical Perspective, basic concepts - Immunity, Innate immunity: Types and factors influencing innate immunity, Acquired immunity: Active and Passive, Nonspecific defense mechanism- Physiological barriers against infection, First and Second line of defense. Humoral and cellular immune response.

Mapping of Course Outcomes for Unit I	CO1: Explain what is immunology and & immune system. Understand the natural and adaptive, specific and nonspecific line of defense in host.	
Unit II	**Immune System**	**(6Hrs)**
Organ and tissues of immune system- Primary and secondary lymphoid organs. Cells of immune system- Structure and functions of monocytes, macrophages, granulocytes, mast cells, dendritic cells, NK cells, lymphocytes-B and T cells development, maturation and activation of immune cells.		
Mapping of Course Outcomes for Unit II	CO2: Define structural and functional role of cells, organs and tissues of immune system.	
Unit III	**Adaptive (Humoral) immunity**	**(8 Hrs)**
Antigens: Chemical nature, types of antigen and factors affecting antigenicity; hapten, adjuvants. Antibody: Immunoglogilins: Structure and function, types of immunoglobulin, Adaptive Immunity Humoral immunity: Activation of B cells, theories of antibody production- clonal selection theory. Immune response: Primary and secondary, Organization and expression of Ig genes, generation of antibody diversity, Monoclonal Antibody, Hybridoma Technology.		
Mapping of Course Outcomes for Unit III	CO3: Understand the antigen-antibody concepts with cellular/molecular theories of humoral immune responses in host.	
Unit IV	**Cell mediated immunity and Major Histocompatibility**	**(8 Hrs)**
Cell mediated immunity, TCR, Mechanism of cell mediated immune response: Cytokines and Complement system, phagocytosis, inflammation, Major Histocompatibility Complex (MHC), Antigen processing and presentation, Transplantation immunology: Graft rejection, Graft-versus-Host and ethics.		
Mapping of Course Outcomes for Unit IV	CO4: Explain the cellular and molecular processes involved in cell-mediated immunity, in state of health and disease.	
Unit V	**Hypersensitivity and Autoimmunity**	**(8 Hrs)**
Hypersensitivity-Types I to IV, immediate hypersensitivity, Anaphylaxis, Cytotoxic, Delayed type of hypersensitivity, Immunodeficiency, Allergy test, Autoimmunity-Organ Specific and Systemic Autoimmune diseases.		
Mapping of Course Outcomes for Unit V	CO5: Explain the hypersensitivity and autoimmunity in state of health and disease.	
Unit VI	**Diagnostics**	**(8 Hrs)**
Antigen – antibody interactions- principles and applications, Precipitation-Gel Diffusion test, agglutination test, Complement fixation test, Fluorescent antibody test, RID, ODD, ELISA, RIA, Vaccines-Active & passive immunization, role of adjuvants, designing vaccines for active immunization, types of vaccines- whole organism purified macromolecules, DNA vaccines, recombinant DNA vaccines, multivalent subunit vaccines.		

Mapping of Course Outcomes for Unit VI	CO6**:** Develop skills in immunological diagnostic techniques

Learning Resources

Text Books:

1. Kuby Immunology (8th Edition)- Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen. WH Freeman, 2019, Ebook – 9781319188535.
2. Roitt's Essential Immunology (Essentials) 13th Edition Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt.Wley Blakswell Scientific Publications, Oxford, 2017. ISBN-13: 978-1118415771

Reference Books:

1. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988 Antibodies A laboratory Manual: Harlow and David Lane (1988), Cold spring harbor laboratory
2. Janeway's Immunobiology by K. Murphy, P. Travers and M. Walport, Publisher: Garland Science.

MOOC / NPTEL Courses link / Any other e- resources link:

For example

1. SWAYAM Immunology By Prof. Sudip Kumar Ghosh, Prof. Agneyo Ganguly IIT Kharagpur

   https://onlinecourses.nptel.ac.in/noc20_bt43/preview

   https://nptel.ac.in/courses/102/105/102105083/

2. NPTEL course Cellular and molecular immunology by Dr Sachin Kumar

   https://nptel.ac.in/courses/102/103/102103038/

Virtual LAB Link:

Immunology Virtual Lab I & II

https://vlab.amrita.edu/?sub=3&brch=69

https://vlab.amrita.edu/?sub=3&brch=70

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 course)

315465 : Elective I-A: Enzyme Technology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 hrs. / week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Total Marks :-100**

Prerequisite Courses, if any:

Basic knowledge of Biochemistry II

Companion Course, if any: --

Course Objectives:

1. To provide an understanding about basics of enzymes molecule
2. To understand the functioning and kinetics of enzyme
3. To understand role of coenzymes in enzyme catalyzed reactions
4. To know about inhibition of enzyme
5. To make acquainted about various techniques of immobilization
6. To understand role of immobilized enzymes

Course Outcomes: On completion of the course, learner will be able to –

CO1: Understand basic information about enzyme molecule

CO2: Know the functioning of enzyme molecule

CO3: Recognize the role coenzymes

CO4: Understand the mechanism of enzyme inhibition

CO5: Understand process of enzyme immobilization

CO6: Students will get acquainted with various applications of immobilized enzyme

Course Contents

Unit I		(7Hrs)

Enzymes – Naming and classification of enzymes, enzyme cofactors, kinetics of enzyme catalyzed reactions, Michaelis Menten equation, effect of pH, temperature on enzyme activity, purification of enzyme,

Mapping of Course Outcomes for Unit I	CO1: Understand basic information about enzyme molecule	
Unit II		**(8 Hrs)**
Substrate specificity of enzyme, Factors leading to rate enhancement of enzyme catalyzed reactions: Acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment, regulatory enzyme, isozymes, multi-enzymes		
Mapping of Course Outcomes for Unit II	CO2: Students will understand the functioning of enzyme Molecule	
Unit III		**(7 Hrs)**
Coenzymes - Coenzyme A, Thiamine diphosphate, pyridine nucleotides, flavins and lipoic acid Coenzyme II Biotin and pyridoxal phosphate		
Mapping of Course Outcomes for Unit III	CO3: Students will recognize the role coenzymes	
Unit IV		**(8 Hrs)**
Enzyme inhibition: feedback inhibition, irreversible and reversible inhibition (competitive, non-competitive, uncompetitive), allosteric inhibition.		
Mapping of Course Outcomes for Unit IV	CO4: Understand the mechanism of enzyme inhibition	
Unit V		**(8 Hrs)**
Immobilization of enzyme by using various matrices, Immobilization of enzyme by using different methods like entrapment, adsorption, cross linking etc., Kinetics of immobilized enzyme		
Mapping of Course Outcomes for Unit V	CO5: Understand process of enzyme immobilization	
Unit VI		**(7 Hrs)**
Application of immobilized enzyme in food industry, in development of biosensor, immobilized enzymes in chemical industry and immobilized enzymes in pharmaceutical industry with case study.		
Mapping of Course Outcomes for Unit VI	CO6: Students will get acquainted with various applications of immobilized enzyme	

Learning Resources

Text Books:

D J Voet, J G Voet, C W Pratt, "Principles of Biochemistry", 3rd ed., John Wiley & Sons, Inc. 2008
D T. Plummer, "An Introduction to practical biochemistry", Tata McGraw Publishing Company Ltd, 1988

Reference Books:

1. J H Weil, "General Biochemistry", New Ages International (P) Ltd.1997.
2. J M Berg,JLTymoczko,LStryer,"Biochemistry",6thed.,FreemanWH&Company,New York,2007
3. D L Nelson, M M Cox "Principles of Biochemistry", 4th ed., W.H. Freeman and company, New York, 2007

MOOC / NPTEL Courses link / Any other e- resources link:

For example

1. NPTEL Course **"Enzyme science and Engineering "**https://nptel.ac.in/courses/102/102/102102033/
2. NPTEL Course **"Biochemistry"** https://nptel.ac.in/courses/104/105/104105076/

Virtual LAB Link:

1. Biochemistry virtual LAB II

   https://vlab.amrita.edu/?sub=3&brch=64

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315465: Elective I-B: Good Laboratory Practices and Good Manufacturing Practices

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hrs / week	**3**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Total : 100 Marks**

Prerequisite Courses, if any: none

Companion Course, if any: --

Course Objectives:

1. To know the objective of GMP and GLP and the various bodies overseeing it.
2. To impart the importance of Quality and understand the principles and implementations of Quality.
3. To orient students towards various GMP in pharma and food industry.
4. To give an overview of various quality control and inspection laws followed in the industry.
5. To introduce the importance of biosafety and the various hazards of not implementing them.
6. To give an introduction to various Quality management concepts in the industry

Course Outcomes: On completion of the course, learner will be able to –

CO1: Learn and adopt quickly in a GMP environment.

CO2: Understand the principles and implementations of Quality

CO3: will be able to implement GMP in pharma and food industry

CO4: Will be able to understand the Quality control laws and implement them

CO5: understand the importance of biosafety and other hazards

CO6: Understand various Quality management concepts in the industry

Course Contents

Unit I		(6 Hrs)

Introduction to GLP

Good laboratory practices-Introduction, WHO guidelines on GLP and GMP, History of Good Laboratory Practices, Quality assurances in Good Laboratory Practices Calibration and Validation: Introduction, definition and general principles of calibration, qualification and validation, importance and scope of validation, types of validation, validation master plan. Calibration of pH meter, Qualification of UV-Visible spectrophotometer, General principles of Analytical method Validation.

Mapping of Course Outcomes for Unit I	CO1: Learn and adopt quickly in a GMP environment.	
Unit II		**(6 Hrs)**

Quality Standards and Quality Assurances

Quality Standards- Advantages and Disadvantages, Concept of Quality Control, Quality Assurance- Their functions and advantages, Quality assurance and quality management in industry, Total Quality Management (TQM): Definition, elements, philosophies, ICH Guidelines: purpose, participants, process of harmonization. Good documentation practices: Preparation Standard operating protocols (SOP), Batch Manufacturing Records (BMR), Master Formula, Site files, recording change controls/deviations etc.
Government and trade standards of quality Federal Food and Drug Law FDA, BSTI action and activities Other food laws (Legalization), ISO 9000 & ISO14000: Overview, Benefits, Elements, steps for registration

Mapping of Course Outcomes for Unit II	CO2: Understand the principles and implementations of Quality	
Unit III		**(6 Hrs)**

Good Manufacturing Practices in Pharmaceutical and Food Industries

Types of validation in Pharma industry, Scope and importance of Validation Limitations, Cleaning Validation, Validation of Analytical Procedures as per ICH Guidelines Implications of cGMP and Food plant sanitation, schedule M and Y of Drug and Cosmetic act in India.. The regulations of cGMPs Planning of Plant Sanitation Programs and Construction factors Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials Control of rats, rodents, birds, insects and microbes. Cleaning and Disinfection: Physical and Microbiological Approach

Mapping of Course Outcomes for Unit III	CO3: will be able to implement GMP in pharma and food industry

Unit IV		**(6 Hrs)**

Quality Control

Quality Control in the industry**,** Various Quality Attributes of food such as size, shape, texture, color, viscosity and flavor, Sensory evaluation of food and statistical analysis, Food Regulation and Compliance, Food Inspection and Food Law, Quality Control: Quality control test for containers, rubber closures and secondary packing, Food Quality and Quality control including the HACCP system, cleanroom, Good Laboratory Practices: General Provisions, Organization and Personnel, Facilities, Equipment, Testing Facilities Operation, Test and Control Articles, Protocol for Conduct of a Nonclinical Laboratory Study, Records and Reports, Disqualification of Testing Facilities

Mapping of Course Outcomes for Unit IV	CO4: Will be able to understand the Quality control laws and implement them

Unit V		**(6 Hrs)**

Biosafety

Introduction: Historical Background, Biosafety in Laboratory/ institution., Laboratory associated infections and other hazards, Assessment of Biological Hazards and levels of biosafety, Prudent biosafety practices in the laboratory/institution Introduction to Biological safety cabinets, Primary Containment of Biohazards, Biosafety Levels, Recommended Biosafety Levels for Infectious Agents and Infected Animals Biosafety guidelines, Government of India Guidelines, Definition of Genetically Modified Organisms (GMOs)

Mapping of Course Outcomes for Unit V	CO5: understand the importance of biosafety and other hazards

Unit VI (6Hrs)

Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)] and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establish quality, safety and efficacy of drug substances and products, ISO and relevant such quality Organizations

Mapping of Course Outcomes for Unit VI	CO6: Understand various Quality management concepts in the industry

Learning Resources

Text Books:

Good Laboratory Practice Regulations, by Sandy Weinberg, Fourth Edition Drugs and the Pharmaceutical Sciences, Vol.168

How to practice GLP by PP Sharma, Vandana Publications.

Reference Books:

3. Good Pharmaceutical Manufacturing practice, Rational and compliance by John Sharp, CRC Press
4. Establishing a cGMP Laboratory Audit System, A practical Guide by David M.Bleisner, Wiley Publication.
5. Laboratory Auditing for Quality and Regulatory compliance bu Donald C.Singer, Drugs and the Pharmaceutical Sciences, Vol.150.
6. Drugs & Cosmetics Act, Rules & Amendments
7. Quality Assurance Guide by organization of Pharmaceutical Products of India.
8. Good Laboratory Practice Regulations, 2
9. Quality Assurance of Pharmaceuticals- A compendium of Guide lines and Relatedmaterials Vol I WHO Publications.
10. A guide to Total Quality Management- Kushik Maitra and Sedhan K Ghosh
11. How to Practice GMP's – P P Sharma.
12. ISO 9000 and Total Quality Management – Sadhank G Ghosh
13. The International Pharmacopoeia – Vol I, II, III, IV- General Methods of Analysis And Quality specification for Pharmaceutical Substances, Excipients and Dosage forms
14. Good laboratory Practices – Marcel Deckker Series
15. ICH guidelines, ISO 9000 and 14000 guidelines

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology (2019 course)
315465: Elective I-C: Agricultural Biotechnology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs. / week	**TH 03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Total Marks :-100**

Prerequisite Courses, if any:

Knowledge of subjects like Molecular Biology, Genetic Engineering and Aseptic Techniques.

Companion Course, if any: --

Course Objectives:

1. To introduce students to scope of Biotechnology in agriculture.
2. To emphasize advantages of transgenic crops, biofertilizers, biopesticides and organic agriculture.
3. To address ethical issues and regulatory aspects of biotechnology in agriculture.
4. To recognize importance of biofertilizers, biopesticides in organic agriculture.

Course Outcomes: On completion of the course, learner will be able to –

CO1. Students will understand global and Indian scenario of GMO

CO2: Students will learn plant genetic engineering technologies

CO3. Students will gain knowledge of Plant tissue culture

CO4. Students will get know advance technology for crop improvement.

CO5. Student learn importance of biofertilizers and biopesticides in Agricultural biotechnology CO6. Students will get expose to regulatory authorities and ethics in GMO and products

Course Contents

Unit I	Introduction of Agri Biotechnology	(6 Hrs)

Scope of Biotechnology in agriculture, Definition of GMO Transgenic crops, Scope and global scenario of GE crops, current status of transgenic crops and public concern and acceptance of transgenic crops-Global and Indian status.

Mapping of Course Outcomes for Unit I	CO1: Students will understand global and Indian scenario of GMO	
Unit II	**Plant Genetic Engineering**	**(6 Hrs)**
Techniques of plant transformation-Direct gene transfer methods and Agrobacterium mediated gene transfer. Vectors Selectable markers, reporter genes promoter and terminators gene construct for tissue specific expression. Strategies for genetic manipulation of herbicide tolerance, insect-pest resistance, abiotic stress resistance, improvement of crop yield and quality, case studies-BT Cotton, BT Brinjal, Golden R		
Mapping of Course Outcomes for Unit II	CO2: Students will understand advanced technologies used for crop improvement	
Unit III	**Plant Tissue Culture**	**(6 Hrs)**
Concept of cellular totipotency, culture types callus, Cell suspension, protoplasts, root cultures, shoot tip, Anther culture, Embryo culture and embryo rescue, Clonal propagation, somaclonal and gametoclonal variations somatic hybridization and cybridization. Application of tissue culture in crop improvement. Secondary metabolite production. In vitro mutagenesis, cryopreservation and plant tissue culture repository.		
Mapping of Course Outcomes for Unit III	CO3: Students will gain knowledge of Plant Tissue Culture	
Unit IV	**Advanced technology for crop improvement.**	**(6 Hrs)**
DNA molecular markers: Principles, type and applications; restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), randomly amplified polymorphic DNA sequences (RAPD), Simple sequence repeats (SSR), Single nucleotide polymorphism (SNP), QTL, Molecular marker assisted selection. Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and applications, Metabolic engineering.		

Mapping of Course Outcomes for Unit IV	CO4: Students will get to know advanced technology for crop improvement.	
Unit V	**Biofertilizers, Biopesticides and Biostimulants**	**(6 Hrs)**
Microbe based biofertilizers/ biopesticides, Cyanobacterial biofertilizers. Azolla and Anabena symbiotic association. Bacteria (Rhizobium) biofertilizers, Fungal (Mycorhiza) bio-fertilizers. Nitrogen fixation-asymbiotic and symbiotic, nodule formation. Genetics and biochemistry of nitrogen fixation. Nif genes. Transfer of nif genes. Isolation of agriculturally important bioproducts, PGR, Biostimulants, Antioxidants etc		
Mapping of Course Outcomes for Unit V	CO5: Student learn importance of biofertilizers and biopesticides in Agricultural biotechnology	
Unit VI	**Regulation of GM crops and Products**	**(6 Hrs)**
Ethical issues in biotechnology, Biosafety Committees, Risk assessment of GMOs, Public perception. PR and Trade related aspects, RCGM, GEAC, Cartagena Protocol, GMO Act 2004, UPOV Act 1978, UPOV Act 1991, PPVFR Act 2001 and patents.		
Mapping of Course Outcomes for Unit VI	CO6: Students will get expose to regulatory authorities and ethics in GMO and products	

Text Books:

Biotechnology Expanding Horizons B. D. Singh Kalyani Publishers ISBN 10: 9327222989 ISBN 13: 9789327222982

Plant Biotechnology: The Genetic Manipulation of Plants Adrian Slater, Nigle W. Scott and Mark R Fowler Oxford University Press ISBN-13 : 978-0199560875

Reference Books:

1. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg. 2000

2. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition (2001) Blackwell science.

3. S.S. Purohit: Agricultural Biotechnology (2003) Agribio in India. Y.P.S. Bajaj: Biotechnology in Agriculture and forestry, Vol. 22 Springer Verlas.

4. Biotechnology in Agriculture, Mac Millon India Ltd., 1992, Edn. M.S.Swaminath.

5. Objective Biotechnology, B.K Prasad, B.D Singh, Sanjeev Kumar, Kalyani Publications 978-81-272-6967-1

MOOC / NPTEL Courses link / Any other e- resources link:

Plant Biotechnology by Dr. Rakhi chaturvedi Indian Institute of Technology Guwahati Guwahati - 781039, Assam, India https://nptel.ac.in/courses/102/103/102103016/

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315466 : Analytical Techniques Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 04 hrs/week	**02**	**Examination Scheme:** **PR: 50 Marks** **Total : 50 Marks**

Prerequisites:-

Basic knowledge of Analytical Techniques

Course Objectives:

1. To bring Hands-On Learning of analytical methods used in biotechnology
2. To demonstrate the analytical techniques used in laboratory.
3. To achieve technical laboratory skills of qualitative & quantitative analysis of biological samples.

Course Outcomes:

On completion of this course, students will be able to

CO1. Analyze biological samples for estimation of macromolecules and sub cellular fractions.

CO2. Demonstrate qualitative and quantitative estimation of biological samples.

CO3. Hands-on-learning for laboratory skills in biotechnology.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Separation of Lipids by Thin Layer Chromatography
2	To study gel filtration chromatography
3	Determination of Void volume of Gel Filtration Chromatography system
Sr. No.	**Group B**
1	Determination of protein concentration in fermentation broth
2	Verification of Beer Lambert's law
3	Determination of λmax for proteins
4	Determination of the Molar Absorptivity of a Light Absorbing Molecule
Sr. No.	**Group C**
1	pH effects on absorption spectra: pKa determination by spectrophotometric method
2	Clarification Technique: Jar Test
3	Study of Batch Filtration and determination of specific cake resistance (α)

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
9. Reagents to be stored should be labeled with due discarding date
10. Instructions for proper disposal of waste material should be followed
11. Report accidental cuts or burns to the instructor immediately.
12. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units For each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology (2019 Course)
315467: Genetic Engineering Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 4 hrs/week	**2**	**Examination Scheme:** **OR : 50** **Total : 50**

Prerequisites:-

Knowledge of Genetics and Molecular Biology

Course Objectives:

1. To give Introduction to various techniques used in Genetic Engineering.
2. Give an overview of recombinant DNA technology.
3. Bring Understanding the underlying molecular tools used
4. Impart Management of information generated in the experiments by applications of the techniques

Course Outcomes:

CO1. Understand the theoretical aspects of techniques used in molecular biotechnology.

CO2. Will orient students to use of these techniques with respect to the research work.

CO3. The techniques will give 'Hands on' training to understand the concepts of molecular biology better

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Isolation of Plant genomic DNA
2	Isolation of Bacterial DNA
3	Isolation of Fungal DNA
4	Isolation of Mammalian DNA
Sr. No.	**Group B**
1	Isolation of Plasmid DNA
2	Isolation of RNA
3	Competent Cell Preparation
4	Transformation
Sr. No.	**Group C**
1	RE digestion and agarose gel electrophoresis
2	PCR (Demo)

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
9. Reagents to be stored should be labeled with due discarding date
10. Instructions for proper disposal of waste material should be followed
11. Report accidental cuts or burns to the instructor immediately.
12. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units For each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University
Third Year Of B.Tech. Biotechnology (2019 Course)
315468 : Elective I-A : EnzymeTechnology Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 2 Hrs/week	**01**	**Examination Scheme:** **TW :25** **Total : 25**

Prerequisites:- Biochemistry II

Course Objectives:

1. To learn fundamental approaches for conduction of the experiment related to enzyme molecule
2. To make students aware about extraction method of enzyme
3. To understand functioning of enzyme molecule
4. To understand kinetic parameters of enzyme

Course Outcomes:

On completion of this course, students will be able to

CO1. Recognize the various approaches for extraction of enzyme

CO2. Understand basics of enzyme

CO3. Recognize the kinetics of biocatalyst

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
	Suggested List of Laboratory Assignments (Any 8)
1	Extraction of an enzyme
2	Construction of standard curve for product of enzyme catalyzed reaction
3	Construction of protein standard curve
4	To study effect of varying enzyme concentration on enzyme activity
Sr. No.	**Group B**
1	Determination of Km and Vmax of an enzyme
2	Effect of temperature on an enzyme activity
3	Effect of pH on an enzyme activity
4	To check the effect of inhibitor on an enzyme activity
Sr. No.	**Group C**
1	Identification of type of inhibition of an enzyme
2	Determination of specific activity of an enzyme
3	Immobilization of enzyme by any one method

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept in their appropriate place after use.
9. Reagents to be stored should be labeled with due discarding date.
10. Instructions for proper disposal of waste material should be followed.
11. Report accidental cuts or burns to the instructor immediately.
12. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units For each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315468: Elective I-B : Good Lab Practices and Good Manufacturing Practices Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 2 Hrs/week	**1**	**Examination Scheme:** **TW: 25** **Total:25**

Prerequisites:-

Course Objectives:

1. To know the objective of GMP and GLP and the various bodies overseeing it.
2. To impart the importance of Quality and Understand the principles and implementations of Quality in the Lab
3. To orient students towards various GMP in pharma and food industry.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Learn and adopt quickly in a GMP environment.

CO2: Understand the principles and implementations of Quality

CO3: will be able to implement GMP in pharma and food industry

CO4: understand the importance of biosafety and other hazards

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Calibration and optimization of Weighing Balance
2	Use of Spectrophotometer for quality check of biological materials.
3	Calibration of the pH Meter, Micropipettes
4	Validation of the autoclave patterns
Sr. No.	**Group B**
1	Microbial load in clean room /laminar flow
2	Testing the cooling efficiency of the freezers
3	Effect of Fumigation on microbial load in laboratory.
4	Quality testing of water for injection (WFI)
Sr. No.	**Group C**
1	Writing and implementing SOP for an experiment.
2	Writing a target product profile (TFF) for a drug using any one of pharmacopeia (or WHO) Guideline
3	Clean room Design/Basis of design (BOD) for sterile area used for aseptic handling like cell culture or microbial culture.
4	Visit to GLP/GMP facility.

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
9. Reagents to be stored should be labeled with due discarding date.
10. Instructions for proper disposal of waste material should be followed
11. Report accidental cuts or burns to the instructor immediately.
12. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units for each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315468: Elective I-C: Agricultural Biotechnology Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 2 Hrs/week	**1**	**Examination Scheme:** **TW : 25** **Total : 25**

Prerequisites:-

Knowledge of Genetics and Molecular Biology

Course Objectives:

1. To give Introduction to various techniques used in Plant Genetic Engineering.
2. Give an overview of recombinant DNA technology.
3. Bring Understanding the underlying molecular tools used
4. Bring laboratory training in Plant Tissue Culture Techniques

Course Outcomes:

CO1. Understand the practical aspects of techniques used in agricultural biotechnology.

CO2. Will orient students to use these techniques with respect to the research work.

CO3. The techniques will give 'Hands on' training to understand the concepts of molecular biology better

CO4: Exposure to commercial lab facilities and techniques

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Isolation of plant DNA
2	RE digestion of Plant DNA
3	Leaf disc method/
4	RAPD or RFLP: PCR
5	RAPD/RFLP: agarose gel and scoring bands
Sr. No.	**Group B**
1	Preparation of media for PTC
2	Induction of callus
3	Suspension culture
4	Somatic embryogenesis
Sr. No.	**Group C**
1	Biofertilizers Production
2	Isolation of N2 fixers
3	Biopesticides preparation
4	Isolation of agriculturally important microorganisms
Sr No.	**Group D**
1	Visit to PTC facility
2	Report for case studies

Text books	1. Keshavachandran.R and K V Peter. 2008 .Plant Biotechnology: Tissue culture and Genetransfer. Orient and Longman, (Universal Press) Chennai. 2. Gresshoff, Peter M. (Ed). Plant biotechnology and development. 1992. 3. Jones, MGK & Lindsey, K. "Plant Biotechnology" in Molecular biology and biotechnology, Walker, JM & Gingold, EB (Eds). 2000. 4.Kumar H D, Agricultural Biotechnology, India ,2005
Reference books:	1. Esau's Plant Anatomy, Meristems, Cells, and Tissues of the Plant Body: Their Structure,Function, and Development, 3rd Edition, John Wiley & Sons, 2006. 2. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992. 3. M. J. Chrispeels and D.F. Sadava (eds), Plants, Genes and Crop Biotechnology, 2nd Edition, Jones and Barlett Press, 2003

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
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8. All chemicals, glassware, reagents and plastic wares should be kept in their appropriate place after use.
9. Reagents to be stored should be labeled with due discarding date
10. Instructions for proper disposal of waste material should be followed
11. Report accidental cuts or burns to the instructor immediately.
12. Perform the experiment. Collect data in a clear and organized fashion. Be sure to note the units For each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology (2019 Course)
315469 :Seminar

Teaching Scheme:	Credit	Examination Scheme:
Tutorial:1 Hrs/week	**01**	**Examination Scheme:** **TW: 50 Marks** **Total : 50 Marks**

Prerequisites:-

Basic knowledge of communication

Course Objectives:

1.To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques

2. To explore the latest technologies

3.To enhance the communication skills

4.To develop problem analysis skills

Course Outcomes:

On completion of the course, learners will be able to

CO1: Analyze a latest topic of professional interest

CO2: Enhance technical writing skills

CO3: Identify an engineering problem, analyze it and propose a work plan to solve it

CO4:Communicate with professional technical presentation skills

Guidelines

- Each student will select a topic in the area of Biotechnology Engineering and preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years.
- The topic must be selected in consultation with the department guide.
- Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and submit the seminar report.
- Active participation at classmate seminars is essential.
- Department coordinator has circulated the format for report and it is recommended to use it.

Guidelines for Assessment

Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.

Savitribai Phule Pune University
Third Yearof B.Tech. Biotechnology (2019 Course)
315470 :Audit Course 5

In addition to credits courses, it is recommended that there should be audit course (non-credit course). Audit course is for the purpose of self-enrichment and academic exploration. Audit course carry no academic credit. Selection of audit courses helps the learner to explore the subject of interest in greater details resulting in achieving objective of audit course's inclusion. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP(Audit course pass) and shall be included such grade in the semester grade report for that course, provided students has the minimum attendance as prescribed by the Savitribai Phule Pune university and satisfactory in-semester performance and secured a passing grade in that audit course. No grade point is associated with this "AP" grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA.

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

1. Lecture/Guest lecture
2. Visit (Social/field) and reports
3. Demonstrations
4. Surveys
5. Mini project
6. Hands on experience on specific focused topic.
7. Seminar/Workshop

Guidelines for Assessment (Any one or more of following but not limited to)

1. Written test
2. Quiz
3. Demonstrations/practical test
4. Presentations/Poster
5. IPR/publication
6. Report

Audit course 2 Options (Anyone)

315470 :A: Lifestyle and Nutrition
315470 :B: Essence of Indian Traditional Knowledge

Semester – VI

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315471: Fermentation Technology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hrs/ week	**03**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Total Marks:-100**

Prerequisite Courses, if any:

Microbiology and Biochemistry

Companion Course, if any: -- Bioseparation Engineering

Course Objectives:

1. To introduce the history, fundamental concepts and significance of microbial fermentation at industrial and domestic level
2. To train the students in concepts of media preparation, nutritional requirements and sterilization of media at industrial level
3. To introduce different types of microbial fermentation processes, both classical and advanced to the students
4. To introduce students with the different methods and engineering aspects of fermentation processes
5. To introduce the mathematical concepts of scale up and its significance in techno commercial feasibility at industrial level

Course Outcomes: On completion of the course, learner will be able to –

CO1: Understand different types of microbial fermentations and the microorganisms used for the same

CO2: Learn different media types used at industrial level and their sterilization methods

CO3: Learn fundamentals of different types of fermentation processes

CO4: Learn different types of fermenters and their operation

CO5: Understand different types of microbial bio-processes like antibiotic, vitamin and enzyme Production.

CO6: Understand fundamentals of and carry out elementary calculations regarding scale up.

Course Contents		
Unit I		**(7Hrs)**
Introduction to Microbial Fermentation, microbial / Industrial fermentation: Applications for production of industrially important products, Examples of classical fermentation systems, Concept of upstream processing - Screening and isolation of microbes, Preserving industrially important microbes, Inoculum preparation		

Mapping of Course Outcomes for Unit I	CO1: Understand different types of microbial fermentations and the microorganisms used for the same	
Unit II		**(7 Hrs)**
Media Preparation and optimization, Different types of media, sources of nutrients i.e. carbon, nitrogen etc., effect of media components on fermentation, media preparation, optimization for maximum yield, Sterilization: Need for sterilization, different types of sterilization techniques – their mechanism of destruction, *in situ* sterilization, HTST		
Mapping of Course Outcomes for Unit II	CO2: Learn different media types used at industrial level and their sterilization methods	
Unit III		**(7Hrs)**
Microbial production of industrially important products: Production of primary metabolites like ethanol, Citric acid etc. Production of secondary metabolite like Antibiotics (Penicillin, Streptomycin etc.) Production of biomass like baker's Yeast, Microbial production of vitamins B2, B12.		
Mapping of Course Outcomes for Unit III	CO3: Learn fundamentals of different types of fermentation processes	
Unit IV		**(8 Hrs)**
Isolation, Production and use of microbial enzymes, Methods of Immobilization, immobilized enzymes and their applications, Case studies of Fructose, Glucose production using enzymes. Single Cell protein Production, Fungal, algal Protein Production, Microbial Transformations.		
Mapping of Course Outcomes for Unit IV	CO4: Learn different types of fermenters and their operation	
Unit V		**(8Hrs)**
Introduction to Bioreactor design: Stirred tank reactor (CSTR), Mixed flow reactor, Plug flow reactor, tubular flow reactor, fluidized bed reactor etc. Mode of operations: Batch, fed-batch, Continuous operation of Bioreactor. Submerged Liquid Fermentation (SLF) and Solid state fermentation (SSF), advantages and disadvantages, applications of SLF and SSF.		

Mapping of Course Outcomes for Unit V	CO5: Understand different types of microbial bio-processes like antibiotic, vitamin and enzyme Production.	
Unit VI		**(8Hrs)**
Scale-up: Principles, theoretical considerations and techniques used, Sterilization, inoculum development, operation parameters Concept of downstream processing, Fermentation and product recovery costs, yields, product recovery, product purity, fermentation efficiency, case example such as ethanol economics; Introduction to GMPs		

Mapping of Course Outcomes for Unit VI	CO6: Understand fundamentals of and carry out elementary calculations regarding scale up.

Learning Resources

Text Books:

Casida, "Industrial microbiology", Newage Publication, 2001

Stanbury, Whitaker, S.Hall. "Principles of Fermentation Technology", Second Edition, Elsevier publication

Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, NewYork

Reference Books:

1. Trevor Horwood, "Enzymes", 2001
2. Prescott and Dunn, "Industrial microbiology", CBS publications 4thEdition, 1999
3. M.Y. Young, "Comprehensive Biotechnology Vol. 1- 4:, Pergamon Press
4. T.D. Brock, "Biotechnology: A Text Book of Industrial Microbiology", SmaeurAssociates, 1990
5. Paulin M. Doran, "Bioprocess Engineering Principles", Academic Press, London
6. S. Aiba, A. E. Humphrey, N. F. Milli, "Biochemical Engineering"

MOOC / NPTEL Courses link / Any other e- resources link: For example

1. NPTEL Course **"Industrial Biotechnology"**
   https://nptel.ac.in/courses/102/105/102105058/

Savitribai Phule Pune University
Third Year of B. Tech. Biotechnology(2019Course)
315472 : Mass Transfer

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs/week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks Total Marks :-100

Prerequisite Courses, if any:

- Basic knowledge of subjects like Material Balances and stoichiometry, heat transfer and fluid flow unit operations.
- Problem Solving ability with concept understanding and applications

Companion Course, if any: --

Course Objectives:

1. To introduce basic concepts of mass transfer, mass transfer operations and its applications.
2. To give emphasis on the importance of mass transfer knowledge while working in bioprocess industries.
3. To study comprehensively mass transfer operations like distillation, absorption, drying and crystallization in detail.
4. To make students aware of designing methods and calculations for efficient mass transfer equipment.
5. To make students apply the concepts of mass transfer to biological systems and operations.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Understand and apply mass transfer principles.

CO2: Write mass balance equations for different unit operations.

CO3: Understand and develop processes based on various mass transfer principles and operations.

CO4: Apply basic knowledge, identify and design mass transfer equipments (Tray towers, dryers etc.) for separation of products.

Course Contents

Unit I	Introduction to Mass transfer	(7 Hrs)

Introduction, General principles of Mass Transfer, Classification of Mass Transfer Operations, Choice of separation method, Methods of conducting mass transfer operations, Design principles Diffusion and Mass transfer, Types of diffusion - Molecular diffusion, Turbulent diffusion, Diffusion in Solids, Fick's and Maxwell law of diffusion, Molecular Diffusion in gases and liquids, Diffusivities of gases and liquids, types of solid diffusion, Introduction to Inter phase mass transfer, Equilibrium, Two resistance theory, Local and overall mass transfer coefficients, Use of local overall, coefficients, Stages, Cascades

Mapping of Course Outcomes for Unit I	**CO1:** To understand and apply mass transfer principles.	
Unit II	**Drying**	**(7 Hrs)**
Drying: Definition, Principles, Equilibrium in drying, Drying hysterisis, Types of moisture binding, Drying operations, Batch drying, Rate of batch drying, Rate of drying curve, Mechanism of batch drying, Mechanism of moisture movement in solid continuous drying, Time required for drying, Classification of drying equipments, Qualitative aspects of freeze drying, Case studies with Numericals		
Mapping of Course Outcomes for Unit II	CO2: mass balance equations for different unit operations. CO3: Understand and develop processes based on various mass transfer principles and operations.	
Unit III	**Crystallization:**	**(6 Hrs)**
Crystallization: Principle rate of crystal growth, Population balance and size distribution, Calculations of yield, Enthalpy balances, Crystallizers used for bioproducts		
Mapping of Course Outcomes for Unit III	CO2: Write mass balance equations. CO3: Understand and develop processes based on various mass transfer principles and operations.	
Unit IV	**Distillation**	**(6 Hrs)**
Distillation: Definition, Vapor-liquid equilibria for Ideal and Non-ideal systems, Relative volatility, Ideal solutions-Raoult's law, Azeotropes, Positive and negative deviations from Ideality, Methods of distillation-Continuous rectification, Differential, Flash, Extractive, Low pressure, Steam distillation, Batch rectification, Molecular distillation		
Mapping of Course Outcomes for Unit IV	CO1: Understand and apply mass transfer principles. CO2: Utilize and design mass transfer equipments (Tray towers, dryers etc.) for separation of products.	
Unit V	**Tray tower calculations**	**(6 Hrs)**
Tray tower calculations: Continuous rectification for binary system, Multistage tray towers-McCabe Thiele method, Tray efficiencies, Reflux ratio-Total reflux, Minimum reflux ratio, Optimum reflux ratio, Types of reboilers, Types of condensers-Total condensers, partial. Condensers, Packed columns, types of packings, NTU, HTU, HETP concept		
Mapping of Course Outcomes for Unit V	CO3: Write mass balance equations for different unit operations. CO4: Utilize and design mass transfer equipments (Tray towers, dryers etc.) for separation of products.	

Unit VI	Gas Absorption	(6 Hrs)
Gas Absorption: Mechanism of gas absorption, Equilibrium in gas absorption, Ideal liquid solutions, Non ideal liquid solutions, Choice of solvent for absorption, L/G ratios for absorbers, Absorption factor, Real trays and Tray efficiency, Use of Reflux, Counter-current operation, case studies		

Mapping of Course Outcomes for Unit VI	CO1: Understand and apply mass transfer principles. CO2: Write mass balance equations for different unit operations. CO4: Apply basic knowledge, identify and design mass transfer equipments (Tray towers, dryers etc.) for separation of products.

Learning Resources

Text Books:

1. Robert Traybal, "Mass Transfer Operations" Third edition, Mc Graw Hill Publication, 2017

Reference Books:

Coulson J.M. and Richardson J.F., "Chemical Engineering", Vol I & II–McGraw Hill International

Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980

Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York, 17 June 2004

MOOC / NPTEL Courses link / Any other e- resources link:

NPTEL Course **"Mass Transfer Operations I " https://onlinecourses.nptel.ac.in/noc20_ch15/preview**

Virtual LAB Link:

1. http://vmt-iitg.vlabs.ac.in/Forced_draft_tray_dryer(theory).html
2. http://vmt-iitg.vlabs.ac.in/Rotary_dryer(theory).html
3. http://vmt-iitg.vlabs.ac.in/Flow_through_porous_media_I(Expt_Calc).html
4. http://vmt-iitg.vlabs.ac.in/Column_tray_efficiency(theory).html
5. http://vmt-iitg.vlabs.ac.in/ASTM_distillation(theory).html

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315473 : Bioseparation Engineering

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3Hrs / week	03	In-Sem (Theory): - 30Marks End Sem (Theory): 70Marks Total Marks :-100

Prerequisite Courses, if any:

Biochemistry, Fluid Flow and Unit Operations, Analytical Techniques

Companion Course, if any: --

Course Objectives:

1. To introduce students with bioseparation techniques. To demonstrate students with techniques of cell disruption; this is the first step in product isolation.
2. Introduce unit operations and their application in separation of bioproducts.
3. To demonstrate techniques for solid liquid extraction
4. To make student understand solvent extraction methods and Aqueous Two Phase extraction
5. To learn membrane separation techniques, types of membranes and Technology of membrane packaging Introduce students with Adsorption Techniques.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Learn the basic Bioseparation techniques along with types of cell disruption methods important for intracellular product.

CO2: Understand the basic unit operation and their applications for Biomolecules separation

CO3: Train students with solid- liquid separation methods (Leaching) other than unit operations like filtration, centrifugation etc.

CO4: Understand the use of liquid -liquid separation techniques for biomolecules

CO5: Students will learn advances separation and purification technique like Membrane Technology

CO6: Learn concept of Adsorption and its application on downstream processing

Course Contents

Unit I	Introduction to Bioseparations	(7 Hrs)

An overview of Bioseparations, Salient features, Advantages, Disadvantages, Need of Bioseparations, Range of Bio products, high volume, low value products and low volume, high value products, Process design criteria and economics of Bioseparations, Mechanical and enzymatic methods of cell disruption, importance of cell disruption in product release

Mapping of Course Outcomes for Unit I	CO1: Learn the basic Bioseparation techniques along with types of cell disruption methods important for intracellular product	
Unit II	**Extraction Operations**	**(7Hrs)**
SLE (Leaching): Definition, Preparation of the solid, Factors affecting leaching operations, Methods of operation, Single stage leaching, Continuous counter current leaching **LLE(Solvent extraction):**Definition, Fields of usefulness, Ternary liquid equilibria, Equilateral triangular coordinates, Mixture rule, Choice of solvent, Material balances - Single stage extraction, Multistage crosscurrent, countercurrent and co current extraction		
Mapping of Course Outcomes for Unit II	CO2: Train students with solid- liquid and liquid-liquid separation methods for biomolecules	
Unit III	**Adsorption**	**(7 Hrs)**
Definition, Types of Adsorption - Physical and Chemical, Nature of adsorbents, Adsorption Isotherms - Langmuir, Freundlich, BET, Heat of adsorption, Introduction to Pressure Swing Adsorption (PSA), and Temperature Swing Adsorption (TSA), Biotechnological Applications of Adsorption processes		
Mapping of Course Outcomes for Unit III	CO3: Learn concept of Adsorption and its application in downstream processing of Biomolecules	
Unit IV	**Chromatography Techniques**	**(8Hrs)**
Gas Chromatography (GC), High Performance Liquid chromatography (HPLC), Instrumentation: Pumps, degasser, mixer, guard column, column and detectors, study and understanding of Chromatograms, Introduction to GC-MS and LC-MS, case studies of GC-MS, LC-MS.		
Mapping of Course Outcomes for Unit IV	CO4: Students will understand functioning of various parts of chromatography system. They will learn to study chromatograms and resolve problems related to it.	
Unit V	**Membrane Separation Techniques**	**(8Hrs)**
Classification of separation techniques, Definition of a membrane, Criteria of membrane separation processes, Types of membranes, Advantages of membrane separation processes over conventional separation techniques ,Industrial Applications, Membrane separations - Micro filtration, Ultrafiltration ,Reverse Osmosis, Piezodialysis, Electro dialysis, Membrane electrolysis, Pervaporation ,Carrier mediated transport- liquid membranes, Membrane contactors, Polarization Phenomenon, Membrane fouling, Membrane modules and Industrial applications of all Processes		
Mapping of Course Outcomes for Unit V	CO5: Students will learn and understand different methods of membrane separation	
Unit VI	**Other separation techniques**	**(8Hrs)**
Precipitation of proteins by different methods, Aqueous two phase systems, Molecular sieves, Adductive crystallization, Supercritical fluid extraction, Reactive extraction.		

Mapping of Course Outcomes for Unit VI	CO6: Students will understand principles of vast variety of separation techniques and their use in separation of biotechnological products

Learning Resources

Text Books:

1. B.Shivshankar, " Bioseparations: Priniples and Techniques", Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
2. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980
3. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International Editions, 1980
4. Pauline Doran, " Bioprocess Engineering Principles", Elsevier Publications, New Delhi,2010
5. Michael R. Ladisch, " Biosepration Engineering, Principles, practice and economics", Wiley-Blackwell Publishers ,9 April 2001

Reference Books:

1. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980

2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", McCabe W.L. and Smith J.C. , 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 2004

3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York,17 June 2004

4.P. A. Belter, E.L. Cussler and W.S. Hu , "A review of Bioseparations (Downstream Processing for Biotechnology)", Wiley Interscience Publishers, New York, 1988.

MOOC / NPTEL Courses link / Any other e- resources link:

1.NPTEL Course on **"Downstream Processing"**

https://nptel.ac.in/courses/102/106/102106022/

2. NPTEL Course on "**Principles of Downstream Techniques in Bioprocess**"
https://nptel.ac.in/courses/102/106/102106048/

Virtual LAB Link:

1. Separation of Casein from Milk

http://biotech01.vlabs.ac.in/bio-chemistry/Isoelectric_Precipitation_of_Proteins_Casein_from_Milk/

2. Determination of Molecular Weight of Intact Proteins using MALDI-TOF MS

http://pe-iitb.vlabs.ac.in/exp11/index.html

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315474: Elective II-A: Instrumentation and Process Control

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs / week	**03**	**In-Sem (Theory): 30 Marks** **End -Sem (Theory): 70 Marks** **Term Work: 50 Marks** **Total Marks: 150**

Prerequisite Courses, if any:

Basic Knowledge of Chemical Engineering Subjects Like Mass Transfer, Material Balance Heat Transfer, Reaction Engineering etc. Problem Solving ability, Information manipulation and processing skills.

Companion Course, if any: --

Course Objectives:

1. To familiarize students with various aspects (principle of operation, construction, characteristics and applicability) of instruments necessary for measurement of different process parameters encountered in the industry
2. To introduce students to the fundamentals of process dynamics – types of processes and different types of inputs as also to study the dynamic and response characteristics of first order systems in detail
3. To understand the dynamic and response characteristics of second order systems
4. To introduce the concept of process control and to provide knowledge of the different components and working of a control system
5. To impart knowledge pertaining to stability analysis of control systems
6. To bring students abreast with different advances in process control systems and demonstrate their applications to the bioprocess industry

Course Outcomes: On completion of the course, learner will be able to –

On completion of the course, learner will be able to :

CO1: Ability to select and operate the most common instruments encountered in the bioprocess Industry.

CO2: A clear understanding of the most important concepts of process dynamics and ability to predict the dynamic responses of various first order systems

CO3: Ability to predict the dynamic behavior of different second order systems

CO4: Ability to analyze a control system and select controllers based on the problem requirement

CO5: Ability to analyze stability and Frequency response of a given system.

CO6: Ability to understand working of multi loop process controls systems.

Course Contents

Unit I		(06 Hrs)
Need for measurement of different process parameters, Instruments used for measurement: **Pressure** – Mechanical and electric transducers, Low pressure – McLeod Gauge and Pirani Gauge, **Temperature** - bi- metal thermometers, resistance thermometer, thermistors, thermocouples, Radiation and optical pyrometers, **Flow** – Hot Wire anemometer and magnetic flow meters.		
Mapping of Course Outcomes for Unit I	Ability to select and operate the most common instruments encountered in the bioprocess Industry.	

Unit II		(06 Hrs)
Dynamics of First Order Systems Introduction Need for studying process dynamics and control, Laplace transforms and its application to process dynamics, characteristics of ideal forcing functions (step, ramp, pulse, impulse, frequency) **Linear open loop Systems – First Order Systems** Definition, characteristics and physical examples of first order systems such as thermometer, liquid tank, CSTR etc., model transfer function and significance of time constant, Dynamic behavior/Response of first order systems to different forcing functions, linearization of non-linear systems (for single variable systems only).		
Mapping of Course Outcomes for Unit II	CO2: A clear understanding of the most important concepts of process dynamics and ability to predict the dynamic responses of various first order systems.	
Unit III		**(08 Hrs)**
Dynamics of Second Order Systems Definition, characteristics and physical examples of second order systems such as manometer, interacting and non-interacting tank systems, model transfer function, Dynamic behavior of second order systems to different forcing functions, Response of Second order system – underdamped, critically damped and overdamped, Transportation lag.		
Mapping of Course Outcomes for Unit III	CO3: Ability to predict the dynamic behavior of different second order systems	
Unit IV		**(06 Hrs)**
Linear Closed Loop Systems Control systems, components of a control system, Concept of feedback control, Controller and final controlling element, pneumatic control valve, control system hardware. Different types of control actions – P, PI, PD, PID; transfer functions, open and closed loop response, advantages and limitations of each controller, Block diagram of a control system, servo and regulatory operations, open and closed loop transfer function, overall transfer function, transfer function for change in load and set point, multi-loop control system transfer function.		

Mapping of Course Outcomes for Unit IV	CO4: Ability to analyze a control system and select controllers based on the problem requirement

Unit V		**(06 Hrs)**
Stability Analysis and Frequency Response Analysis Concept of stability in control systems, stability criterion, Routh's test for stability, root locus analysis, root locus design and plots, frequency response analysis and stability criterion (Bode plots), controller tuning - Ziegler Nichols and Cohen-Coon methods.		
Mapping of Course Outcomes for Unit V	CO5: Ability to analyze stability and Frequency response of a given system.	
Unit VI		**(08 Hrs)**
Advanced Control Systems and Industrial Applications Introduction to advanced control systems: Cascade, feed forward, selective, ratio, override and split range control strategies; Application to fermentation industries: Speed control, Temperature control, Control of gas supply, Control of pH, Control of dissolved oxygen, Antifoam control.		

Mapping of Course Outcomes for Unit VI	CO6: Ability to understand working of multi loop process controls systems.

Learning Resources

Text Books:

1. George Stephanopoulos., "Chemical Process control : An Introduction to Theory and Practice"Pearson Prentice Hall
2. Stanbury, P.F. and Whitaker, A., "Principles of Fermentation Technology",Butterworth- Heinemann

Reference Books:

1. Coughanowr, D., "Process System analysis and control" Mc-Graw Hill
2. A.K.Jairath., "Problems and Solutions of Control Systems", CBS

NPTEL Courses link.

1. NPTEL Course "Process Control and Instrumentation" https://nptel.ac.in/courses/103/103/103103037/
2. NPTEL Course "Process Control and Instrumentation" https://nptel.ac.in/courses/103/105/103105064/

Savitribai Phule Pune University

Third Yearof B.Tech. Biotechnology (2019 Course)

315474: Elective II-B: Food Biotechnology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3Hrs / week	**03**	**In-Sem (Theory): - 30 Marks** **End-Sem (Theory): -70 Marks** **Term Work: - 50** **Total Marks:- 150**

Prerequisite Courses, if any:

Students should have prior knowledge of subjects microbiology, fermentation technology, basic biology, physics, and mathematics.

Companion Course, if any: --

Course Objectives:

1. To introduce students to the applications of biotechnology in the food industry with major focus on the causes, types and factors affecting food spoilage along with the effects of such on food .
2. To acquaint students with the different processing techniques generally applied in the food industry for treatment and preservation of food articles.
3. To develop an ability to apply underlying engineering principles for the design of most commonly Used equipment's in food processing .
4. To bring students abreast with different aspects of microbial fermentation and to study industrial processes for production of a number of technologically important food products.
5. To impart knowledge of classes of industrially important enzymes with specific applications in the food industry.
6. To emphasize the importance of treatment of wastes generated from the food industry and various methods of treating them.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Ability to apply principles of biotechnology to food industry with a clear understanding of role of micro- organisms, the mechanisms and effects of food spoilage and methods to prevent the same

CO2: Ability to select the best possible processing and/ or preservation technique based on the characteristics of Food and the requirements along with an understanding of the intricacies associated therein

CO3:An ability to apply engineering principles to effectively design most commonly used processing equipment's in food industry

CO4:A clear understanding of the process and the salient characteristics of systems involving micro-organisms and an ability to design new processes based on similar principles

CO5:An understanding of the role and important applications of enzymes in the food industry

CO6: Ability to characterize the wastes generated from the food industry and apply a suitable method of treating them

Course Contents		
Unit I	Introduction to Food Biotechnology and Spoilage of Food	**(7 Hrs)**
Biotechnology in relation to the food industry, Food Biotechnology- Scope and applications, classes of industrially important food, Characteristics of food - Nutritional value and sensory characteristics, spoilage of food –Mechanisms and types of spoilage, Intrinsic and extrinsic factors affecting spoilage: water activity, pH, temperature, redox potential etc., major spoilage microorganisms and their growth conditions, effect on food.		
Mapping of Course Outcomes for Unit I	CO1: Ability to apply principles of biotechnology to food industry with a clear understanding of role of micro-organisms, the mechanisms and effects of food spoilage and methods to prevent the same	
Unit II	**Introduction to Food Processing**	**(7 Hrs)**
Preliminary processing methods – need and types, Raw material preparation: Cleaning, sorting, grading, peeling etc Principles and methods of food preservation – Low temperature techniques: Refrigeration, Freezing and freeze drying, High temperature techniques: Blanching, HTST pasteurization, canning, UHT treatment, dehydration, drying, extrusion cooking, Irradiation techniques: UV light, microwave processing, gamma rays, hydrostatic pressure cooking, use of additives, modified atmosphere packaging and storage		
Mapping of Course Outcomes for Unit II	CO2: Ability to select the best possible processing and/ or preservation technique based on the characteristics of food and the requirements along with an understanding of the intricacies associated therein	
Unit III	**Design of Food Preservation Equipments**	**(7 Hrs)**
General engineering aspects and processing methods, types of equipments and their design: Refrigerator, freezer, dryer, thermal death kinetics of micro-organisms, calculation of pasteurization time, time and temperature calculation for HTST sterilization		
Mapping of Course Outcomes for Unit III	CO3: An ability to apply engineering principles to effectively design most commonly used processing equipments in food industry	
Unit IV	**Microbial and Fermentation Biotechnology**	**(8 Hrs)**
Technologies used for microbial production of food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology of food flavor production, microbial production of oils and fats, food applications of algae, Process developments in solid state fermentation for food applications, solid state bio- processing for functional food ingredients, Fermentation biotechnology of traditional foods of the Indian Subcontinent.		
Mapping of Course Outcomes for Unit IV	**CO4:** A clear understanding of the process and the salient characteristics of systems involving micro-organisms and an ability to design new processes based on similar principles	
Unit V	**Role of Enzymes in Food Processing**	**(8 Hrs)**
Classes of industrially important enzymes in food industry, Role of enzymes in bakery industry, cereal and beverage industry, meat processing, beer mashing and chill-proofing, production and application of pectinases, proteases etc.		
Mapping of Course Outcomes for Unit V	**CO5:** An understanding of the role and important applications of enzymes in the food industry	

Unit VI	Processes for the treatment of food processing waste	(8 Hrs)

Classification and characterization of food industrial waste: solid, liquid and hazardous wastes, Waste disposal methods- physical, chemical and biological, Treatment methods of solid wastes, Treatment methods for liquid wastes from food industry, activated sludge and anaerobic processes for treatment of food processing wastes.

Mapping of Course Outcomes for Unit VI	CO6: Ability to characterize the wastes generated from the food industry and apply a suitable method of treating them.

Learning Resources

Text Books:

1. B.Shivshankar, " Bioseparations: Principles and Techniques", Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
2. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980
3. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International Editions, 1980
4. Pauline Doran, " Bioprocess Engineering Principles", Elseveir Publications, New Delhi,2010
5. Michael R. Ladisch, " Biosepration Engineering, Principles, practice and economics", Wiley-Blackwell Publishers ,9 April 2001

Reference Books:

1. Alan Shivers Foust, Leonard A. Wenzel, L. Bryce Andersen, Louis Maus, Curtis W. Clump, "Principles of Unit Operations in Chemical Engineering", John Wiley & Sons, January 1st 1980
2. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", McCabe W.L. and Smith J.C. , 7th Edition, McGraw Hill Chemical Engineering Series, 0ctober 27, 2004
3. Buford D. Smith, "Design of Equilibrium Stage Processes", McGraw-Hill, New York,17 June 2004
4. P. A. Belter, E.L. Cussler and W.S. Hu , "A review of Bioseparations (Downstream Processing for Biotechnology)", Wiley Interscience Publishers, New York, 1988

MOOC / NPTEL Courses link / Any other e- resources link:

NPTEL Course on **"Food Technology"**

https://nptel.ac.in/courses/103/107/103107088/

NPTEL Course on "**Dairy and Food Processes and products technology**" https://nptel.ac.in/courses/126/105/126105013/

Savitribai Phule Pune University
Third Year Of B.Tech. Biotechnology (2019 course)

315474: Elective II-C: Database Management Systems

Teaching Scheme:	Credit	Examination Scheme:
Theory: 4 Hrs/ week	**3**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **TW:- 50 Marks** **Total : 150 Marks**

Prerequisite Courses, if any:

Data structures.

Discrete structures.

Companion Course, if any: --

Course Objectives:

1. To understand the fundamental concepts of database management. These concepts include aspects of database design, database languages, and database-system implementation.
2. To provide a strong formal foundation in database concepts, technology and practice.
3. To give systematic database design approaches covering conceptual design, logical design and an Overview of physical design.
4. To be familiar with the basic issues of transaction processing and concurrency control.
5. To learn and understand various Database Architectures and Applications.
6. To understand how analytics and big data affect various functions now and in the future.

Course Outcomes: On completion of the course, learner will be able to –

CO1. To define basic functions of DBMS & RDBMS.

CO2. To analyze database models & entity relationship models.

CO3. To design and implement a database schema for a given problem-domain. CO4. To populate and query a database using SQL DML/DDL commands.

CO5. Do Programming in PL/SQL including stored procedures, stored functions, cursors and packages.

CO6. To appreciate the impact of analytics and big data on the information industry and the external ecosystem for analytical and data services.

Course Contents		
Unit I	**Introduction TO DBMS**	**(8 Hrs)**
Introduction: Database Concepts, Database System Architecture, Data Modeling: Data Models, Basic Concepts, entity, attributes, relationships, constraints, keys. **Relational Model:** Basic concepts, Attributes and Domains, how the relational models builds biological database. Relational Integrity: Domain, Entity, Referential Integrities, Enterprise Constraints, Schema Diagram.		

Mapping of Course Outcomes for Unit I	CO1: To define basic functions of DBMS & RDBMS.

Unit II	**Database Design And SQL**	**(8 Hrs)**
Database Design: Functional Dependency, Purpose of Normalization, Data Redundancy. Introduction to SQL: Characteristics and advantages, SQL In Bioinformatics database, SQL Data Types and Literals, Tables: Creating, Modifying, Deleting, Views: Creating, Dropping, Updating using Views, Indexes, Nulls SQL DML Queries: SELECT Query and clauses, biological query, uniqueness. Set Operations, Predicates and Joins, Set membership, BIOLOGICAL Tuple Variables, Set comparison, Ordering of Tuples, Nested Queries, Database Modification using SQL Insert.		

Mapping of Course Outcomes for Unit II	CO2: To analyze database models & entity relationship models.

Unit III	**Query Processing**	**(8 Hrs)**
Query Overview, Evaluation of expression, Operators, Materialization and Pipelining algorithm. Serializability: Conflict and View, Cascaded Aborts, Recoverable and No recoverable Schedules. Programmatic SQL: Embedded SQL, Dynamic SQL, biological transactions, database updation, protein databases. how to update databases.		

Mapping of Course Outcomes for Unit III	CO3: To design and implement a database schema for a given problem-domain.

Unit IV	**Advanced Databases**	**(8 Hrs)**
Concurrency Control: Need, Locking Methods, Deadlocks, Time-stamping Methods, and Optimistic Techniques. Checkpoints, Performance Tuning, Query Optimization with respect to SQL Database. Database Architectures: 2 Tier and 3 Tier Architecture, Introduction to Parallel Databases, Key elements of Parallel Database Processing, Architecture of Parallel Databases, Introduction to Distributed Databases, parallel and distributed databases and their advantages for biological data.		

Mapping of Course Outcomes for Unit IV	CO4: To populate and query a database using SQL DML/DDL commands

Unit V	**Large Scale Data Management**	**(8 Hrs)**

Emerging Database Technologies: Introduction to SQL Databases- Internet Databases, Cloud Databases, Mobile Databases, SQLite Database, XML Databases

Introduction to Big Data and XML: DTD, XML Schemas, XQuery, XPath.

Python. Introduction to Hadoop: Introduction to HBase: Overview, HBase Data Model, HBase Region, Hive. Managing genomic data and proteomic data, using the large scale data management technologies.

Mapping of Course Outcomes for Unit V	CO5: Do Programming in PL/SQL including stored procedures, stored functions, cursors and packages

Unit VI	**Data Warehousing And Data Mining**	**(8 Hrs)**

Data Warehousing: Introduction, Evolution of Data Warehouse, Characteristics, Benefits, Limitation of Data Warehousing, Architecture and Components of Data Warehouse, Conceptual Models

Data Mining: concept, Process, Knowledge Discovery, Goals of Data Mining in biology, Data Mining Tasks, Association, Classification, Clustering, Big Data (Terminology and examples) Introduction to Machine learning for Big Data in biology.

Mapping of Course Outcomes for Unit VI	CO6: To appreciate the impact of analytics and big data on the information industry and the external ecosystem for analytical and data services.

Learning Resources

Text Books:

1. Silberschatz A., Korth H., Sudarshan S, Database System Concepts, McGraw Hill Publication, ISBN-0-07-120413-X, Sixth Edition.
2. S. K. Singh, Database Systems: Concepts, Design and Application, Pearson Publication, ISBN-978-81- 317-6092-5.

Reference Books:

1. Kristina Chodorow, Michael Dirolf, MongoDB: The Definitive Guide, O'Reilly Publications,
2. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, Elsevier,
3. Bill Schmarzo, Big Data: Understanding How Data Powers Big Business, Wiley, 978-81-265-4545-2

MOOC / NPTEL Courses link / Any other e- resources link:

For example

1. NPTEL Course **"Database Management system"** https://nptel.ac.in/courses/106/105/106105175/

Virtual LAB Link:

1. Vlabs**: Database Management system** http://vlabs.iitb.ac.in/bootcamp/labs/dbms/exp8/exp/theory.php

Savitribai Phule Pune University Third Year of B.Tech. Biotechnology (2019 Course) 315475 : Fermentation Technology Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Teaching Scheme: PR: 4 Hrs/week	**02**	**Examination Scheme: OR: 50 M Total : 50 M**

Prerequisites:- Microbial Techniques, Basic analytical Techniques

Course Objectives:

1. To train students for handling of microbial cultures and perform fermentation processes for production of different biomolecules
2. To train students to optimize fermentative production processes and learn effect of various parameters on processes
3. To train students to learn different modes of fermentations like SLF, SSF etc.

Course Outcomes: On completion of this course, students will be able to

CO1. Handle microbial cultures and perform fermentative processes for production of different biomolecules

CO2. Optimize production process and evaluate effect of different parameters on total product yield

CO3. Perform Different modes of Fermentations like SSF, immobilization of Cells etc.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Pretreatment, preparation of fermentation media and sterilization of media.
2	Determination of size of inoculum and fermentative production of organic acid (Citric Acid).
3	Estimation of Reducing sugars (Pre and post fermentation) from fermentation broth.
4	Estimation of proteins from fermentation broth during fermentation
5	Estimation of Biomass production during fermentation process.
Sr. No.	**Group B**
1	Preparation of wine from fruits and quality assessment.
2	Lab scale production of Industrially important Enzyme from microorganisms, like Amylases.
3	Study of substrate utilization kinetics in fermentation for determination of yield.
4	Study of product formation kinetics in fermentation for determination of yield.
Sr. No.	**Group C**
1	Study of changes in pH profile of fermentation media during fermentation process to understand metabolic activities of microorganisms.
2	Immobilization of Yeast cells for alcohol production.
3	Production of alcohol using immobilized yeast cells

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Regularity and sincerity of students during lab Practicals
2. Journal presentation
3. Understanding of the experiment
4. Performance in unit tests
5. Attendance during theory lectures

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Enter the usage of chemicals and equipment's in a logbook
3. Students should make aware of hazard warning symbols on reagent bottle
4. Protective devices must be worn while handling acid bottles and preparing appropriate solvents. It is necessary to protect the eyes and face from splashes
5. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

Virtual LAB Link:

Estimation of Carbohydrates from Fermentation Broth

http://vlab.amrita.edu/?sub=3&brch=73&sim=1139&cnt=2

Fermentation of microbial product (Acetone -Butanol-Ethanol)

http://209.211.220.205/model/abef/theory.html

Fermentation of microbial product bioopolymer) **http://209.211.220.205/model/bp/theory.html**

Use of alginate for cell immobilization **http://209.211.220.205/model/iwc/theory.html**

Study of fermenter design **http://209.211.220.205/model/15lb/theory.html**

Effect of aeration in fermentation **http://209.211.220.205/model/15lb/theory.html**

Savitribai Phule Pune University
Third Year of B.Tech. Biotechnology 2019Course)
315476 :Mass Transfer Lab

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 2 Hrs/week	**01**	**Examination Scheme:** **TW: 50 Marks** **Total : 50 Marks**

Prerequisites:- Understanding of basic mass transfer principles and unit operations

Course Objectives:

1. To demonstrate students to biphasic and interphasic diffusion systems.
2. To study various unit operations with different characteristics.
3. To study design and optimization of parameters while working with equipments like dryers, distillation tower, crystallisers etc.

Course Outcomes:

On completion of this course, students will be able to

CO1. Visualize phase separation and calculate diffusion co-efficient of various systems.

CO2. Learn about detailed design and working of different unit operations and its characteristics.

CO3. Able to optimize equipment performance parameters for better product yield and equipment efficiency.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Liquid-Liquid diffusion – To calculate the diffusion co-efficient for a liquid-liquid system.
2	Solid-Liquid diffusion –To calculate the diffusion co-efficient for a solid-liquid system.
3	Interphase Mass transfer Co-efficient- To calculate the individual and overall Mass transfer co-efficient.
Sr. No.	**Group B**
1	Process of Crystallization and its characteristics.
2	Tray Dryer- To study the characteristics of Tray Dryer
3	Differential/Steam distillation
4	Liquid-Liquid Extraction to calculate the partition co-efficient of LLE.
Sr. No.	**Group C**
1	Batch/ continuous leaching
2	Fluidized Bed Dryer- To study the characteristics of fluidized bed dryer.
3	To study the design and operating principle of spray dryer.

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Regularity and sincerity of students during lab Practicals
2. Journal presentation
3. Understanding of the experiment
4. Performance in unit tests
5. Attendance during theory lectures

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Enter the usage of chemicals and equipment's in a logbook
3. Students should make aware of hazard warning symbols on reagent bottle
4. Protective devices must be worn while handling acid bottles and preparing appropriate solvents. It is necessary to protect the eyes and face from splashes
5. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

Savitribai Phule Pune University
Third Year Of B.Tech. Biotechnology (2019 Course)
315477 : Bioseparation Engineering LAB

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: PR: 4 Hrs/week	**02**	**Examination Scheme:** **PR : 50M** **Total : 50M**

Prerequisites:-

Analytical Techniques, Biochemistry

Course Objectives:

1. To train students for use of different cell disruption techniques
2. To train students to learn different separation techniques like Precipitation, Dialysis etc
3. To train students to understand application of modern separation techniques like membrane separation using TFF, Instrumentation of HPLC etc.

Course Outcomes:

On completion of this course, students will be able to

CO1. Apply different cell disruption techniques for purification of biomolecules

CO2. Use different separation techniques for separation and purification of biomolecules

CO3. Correlate basic principles of Bioseparation engineering and development of modern separation Techniques.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A
1	Cell disruption using Ultra sonication
2	Use of Blender for disruption of plant tissue
3	Lab scale Homogenization of Baker's Yeast
Sr. No.	**Group B**
1	Adsorption on charcoal: Application in removal of unwanted dye.
2	Precipitation of proteins using Ammonium Sulphate.
3	Purification of proteins using Dialysis
Sr. No.	**Group C**
1	Separation of casein protein from milk using isoelectric point
2	Study of tangential flow filtration System for purification of biomolecules
3	Study of SDS-PAGE for determination of molecular weight of proteins

Guidelines for Lab /TW Assessment

Lab Assessment will be based on the following points

1. Present/Absent
2. A completion date of the journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed during laboratory conduction

1. Lab coat should be worn by students before entering the laboratory
2. Students shall keep their belongings on storage rack
3. Loose hair and flowing parts of apparel shall be properly tied before commencing of work
4. Enter the usage of chemicals and equipment's in a logbook
5. The instruction manual should be read before operating any instrument
6. Students should make aware of hazard warning symbols on reagent bottle
7. Protective devices must be worn when it is necessary to protect the eyes and face from splashes
8. All chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after u.
9. Reagents to be stored should be labeled with due discarding date 10.Instructions for proper disposal of waste material should be followed
10. Report accidental cuts or burns to the instructor immediately
11. Perform the experiment. Collect data in a clear and organized fashion.
12. Be sure to note the units for each measurement. Also, be sure to participate in the experiment rather than just recording data for your group

General Guidelines:

Before starting any experiment, clearly define the goals. What question are you answering or what principle are you trying to demonstrate? What data is needed to solve the problem?

Identify the methods of measurement and instrumentation to be used.

Savitribai Phule Pune University
Third Yearof B.Tech. Biotechnology (2019 Course)
315478 :Audit Course 6

In addition to credits courses, it is recommended that there should be audit course (non-credit course). Audit course is for the purpose of self-enrichment and academic exploration. Audit course carry no academic credit. Selection of audit courses helps the learner to explore the subject of interest in greater details resulting in achieving objective of audit course's inclusion. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP(Audit course pass) and shall be included such grade in the semester grade report for that course, provided students has the minimum attendance as prescribed by the Savitribai Phule Pune university and satisfactory in-semester performance and secured a passing grade in that audit course. No grade point is associated with this "AP" grade and performance in these courses is not accounted in the calculation of the performance indices SGPA andCGPA.

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

1. Lecture/Guest lecture
2. Visit (Social/field) and reports
3. Demonstration Surveys
4. Mini project
5. Hands on experience on specific focused topic.
6. Seminar/Workshop

Guidelines for Assessment (Any one or more of following but not limited to)

1. Written test
2. Quiz
3. Demonstrations/practical test
4. Presentations
5. IPR/publication
6. Report

Audit course 2 Options (Anyone)

315478:A: Technical Communication

315478:B: Financial Management

Savitribai Phule Pune University

Third Year of B.Tech. Biotechnology (2019 Course)

315479 :Internship

Credits:4

TW: 100 Marks

Total Marks:-100

Course Objectives:

1. To encourage and provide opportunities for students to get professional/personal experience through internships.
2. To learn and understand real life/industrial situations.
3. To get familiar with various tools and technologies used in industries and their applications.
4. To nurture professional and societal ethics.
5. To create awareness of social, economic and administrative considerations in the working environment of industry organizations

Course Outcomes:

On completion of the course, learners should be able…

CO1: To demonstrate professional competence through industry internship.

CO2: To apply knowledge gained through internships to complete academic activities in a professional manner.

CO3: To choose appropriate technology and tools to solve given problem.

CO4: To demonstrate abilities of a responsible professional and use ethical practices in day to day life.

CO5: Creating network and social circle, and developing relationships with industry people.

CO6: To analyze various career opportunities and decide carrier goals.

Guidelines:

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales. Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations. Engineering internships are intended to provide students with an opportunity to

apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum

Duration:

As per the apex bodies' recommendations and guidelines, it is need of the day to train the pre-final year students for the industrial readiness through internship. As per the guidelines of AICTE, the duration of internship is 4-6 weeks after completion of semester V and before commencement of semester VI, so it is apparent that the contact hours of the TE students need to be managed meticulously. It becomes mandatory as per the structure that 4 credits for internship must earned by the students. Internship to be completed after semester 5 and to be assessed in semester 6. Internship will be of 4 to 6 weeks maximum.

Internship work Identification:

Student may choose to undergo Internship at Industry/Govt. Organizations/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry[1].

Students must register at Internshala [2]. Students must get Internship proposals sanctioned from college authority well in advance. Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination and before academic schedule of semester VI.

Student can take internship work in the form of the following but not limited to:

- Working for consultancy/ research project,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /
- Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,
- Development of new product/ Business Plan/ registration of start-up,
- Industry / Government Organization Internship,
- Internship through Internshala,
- In-house project work, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship
- Research internship under professors, IISC, IIT's, Research organizations,

- NGOs or Social Internships, rural internship,
- Participate in open source development.

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed every day by the supervisor. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.)

Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks + Internship Diary/Workbook and Internship Report - 50 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute-

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

• Depth of knowledge and skills
• Communication & Presentation Skills
• Team Work
• Creativity
• Planning & Organizational skills
• Adaptability
• Analytical Skills
• Attitude & Behavior at work

• Societal Understanding

• Ethics

• Regularity and punctuality

• Attendance record

Diary/Work book

• Student's Feedback from External Internship Supervisor

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period

Internship Diary/workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries
- Adequacy & quality of information recorded
- Data recorded
- Assays/protocols used
- Organization of the information

The report shall be presented covering following recommended fields but limited to,

• Title/Cover Page

• Internship completion certificate

• Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details

• Index/Table of Contents

• Introduction

• Title/Problem statement/objectives

• Motivation/Scope and rationale of the study

• Methodological details

• Results / Analysis /inferences and conclusion

• Suggestions / Recommendations for improvement to industry, if any

• Attendance Record

• Acknowledgement

• List of reference (Library books, magazines and other sources)

Feedback from internship supervisor(External and Internal)

Post internship, faculty coordinator should collect feedback about student with recommended parameters include as- Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership…..

Reference:

[1] https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

[2] https://internship.aicte-india.org/