Faculty of Engineering

Savitribai Phule Pune University

Syllabus of

Final Year

(Biotechnology Engineering)

(2019Course)

(With effect from June2022)

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SavitribaiPhulePuneUniversity,Pune
Final Year (B.Tech. Biotechnology)2019Course
(WitheffectfromAcademicYear2022-23)

Semester-VII

Course Code	CourseName	TeachingScheme(Hours/Week)			Examination SchemeandMarks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
415461	Biochemical Engineering	3			30	70				100	3			3
415462	Bioinformatics	3			30	70				100	3			3
415463	Elective III	3			30	70				100	3			3
415464	Elective IV	3			30	70				100	3			3
415465	Biochemical Engineering Lab		4				50			50		2		2
415466	Bioinformatics Lab		2					50		50		1		1
415467	Elective III Lab		2						50	50		1		1
415468	Project Stage -1	-	4				50		50	100	2			2
415469	MOOCs NPTEL,COURSERA etc.						50			50	2			2
415470	Audit course 5 A Biodiversity B Bioethics	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	12	12		120	280	150	150		700	16	04		20
							TotalCredit							

Elective III A. Bioprocess Equipment Design B. Environmental Biotechnology
C. Genomics
Elective IV A. Bioenergy and Renewable Resources B. Industrial Organization and Management
C. Stem Cell Biology and Regenerative Medicine

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SavitribaiPhulePuneUniversity,Pune
Final Year (B.Tech. Biotechnology)2019Course
(WitheffectfromAcademicYear2022-23)

Semester- VIII

Course Code	CourseName	TeachingScheme(Hours/Week)			Examination SchemeandMarks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
415471	Bioprocess Modeling and Simulation	3			30	70		-	-	100	3	-	-	3
415472	Plant Engineering and Project costing	3			30	70	-			100	3	-	-	3
415473	ElectiveV	3			30	70	-			100	3	-	-	3
415474	Elective VI	3	-		30	70				100	3	-	-	3
415475	BMS and Plant Engineering and Project Costing Lab		2				25		50	75		1		1
415476	ElectiveV TW & Elective VI Oral			1			50		25	75			1	1
415477	ProjectStage-2		12		-	-	100	-	50	150	06	-	-	6
415478	Auditcourse 6 A Public Health and Hygiene B IndianConstitution									-				
Total		12	14	1	120	280	175	125		700	18	02		20
TotalCredit														

Elective V A. Biomaterials B. Molecular diagnostics
C.. Bio-therapeutics Technology
Elective VI A. Management and EntrepreneurshipB. IPR, Intellectual Property Rights.
C. Nanotechnology

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FINAL YEAR BIOTECHNOLOGY SYLLABUS

SEM I

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SavitribaiPhule Pune University, Pune
Final Year of B.Tech. Biotechnology (2019 Course)
415461 :Biochemical Engineering

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

Prerequisite Courses, if any:
Knowledge of subjects like Microbiology, Material Balances andStoichiometry, Mass transfer, Heat transfer

Course Objectives:

1. To study fermentation process kinetics.
2. To study modes of operation and types of fermenters with its applications.
3. To make students aware of design of fermenter with its auxiliaries and operatingparameters.
4. To study importance of aeration and agitation in bioprocesses.
5. To give brief idea and standards procedures of scale up and scale down of fermentation.
6. To introduce students about advanced and recent fermentation techniques used in industries.

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

CO1: Have an ability to evaluate microbial process kinetics and parameter optimization.
CO2: Students will be able to choose and design an appropriate type of fermenter based on its application.
CO3: Assemble fermenter auxiliaries and able to set the required process parameters.
CO4: Built an ability to understand need and general considerations of process scale up and scale down.
CO5: Gain knowledge about recent trends in biotransformation's and bioconversions.

Course Contents

Unit I		(6 Hrs)

Fermentation Process Kinetics:

Introduction to Growth Kinetics, Balanced growth kinetics, Transient growth kinetics, Structured Kinetic models, Product formation kinetics, Thermal death Kinetics of cells and spores.

Mapping of Course Outcomes for Unit I	CO1: Have an ability to evaluate microbial process kinetics.

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Unit II		(7 Hrs)

Types of Fermenters, design & Operation:

CSTR, Modes of operation in stirred reactors: discontinuous batch operation, continuous operation, open and closed loop controlled reactors, semi continuous reactors, periodic fed batch cultivation, bubble column reactors, air lift tray bioreactors, hollow fiber configuration and application of bioreactors.

Mapping of Course Outcomes for Unit II	CO2: Students will be able to choose and design an appropriate type of fermenter based on its application.

Unit III		(6 Hrs)

Fermenter Auxiliary design & Operation:

Detailed study of design and operation of different types of fermenters, auxiliary fittings, like sampling port, impeller design, agitated power requirement, measurement and control of dissolved oxygen, CO_2, temperature, pH and foam, effect of rheological properties and its importance in fermentation operation.

Mapping of Course Outcomes for Unit III	CO3: Assemble fermenter auxiliaries and able to set the required process parameters.

Unit IV		(7 Hrs)

Aeration and agitation:

Aeration and agitation, effect of shear, oxygen requirement of microorganisms, mass transfer theory, diffusional resistance to oxygen transfer, methods of measurement of mass transfer coefficients:$k_La$measurement methods-sulphite oxidation methods and Gassing out, Type of impellers, Case study on$k_La$measurement

Mapping of Course Outcomes for Unit IV	CO1: Have an ability to evaluate microbial process kinetics and parameter optimization. CO3: Assemble fermenter auxiliaries and able to set the required process parameters.

Unit V		(6 Hrs)

Scale up of Fermentation Process:

Introduction to scale up, Applications, thumb rules to scale up, similarity principles, Environmental approach, regimen analysis, Economics of Scale-up.

Mapping of Course Outcomes for Unit V	CO3: Assemble fermenter auxiliaries and able to set the required process parameters. CO4: Built an ability to understand need and general considerations of process scale up and scale down.

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Unit VI		(6 Hrs)
Advanced Fermentation Techniques: Immobilization Techniques, Reactors with immobilized cells/enzymes, Animal and plant cell reactors: Case Study, semi synthetic fermentation process: Case Study, Disposable fermenters- Case study.		
Mapping of Course Outcomes for Unit VI	CO1: Have an ability to evaluate microbial process kinetics and parameter optimization. CO2: Students will be able to choose and design an appropriate type of fermenter based on its application. CO5: Gain knowledge about recent trends in biotransformations and bioconversions.	

Learning Resources

Text Books:

- James E.Bailey, David F.ollis, Biochemical Engineering Fundamentals 2nd edition, Tata McGraw Hill Edition
- E.M.T. El-Manasi, C.F.A. Bryce, A.L.Demain, A.R.Allman, Fermentation Microbiology and Biotechnology 2nd Edition Taylor &Fransis
- Michael L.shuler, FikretKargi, Bioprocess Engineering- Basic concepts 2nd edition, PHI Learning Pvt. Ltd.
- Bioreactor Design and Product Yield- Biotol Series

Reference Books:

- Rosevear, John F Kennedy, Joaquim M S Cabral, Adam Hilger, Immobilized Enzymes and Cells
- S.N. Mokhopadhyay, Experimental Process Biotechnology Protocols, Viva Books Pvt.Ltd.

MOOC / NPTEL Courses:

- NPTEL Course : Aspects of Biochemical Engineering
- https://nptel.ac.in/courses/103105054

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SavitribaiPhule Pune University, Pune

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

415462 : Bioinformatics

TeachingScheme:	Credit	ExaminationScheme:
TH: 3 Hrs./Week	3	In-Sem(Theory): 30Marks End Sem(Theory): 70 Marks Total : 100 Marks

PrerequisiteCourses,ifany:

Knowledge about Molecular Biology, Genetic engineering and genome sequencing.

Basic concepts of computers like algorithms, computer programs and how they function..

CourseObjectives:

1. To give an overview of bioinformatics, databases and their applications with respect to genome analysis.
2. To acquaint students with various genomic databases available and the way to access and utilize the information contained therein.
3. To introduce primary, secondary and structural databases of proteins and the way to access them and retrieve information for a specific purpose.
4. To introduce to the structural protein information available in various databases
5. To introduce sequence alignment and make the students understand the concept of algorithms.
6. To introduce phylogeny and tree concept and their application to bioinformatics.

CourseOutcomes: Oncompletionofthecourse,learnerwillbeableto–

CO1: Understand concept of databases their crosstalk and types of databases and their use in bioinformatics to understand and analyze genomic data

CO2: Access and retrieve genomic information of relevance from various nucleotide databases available and know how the information is stored there

CO3: Understand how to accessvarious protein databases to retrieve protein information and acknowledge the complexity of protein data

CO4: Utilize the structural protein information available in various databases and use it to understand real life case studies.

CO5: Perform an alignment of sequences and also will be able to analyze and optimize the alignments by changing parameters

CO6: Learn how to construct the phylogenetic trees and understand the application and significance of phylogenetic analysis in bioinformatics and pharmacology.

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CourseContents		
Unit I		**(6 Hrs)**
Database concept and Bioinformatics Database concept, Database Management system: Data structure, Query language Basics of Structured Query Language (SQL), Relational Model, Object Model, Object oriented and Relational databases. Introduction and Scope of computational biology and Bioinformatics, File formats, PubMed, Genome and Organism specific databases		
MappingofCourseOutcomes forUnitI	**CO1 :** Understand concept of databases their crosstalk and types of databases and their use in bioinformatics to understand and analyze genomic data	
Unit II		**(6 Hrs)**
Nucleic Acid Databases Major Genome Servers – Genbank at NCBI, DNA Data Bank of Japan (DDBJ), European Bioinformatics Institute is part of European Molecular Biology Laboratory (EMBL). Specialized genomic recourseslike - SGD, UniGene.Data retrieval systems - Entrez, DBGET/LinkDB and SRS. Database Searching, Description of the entries and Sequence Data File, Sample Sequence Data File.		
MappingofCourseOutcomes forUnitII	**CO2:** Access and retrieve genomic information of relevance from various nucleotide databases available and know how the information is stored there	
Unit III		**(6 Hrs)**
Protein Databases Uniqueness of Polypeptide sequence and properties, Primary, Secondary, Tertiary & Quaternary Structure, Hydrophobicity, Disulphide bonds, Active Sites, Secondary structure composition, backbone flexibility, Ramchandran Plot Primary protein Databases UNIPROT - PIR, SWISS-PROT, TrEMBL, Description of the entries and Sequence Data File, Sample Sequence Data File, Representation of sequence.		
MappingofCourseOutcomesforUnitIII	**CO3:** Understand how to accessvarious protein databases to retrieve protein information and acknowledge the complexity of protein data.	
Unit IV		**(6 Hrs)**
Structural Bioinformatics Secondary protein databases: Patterns, Motifs and Profiles databases like PROSITE, PRINTS, BLOCKS. Protein fold classification- SCOP, CATH, and FSSP. Various tools for protein Structure Visualization Rasmol, Jmol, PyMOL etc. Proteomics, Secondary and tertiary structure prediction methods.Basic Molecular Docking concept.		

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MappingofCourseOutcomesforUnitIV	**CO4:** Utilize the structural protein information available in various databases and use it to understand real life case studies.

Unit V	**(6 Hrs)**

Alignment of sequences

Pairwise Sequence Alignment – Sequence alignment.similarity, identity, homology, Local and Global Sequence Alignment, Needleman-Wunsch& Smith-Waterman Algorithm, Dot Plot.Scoring Matrices such as PAM and BLOSUM.Gap penalty concept, alignment's statistical significance, and heuristic alignments. Multiple Sequence Alignment – Clustal W.

MappingofCourseOutcomesforUnitV	**CO5:** Perform an alignment of sequences and also will be able to analyze and optimize the alignments by changing parameters

Unit VI	**(6 Hrs)**

Phylogenetic Analysis

Definition of Phylogeney and phylogenetic trees, evolutionary tree construction, tree building methods, rooted and unrooted trees. Elements of phylogenetic models. Homologs, orthologs and paralogs.Phylogenetic data analysis: alignment, substitution, parsimony, building the data model, determining substitution model, phylogenetic prediction, data phylogenetic software like PHYLIP, CLUSTAL W, Tcofee, Phylogenetics on the web

MappingofCourseOutcomesforUnitVI	**CO6:** Learn how to construct the phylogenetic trees and understand the application and significance of phylogenetic analysis in bioinformatics and pharmacology.

LearningResources

Text Books:

1. Introduction to Bioinformatics – Author Arthur M. Lesk Oxford University Press
2. Bioinformatics Methods & Applications – Author S.C.Rastogi, N. Mandiratta, P. Rastogi.

Reference Books:

1. Bioinformatics Sequence and Genome Analysis – Author - David W. Mount, Cold Spring Harbor Laboratory Press
2. Bioinformatics: A practical guide to the analysis of genes and proteins – Author A. D. Baxevanis and B.F.F. Ouellette John Wiley and Sons
3. Bioinformatics computing – Author Bryan Bergeron, Pearson Education.
4. Biological Sequence Analysis (Probabilistic Models of Proteins and Nucleic Acids) – Author Sean Eddy, Anders Krogh, Richard M. Durbin, Cambridge University Press.
5. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Author Andreas D. Baxevanis, Gary D. Bader, David S. Wishart.

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Bioinformatics for Dummies – Author Jean Claverie, Cedric Notredame, John Wiley and Sons.

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

For example

NPTEL Course **"BioInformatics: Algorithms and Applications"**https://onlinecourses.nptel.ac.in/noc21_bt06/preview

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SavitribaiPhule Pune University, Pune

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

415463 : Bioprocess Equipment Design Elective-III (A)

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

Prerequisite Courses, if any:

Knowledge of subjects like, Material balance and stoichiometry, Mass transfer, Heat transfer, Thermodynamics, Reaction Engineering, Fluid Flow and Unit Operation

Course Objectives:

1. The objective of this course is to acquire basic understanding of design parameter completeknowledge of design procedures for commonly used bioprocess equipment.
2. This course to give up-to-date knowledge for designing of bioreactor/fermenterused in chemical and biochemical process plants.
3. To Import knowledge to analyse a problem andfinding a process design method for equipment's used in biotech industry.

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

CO1: Understand the analysis and use of Bioreactors

CO2: Understand the design Principles of Bioreactors/Reaction vessels

CO3: Ability to design internal pressure vessels and reaction vessels required in bioprocess industry

CO4: : Understand the use and concept of process design for heat exchange equipment's.

CO5: Understand the process design of distillation column for bioprocess industry

CO6: Understand the engineering aspects of scale up of Bioreactor/Fermenter

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Course Contents

Unit I	**Analysis of Bioreactors/Reactors**	**(7 Hrs)**
Modeling of non-ideal behavior in bioreactors, tanks-in-series and dispersion models-application to design of continuous sterilizers, air-lift loop reactors, fluidized- bed bioreactors, stability analysis of bioreactors.		
Mapping of Course Outcomes for Unit I	**CO1**: Understand the analysis and use of Bioreactors	
Unit II	**Design Pressure Vessels**	**(7 Hrs)**
Geometric configuration, types of pressure vessels, material of construction, selection of corrosion allowance and weld joint efficiency, purging of vessels, Selection and design of various types of heads, flanges, nozzles, gaskets.		
Mapping of Course Outcomes for Unit II	**CO2** : Ability to design internal pressure vessels and reaction vessels required in bioprocess industry	
Unit III	**Design Principles of Bioreactors/Reaction Vessels**	**(7 Hrs)**
Introduction, accessories for bioreactors: agitators, aerators, air filters, stabilizers, power requirement, heating systems, various types of jackets like plain, half coil, channel, and limpet coil. Study and design of internal coil of reaction vessels.		
Mapping of Course Outcomes for Unit II	**CO3**: Understand the design Principles of Bioreactors/Reaction vessels	
Unit IV	**Heat Exchange Equipment's**	**(7 Hrs)**
Heat Exchangers: codes and standards for heat exchangers, materials of construction, baffles and tie rods, tube joining methods, Design of shell and tube heat exchangers (U tube and fixed tube) as per IS: 4503 and TEMA standards. Design of heat exchange equipment's such as evaporator, plate type heat exchanger.		
Mapping of Course Outcomes for Unit IV	**CO4**: : Understand the use and concept of process design for heat exchange equipment's.	
Unit V	**Design of Distillation Column**	**(7 Hrs)**
Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors and plate hydraulic design. Model simulation using MATLAB-SIMULINK and ISIM software packages.		
Mapping of Course Outcomes for Unit V	**CO5**: Understand the process design of distillation column for bioprocess industry	
Unit VI	**Engineering Aspects Of Scale Up Of Bioreactor**	**(7 Hrs)**
Introduction, engineering aspects of scale up, equipment, Installation, commissioning and validation.safety measures in bioreactors. Material for construction of bioreactors and selection criteria. Cost estimation methods and economic evaluation of projects.		

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Mapping of Course Outcomes for Unit VI	CO6: Understand the engineering aspects of scale up of Bioreactor/Fermenter

Learning Resources

Text Books:

1. Process Equipment Design, Vol-1 & 2 by Dawande S. D., Dennet and Company.
2. Process Equipment Design by Joshi, M. V., McMillan, India.
3. Plant Design & Economics for Chemical Engineers, 4th Edition by Max Peters &Klans D Timmerhauss, McGraw Hill Book Co.
4. Bioreactors in Biotechnology: A practical approach by Scragg.A.H., E. Horwood, 1991.
5. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill
6. Introduction to Chemical Equipment Design by Bhattacharya, B. C., C.B.S. Publications.
7. Bioprocess Engineering-Systems, Equipment and Facilities by Bjorn K. Lydersen, Nancy D'elia and Kim L. Nelson. A Wiley Interscience Publication.

Reference Books:

1. Process equipment design" by L.E. Brownell and E. Young, John Wiley, New York, 1963.
2. Chemical Engineering Vol. 6" by J.M. Coulson, J.F. Richardson, and R.K. Sinott, PergamonPress.
3. Chemical Engineering volume 2" by J.M. Coulson, J.F. Richardson, and R.K. SinottPergamon Press.
4. Mixing theories and practices" by Uhl V.W. and Grey J.B. Academic Press, New York, 1967.
5. Mass Transfer Operations" by Treyball R.E., McGraw Hill, New York.
6. Chemical Process Equipment-Selection and design" Walas S.M., Butter worth Heinamer, McGraw Hill book company, New York.
7. Indian standards Institution" code for shell and tube heat exchangers, IS – 4503
8. Applied Process Design for Chemical and Petrochemical Plants" vol 1 and 2, Ludwig E.E., Gulf publishing co. publishing company.

MOOC/ NPTEL Courses:

- https://onlinecourses.nptel.ac.in/noc21_ch18/preview
- https://chemeng.iisc.ac.in/jayantmodak/WWW/page-7/index.html

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Final of B.Tech. Biotechnology (2019 Course)

415463 : Environmental Biotechnology (Elective III) (B)

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

Prerequisite Courses, if any:

Students should have basic knowledge of microbiology, biochemistry and working of bioreactors.

Companion Course, if any: --

Course Objectives:

1. To introduce various concerns regarding the environment, including various types of pollutants, human factors contributing to environmental issues.
2. Aims to introduce and elaborate the fundamental concepts and applications of biotechnology in all aspects of the environment including its protection, restoration and sustainability.
3. To demonstrate knowledge and understanding of the social economic and legislative impact of biotechnology as applied to environment protection, pollution control and waste management.

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

CO1: Students will understand the domestic and industrial wastewater types and its characterization methods.

CO2: Students understand the physical chemical and biologicalmethods of wastewater treatment

CO3: Students will learn treatment methods for Industrial waste waters

CO4: Students will understand the causes of Air pollution and pollution control measures

CO5: Students will learn different methods of solid waste management.

CO6: Understand the new trends such as bioremediation to clean up the environment. Give examples of how biotechnology can help in monitoring and/or removing the pollutants.

Course Contents

Unit I	Introduction to water and waste water management	(6 Hrs)

Domestic and industrial wastewater, types, sources and effects of water pollutants, Waste water characteristics–DO, BOD, COD, TOC, total suspended solids, colour and odour, bacteriological quality, oxygen deficit, determination of BOD constants, heavy metals, Water quality standards: ICMR, WHO, MPCB and CPCB.

Mapping of Course Outcomes for Unit I	CO1: Students will learn the Domestic and industrial wastewater types and its characterization methods

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Unit II	Methods of wastewater treatment	(6Hrs)
Principles of primary treatment and secondary treatment, process design and basic operating principles of activated sludge (suspended growth) process, sludge treatment and disposal, Aerobic & Anaerobic systems - Trickling filters and their biological principle, different T.F media and their characteristics; principle, advantages and disadvantages of rotating biological contactors(RBC); aerated lagoons, oxidation ditches, Fluidized bed reactor (FBR), packed bed reactors air- sparged reactors; UASB, photo catalytic reactors, wet-air oxidation.		
Mapping of Course Outcomes for Unit II	**CO2:** Students understand the physical chemical and biologicalmethods of waste water treatment	
Unit III	**Industrial wastewaters**	**(6 Hrs)**
Treatment of industrial effluents: neutralization, proportioning, effluent sampling and characterization, treatment strategies and disposal standards for different industries: paper and pulp, sugar, distillery, textile, tannery, dairy.		
Mapping of Course Outcomes for Unit III	**CO3: Students will learn treatment methods for Industrial waste waters**	
Unit IV	**Air Pollution- Sources, Effects and Control Measurement**	**(6 Hrs)**
Sources of air pollutants, Effects of air pollutants on human health, plants, animals, materials, Sampling and measurement of air pollutants, Air pollution control standards, Particulate pollution: cleaning methods, collection efficiency, particulate collection systems, Basic design and operating principles of settling chamber, cyclone separator, fabric filter, electrostatic precipitator, Operating principles of spray tower, centrifugal scrubber, venturi scrubber, Selection of particulate collector, Gaseous pollution: Principles of control by absorption, adsorption, combustion or catalytic oxidation, removal of SOx, NOx. CO2 sequestration by algae.		
Mapping of Course Outcomes for Unit IV	**CO4: Students will understand the causes of Air pollution and pollution control measures**	
Unit V	**Hazardous and Solid Waste Management**	**(6 Hrs)**
Sources & Classification, physicochemical properties, Concept of Waste minimization, Hospital Waste Management, Solid Waste Management Plan: Sanitary land filling, Recycling, Incineration, Biotechnology application to hazardous waste management - Biodegradation and Biological detoxification; examples of cyanide and phenols		
Mapping of Course Outcomes for Unit V	**CO5: Students will learn different methods of solid waste management.**	

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Unit VI	Bioremediation	(6 Hrs)
Constraints and priorities of Bioremediation; Biostimulation and Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Bioremediation Case studies: Oil pollution – treatment with micro-organisms, Recovery of metals from waste water and sludge, Xenobiotics – degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons; Solid phase bioremediation – land farming, prepared beds, soil piles; Phytoremediation, Bioventing &Biosparging; Composting, Wetland Management, Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors Membrane based waste water treatment processes.		

Mapping of Course Outcomes for Unit VI	CO6: Understand the new trends such as bioremediation to clean up the environment.

Learning Resources

Text Books:

1.WasteWater Engineering, Dr. B.C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, Laxmi Publications Pvt Ltd, ISBN 8170080916

2.Wastewater Engineering: Treatment and Disposal fourth edition,Metcalf and Eddy, Inc McGraw-Hill Companies, 2002

3.Environmental engineering – Peavy, Rowe – McGraw Hill Publications

Reference Books:

1.Waste water treatment for pollution control , Soli J. Arciwala, Tata McGraw-Hill Publications, New Delhi

2. Manual Sewerage and Sewage Treatment – Public Health Department, Govt. of India.

3. Sewage disposal and treatment – Dr. Modi , Standard Publications, NewDelhi.

4. Wastewater Treatment – M. N. Rao and A. K. Dutta, Oxford and IBH Publlishing Co Pvt Ltd, New Delhi, 1987

5. Environmental Pollution Control Engineering, First edition, C.S. Rao, New Age International (P) Ltd., 1991 6.

Wastewater Engineering, second edition, B.C.Punmia, Ashok Kr Jain– Laxmi Publications (P) Ltd, New Delhi, India, 1998

7. Fundamentals of Environmental biology, S. Arora Kalyani Publishers, New Delhi, 2008

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

For example

NOC:Environmental Biotechnology - NPTEL

https://nptel.ac.in/courses/102105088

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SavitribaiPhulePuneUniversity
Final Year of B.Tech. Biotechnology(2019Course)
415463 :– Genomics Elective III(C)

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

Prerequisite Courses, if any:

- Students should have the basic knowledge of Genetics and molecular Biology

Companion Course, if any: --

Course Objectives:

1. To familiarize students with the study of whole genomes or the products of these genomes.
2. To introduce students to genome sequencing methods and strategy, NGS, Comparative genomics
3. To study gene functions and cutting edge methods of gene expression analysis such as microarray and RNA interference
4. To understand Mechanisms and techniques to study epigenetics and its importance in health and disease
5. To introduce students to applications of Genomics such as personalized medicine and its applicability to this rapidly evolving field of research.
6. To introduce students to applications of Genomics such as nutrigenomics and metagenomics in health and disease.

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

CO1: Graduates are made aware of differences in genome size, Genome organization, human genome project and its outcome.

CO2: Familiarization with genomic methods such as sequencing, NGS and strategies and their importance

CO3: Elementary knowledge of gene expression, Gene silencing and methods to study gene expression.

CO4: Graduates are made aware about heritable phenotype changes that do not involve alterations in the DNA sequence, How gene environment interactions take place and their role in health and disease.

CO5: Graduates are able to understand variation in drug response and design comparative study experiment

CO6: Graduates will have knowledge of diet gene interactions, personalized nutrition and application of nutrigenomics and metagenomics in health and diseases

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Course Contents for Theory Subject		
Unit I		**(6Hrs)**
Introduction to genomics Genome organization, C value paradox, repetitive DNA, gene families, structural genomics, human genome project, HAPMAP, 1000 Genome project, ENCODE		
Mapping of Course Outcomes for Unit I	**CO1:** Graduates are made aware of differences in genome size, human genome project and its outcome	

Unit II		**(8Hrs)**
Genome analysis Sequencing strategies for whole genome analysis, Shotgun method, Sequencing methods, capillary sequencing, Next Gen sequencing methods, Comparative genomics, genome annotation, YAC, BAC libraries		
Mapping of Course Outcomes for Unit II	**CO2:** Familiarization with genomic methods such as sequencing, NGS and strategies and their importance	
Unit III		**(8Hrs)**
Functional genomics Global analysis of gene expression, Transcriptomics and microarray, Microarray-Types, Analysis, Applications, RNA interference, siRNA, miRNA		
Mapping of Course Outcomes for Unit III	**CO3:** Elementary knowledge of gene expression, epigenetic changes, methods to measure epigenetic changes and their role in diseases	
Unit IV		**(8Hrs)**

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Epigenetics

Epigenetics: Regulation of Organization & Gene Expression, Epigenetic Mechanisms, Methylation, Acetylation, Histone modifications, DNA methylation, model organisms for epigenetic studies, methods-CHIP on CHIP assays, CpG islands microarrays, Epigenetics and diseases.

Mapping of Course Outcomes for Unit IV	**CO4:** Graduates are given introduction to personalized medicine and application of pharmacogenomics, nutrigenomics and metagenomics in health and disease.

Unit V		**(8Hrs)**

Genomics application: Pharmacogenomics

Introduction to Pharmacogenomics, Variation in drug response, ADME, Drug Metabolizing enzymes and genes, Slow metabolizers, Extensive metabolizers, Case studies in Pharmacogenomics, Traditional medicine based Pharmacogenomics, Toxicogenomics

Mapping of Course Outcomes for Unit V	**CO5:** Graduates are given introduction to personalized medicine and application of pharmacogenomics, in health and disease.

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Unit VI		(8Hrs)

Genomics Applications

Nutrigenomics- Overview of nutrigenomics, diet gene interactions. Diet, genes and diseases, Nutrigenomics and metabolic diseases, personalized nutrition. Metagenomics- tools and techniques, Role of metagenomics in health and disease, Genome Editing.

Mapping of Course Outcomes for Unit VI	**CO6:** Graduates will hane knowledge of diet gene interactions, personalized nutrition and application of nutrigenomics and metagenomics in health and disease.

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

Proteomics and Genomics, IIT Guwahati, Dr. Vikash Kumar Dubey. https://nptel.ac.in/courses/102103017

Functional Genomics, By Prof. S. Ganesh | IIT Kanpur. https://onlinecourses.nptel.ac.in/noc20_bt40/preview

Epigenetics. https://dth.ac.in/medical/course-inner.php?id=83

Text Books:

1. **Genes IX** by Benjamin Lewin
2. L.Alberghina and H. Westerhoff, ed (2005). *Systems Biology: Definitions and Perspectives*. Topics in Current Genetics. 13. Springer Verlag. ISBN 978-3540229681

Discovering Genomics, Proteomics and Bioinformatics (2nd Edition) by A. Malcolm Campbell and Laurie J. Heyer (Mar 12, 2006)

Reference Books:

1. Pharmacogenomics in Drug Discovery and Development, Series: Methods in Molecular Biology, Vol. 448, Yan, Qing (Ed.),2008, XIII, 487 p. 62 illus.ISBN: 978-1-58829-887-4.
2. Denis Noble (2006). The Music of Life: Biology beyond the genome. Oxford University Press. ISBN 978-0199295739. p21

SPPUQuestionPapers.com

References:

3. Allen Roses, Pharmacogenetics and the practice of medicine. NATURE, VOL 405, 15 JUNE 2000, 857-865. www.nature.com
4. DeBusk RM, Fogarty, CP, Ordovas JM, Kornman KS. Nutritional genomics in practice: where do we begin?. J Am Diet Assoc. 2005; 105:589-98. http://web.udl.es/usuaris/e4650869/Morella06/BB/Debusk_Nutrigenomics%20in%20practice.pdf
5. Fenech M, El-Sohemy A, Cahill L, Ferguson LR, French TA, Tai ES, Milner J, Koh WP, Xie L, Zucker M, Buckley M,Cosgrove L, Lockett T, Fung KY, Head R. Nutrigenetics and nutrigenomics: viewpoints on the current status and applications in nutrition research and practice. J Sci Food Agric. 2011; 4:69-89.
6. Qiang Ma and Anthony Y. H. Lu. Pharmacogenetics, Pharmacogenomics, and Individualized Medicine, Pharmacol Rev 63:437–459, 2011. online at http://pharmrev.aspetjournals.org. doi:10.1124/pr.110.003533.
7. Nutrigenomics, Environmental Health Perspectives • VOLUME 115 | NUMBER 12 | December 2007

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SavitribaiPhule Pune University, Pune **Final Year of B.Tech. Biotechnology (2019 Course)** **415464(A) : Bioenergy And Renewable Resources Elective IV**		
TeachingScheme:	**Credit**	**ExaminationScheme:**
TH: 03 Hrs./Week	**03**	**In-Sem (Theory): 30 Marks** **EndSem(Theory): 70 Marks** **Total Marks :100**
PrerequisiteCourses,ifany:		

CourseObjectives:

1. The objective of the course is to develop in-depth knowledge for the following:
2. Various renewable energy resources available at a location and assessments of its potential.
3. Understand the various forms of conventional energy resources
4. Learn the present energy scenario and the need for energy conservation
5. Site selection for wind turbines, wind systems, Geothermal, wave, tidal resources
6. Properties critical for Bio-energy re source assessment, pathway selection, biomass supply

CourseOutcomes: Oncompletionofthecourse,learnerwillbeableto–

CO1: List and generally explain the main sources of energy and their primary applications in the India, and the world.

CO2: Describe the challenges and problems associated with the use of various energy sources, including
fossil fuels, with regard to future supply and the environment.

CO3: Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.

CO4: Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations

CO5: Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

CO6: Understand the concept of Biomass energy resources and their classification, types of biogas Plants- Applications.

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CourseContents		
Unit I		**(6 Hrs)**
Energy resources and their utilization Indian and global energy sources, Energy demand, Energy exploited, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), Environmental impacts of the conventional and renewable sources, Renewable Energy: Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, Decentralized and dispersed generation		

MappingofCourseOutcomes forUnitI	**CO1:** List and generally explain the main sources of energy and their primary applications in the India, and the world.

Unit II		**(6 Hrs)**
Wind and Geothermal energy Wind energy, Characteristics of wind: Effect of density, Frequency variances, Angle of attack, Wind velocity, Principles of wind turbine: operation, siting and control, Process of electricity generation and supply to the grid - wind energy farms, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Availability of wind energy in India Geothermal: Uses of geothermal energy and the geothermal power plants, Mechanisms for deep geothermal heat extraction and power generation, Dry-steam Flash-steam and Binary-cycle, Shallow geothermal and heat-pumps, Wave and Tidal		
MappingofCourseOutcomes forUnitII	**CO2:** Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.	
Unit III		**(6Hrs)**
Solar energy and Photovoltaic Need of solar energy in the world and India, Basics of converting sunlight into electricity, Technologies of producing solar fuels, solar energy collectors, System components, Grid connection and applications, Solar thermal: Technologies and applications of solar thermal energy - Power production and heating applications, Solar heating and solar cooling, Concentrated solar power (CPV and CSP) for utility-scale applications		
MappingofCourseOutcomesforUnitIII	**CO3:** Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.	

Unit IV		**(6Hrs)**
Biodiesel Definition, advantages of biodiesel, properties of biodiesel, feedstocks - jatropha, Karanja, Neem, plantation, Transesterification, process issues, homogeneous and heterogeneous catalysis, biodiesel from microalgae, algae cultivation, types of photobioreactor, Indian perspective		

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MappingofCourseOutcomesforUnitIV	**CO4:** Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations

Unit V		**(6 Hrs)**

Alcohol fuels Feedstock for alcohol fuels, common methods for alcohol production, ethanol production from lignocellulosic materials, pretreatment-dilute acid, hot water, steam explosion, Ammonia; enzymatic hydrolysis, detoxification, fermentation, butanol fermentation, challenges in ethanol and butanol production, case studies, concept of biorefinery

MappingofCourseOutcomesforUnitV	**CO5:**Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

Unit VI		**(6 Hrs)**

Gaseous fuels Biomethanization, microbiological aspects of biogas production, biogas anaerobic fermentation & process, raw materials, factors affecting biodigestion, classification of biogas plants, methods for maintaining biogas production, problem in biogas plants, thermal processes, case study on biogas production, introduction to hydrogen as a fuel

MappingofCourseOutcomesforUnitVI	**CO1:**Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications

LearningResources

Text Books:

- Renewable Energy Resources: Basic Principles and Applications, G N Tiwari and M GhosalNarosa Publishing House, India, 2004
- Non-Conventional energy Source, Rai G.D Khanna Publishers, New Delhi, 2004
- Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata McGraw Hill. 3. Renewable energy resources and emerging technologies, Kothari D.P, Prentice Hall of India Pvt. Ltd., 2008

Reference Books:

- Renewable Energy Resources 2nd Ed. - John Twidell and Tony Weir, New York, 2006
- Solar Energy - Principles of Thermal Collection and Storage, S.P. Sukhatme and J. K. Nayak, third edition, Tata McGraw Hill Publishing Company Ltd, 2008
- Solar Power Engineering / B.S Magal Frank Kreith& J.F Kreith.

SPPUQuestionPapers.com

- Principles of Solar Energy, D. Yogi Goswami, Frank Kreith and Jan F. Kreider, second edition, CRC press, 2000
- Non-Conventional Energy Systems, K M Mital, A H Wheeler Publishing Co Ltd , 1999
- Renewable Energy Technologies, Ramesh R & Kumar K U, Narosa Publishing House, New Delhi, 2004 7. Progress in Biomass and Bioenergy Research, S. F. Warnmer, (Ed), Nova Publishers, 2006
- Bioenergy: Realizing the Potential, S. Silveira, (Ed), Elsevier Science, 2005
- Non-Conventional Energy, Ashok V Desai, New Age International (P) Ltd, New Delhi, 2003
- The Biomass Assessment Handbook: Bioenergy for a Sustainable Environment, Rosillo- Calle, P. D. Groot, S. Hemstock, J. Woods, Earthscan Publisher, 2006.
- 11. Biomass and Bioenergy: New Research, M. D. Brenes, (Ed), Nova Publishers, 2006

MOOC/ NPTELCourses:

- **https://onlinecourses.nptel.ac.in/noc21_ch11/preview**
- **https://nptel.ac.in/courses/103103206**

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019Course) 415464 (B) :Industrial Organization and ManagementElective - IV		
Teaching Scheme:	**Credit**	**Examination Scheme:**

TH: 3Hrs./Week	**3**	**In Sem (Theory):30 Marks** **EndSem(Theory):70 Marks** **Oral : 25 Marks** **Total : 125 Marks**

Prerequisite Courses:

Course Objectives:

1. This course introduces the basic concepts of management and organisation structure of an industry.
2. Introduce the concept of PersonnelManagement and Purchase and stores management.
3. Gain an enhanced understandingmarketing management,Export and import management Management Laws.

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

CO1: Demonstrate the concepts of Management and organisational structure

CO2: Understand the economic and operations management concepts useful in personnel management.

CO3: Apply the project management tools in effective development and implementation of the business activities for purchase and store management.

CO4: Understand the of the role and process of research inmaking **marketing** decisions

CO5: Understand the basic concepts related with international marketing, selection of target market, adaptation of marketing mix

CO6: Understand the basic knowledge in business **laws** in **management**to start their own enterprise.

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Course Contents		
Unit I	**Management Science**	**(6Hrs)**
Management, its growth, concepts of administration and management of organization, Definition of management, functions, authority and responsibility, Unity of command and direction, Decision making in management by objectives Business Organization: Different forms of organization, their formation and working, Different organization structure- line organization, functional organization, line and staff organization		
Mapping of Course Outcomes for Unit I	**CO1:** Demonstrate the concepts of Management and organisational structure	
Unit II	**Personnel Management**	**(6Hrs)**
Manpower planning, sources of recruitment, selection and training of staff, Job evaluation, merit rating, performance appraisal, wage administration and system, of wage payment, incentive, motivations, industrial fatigue, Trade unions – industrial relations		
Mapping of Course Outcomes for Unit II	**CO2:** Understand the economic and operations management concepts useful in personnel management	
Unit III	**Purchase and stores management**	**(6Hrs)**
Concepts of quotation, tenders and comparative statement, inspection and quality control, Inventory, carrying cost and fixed cost of inventory, examples of cost of Inventory, Stores management, functions of storekeeper, methods of inventory : LIFO, FIFO		
Mapping of Course Outcomes for Unit III	**CO3:**Apply the project management tools in effective development and implementation of the business activities for purchase and store management.	
Unit IV	**Marketing management**	**(6Hrs)**
Concepts of selling, marketing, definition of marketing, market research and of pricing, penetration, pricing, skimming pricing, distribution of product, advertising and promotion		
Mapping of Course Outcomes for Unit IV	**CO4:** Understand the of the role and process of research in making marketing decisions	

Unit V	**Export and import management**	**(6Hrs)**
Concepts of international trade, duties, antidumping duty, cost involved in exporting a product, pricing of export product, Government aids for export promotion, export houses, export promotion counsel, MODVAT, patent and patent rights, Quality Management: TQM, quality circles, ISO systems		
Mapping of Course Outcomes for Unit V	**CO5:** Understand the basic concepts related with international marketing, selection of target market, adaptation of marketing mix.	

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Unit VI	Management Laws	(6Hrs)
Concepts of contract act, offer, and acceptance, types of contracts, Void contract, concept of guarantee and warranty, Introduction of MRTP and FERA		
Mapping of Course Outcomes for Unit VI	**CO6:** Understand the basic knowledge in business laws in management to start their own enterprise.	

LearningResources

Text Books:

1. Industrial Engineering and Management- Shama and Banga S.C., Khanna Publishers,
2. Industrial Engineering and Management O.P.Khanna Khanna Publishers.
3. Principles of Management-Tripathy&Reddy,ThirdEdn.,Tata McGraw Hill Publishers.

Reference Books:

1. Organizational Behaviour, Fred Luthans, Tenth Edn. Tata McGraw Hill Publications.
2. Business Law & Including Company Law, S.S.Gulshan, G.K.Kapoor, Fourteenth Edn.,New Age International Ltd.
3. Marketing Management V.S.Ramaswamy&S.Namakumari,MacMillan India Ltd
4. Financial Management, PV.Kulkarni, B.G.Satyaprasad, Thirteenth Edn. Himalaya Publishers Ltd.
5. Production & Operations Management, Everett Adam &R.J.Ebert., Fifth Edn., Pearson Publication.
6. Managerial Economics, Peterson, Lewis and Jain, Fifteenth Edn.,Perarson Publishers.
7. Quantitative Techniques, L.C.Jhamb, Sixteenth Edn.,Everest Publishing House.
8. Dynamics of Industrial Relationns, Mamoria,Mamoria&Gankar,FifteenthEdn., Himalaya Publishing House.
9. Personal Management & Industrial Relations, R.S.Davar, Tenth Edn.,Vikas Publishing House.
10. Industrial &Labour Laws, S.P.Jain&K.Jain., Thirteenth Edn, DhanpatRai Publishers.

MOOC/ NPTELCourses:

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Suggested List of Laboratory Assignments (Any 8)	
A	
1	Evaluation of Molar volume and compressibility factor from Vander Waals equation
2	Steady state material balance on a separation tray and calculating molar flow rates and Compositions on the tray.
3	Calculation of terminal velocity of falling particles.
B	
4	Reaction equilibrium for multiple gas phase reactions
5	Material and energy balances for a batch reactor.
6	Evaluation of liquid composition in a batch distillation column
7	Reaction equilibrium for multiple gas phase reactions using polymath
C	
8	Study of characteristics of multicomponent distillation column.
9	Study of multicomponent absorption column
10	Steady stages tow stage extraction

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 microbial cultures, chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents and experimental glass wares to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019 Course) 415464 :Stem Cell Biology and Regenerative Medicine Elective-IV (C)		
TeachingScheme:	**Credit**	**ExaminationScheme:**
TH: 3 Hrs./Week	**3**	**In-Sem (Theory): 30 Marks** **EndSem(Theory): 70 Marks** **Total Marks : 100 Marks**
PrerequisiteCourses,ifany: Cell Biology and Tissue culture and Genetic Engineering basics.		

CourseObjectives:

1. To introduce to the concept of stem cells and offer basic understanding of how they function and their significance
2. To study the different techniques used to isolate and study stem cells
3. To know generations and related characteristics.
4. To give information about the different regulations and the different guidelines governing the stem cell research in India and in the world.
5. To introduce to the various methods for stem cell growth and engineering.
6. To apply stem cell biology to cure various degenerative & other diseases.

CourseOutcomes: Oncompletionofthecourse,learnerwillbeableto–

CO1: Understand the significance of stem cells and their function.

CO2: Learn the techniques used to identify, isolate and culture stem cells in lab.

CO3: Learn the methods of regeneration of stem cells in different model organisms

CO4: Have knowledge about the regulations and rules for stem cell research in India and abroad.

CO5: Learn techniques and application of stem cells in tissue engineering

CO6: Define different methods for using stem cells to study and treat disease

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CourseContents		
Unit I		**(6 Hrs)**
What are stem cells? Types : Totipotent, pluripotent, multipotent, unipotentprogenitor stem cells General properties of stem cells, Stem cell niche - what it is and how it regulates stem cell		
MappingofCourseOutcomes forUnitI	**CO1:** Understand the significance of stem cells and their function.	
Unit II		**(6 Hrs)**
Establishment of embryonic stem cells (ESCs) , Characterizations of pluripotent stem cells (PSCs), Molecular mechanisms underlying pluripotency, Induction of pluripotency, Potential of induced pluripotent stem cells (iPSCs), in basic and clinical applications and ways to identify and isolate the stem cells		
MappingofCourseOutcomes forUnitII	**CO2:** Learn the techniques used to identify, isolate and culture stem cells in lab.	
Unit III		**(6 Hrs)**
Adult Stem Cells and Regeneration, Tissue regenerative capacity, Regeneration in planaria, zebrafish, axolotl, and mammals, Facultative stem cells, Transdifferentiation, Dedifferentiation and plasticity, Characteristics, Isolation, Culture and Characterization protocols somatic stem cells.		
MappingofCourseOutcomesforUnitIII	**CO3:** Learn the methods of regeneration of stem cells in different model organisms	

Unit IV		**(6 Hrs)**
Guidelines for stem cells therapy and clinical trails in India, Embryo ethics, Egg donation Ethics, ethics in gene editing, stem cell interventions in stem cell translations, communication and disclosure to public,		
MappingofCourseOutcomesforUnitIV	**CO4:** Have knowledge about the regulations and rules for stem cell research in India and abroad	

Unit V		**(6 Hrs)**
Leveraging Tools to Study Stem Cell Biology, Editing the stem cell genome, In vivo tools in stem cell biology, Computational tools to dissect stem cell, heterogeneity, In vitro cultures of adult stem cells to analyse, differentiation and other properties, matrix in tissue engineering - hydrogel, matrix gel, scaffolds –natural, synthetic, 3D polymeric scaffold, porous microsphere scaffolds, bio ceramic etc.		

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MappingofCourseOutcomesforUnitV	**CO5 :**Learn techniques and application of stem cells in tissue engineering

Unit VI		**(6 Hrs)**
Stem cells are ideal cells for clinical applications since they can regenerate and differentiate;The clinical translation process of stem cell technologies;Cell replacement therapies;Disease modeling;Drug screening; Personalized medicine.Cell replacement therapies from pluripotent cells: dopaminergic neurons or age-related macular degeneration, In vitro transdifferentiation: fibroblast to neuron (diseases and aging), in vivo transdifferentiation: cardiac fibroblasts into cardiomyocytes		
MappingofCourseOutcomesforUnitVI	**CO6:** Define different methods for using stem cells to study and treat disease	

LearningResources

Text Books:

- Essentials of Stem Cell Biology. By Robert Paul Lanza. Elsevier Academic Press.
- Molecular Biology of the Cell, 6th edition, 2017 by Bruce Alberts, Garland Science.
- Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring HarbourLaboratory Press
- Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
- Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler,Jonathan Leo, Springer,

Reference Books:

- Methods in Molecular Biology: Basic Cell Culture Protocols. Editors: Cheryl D. Helgason and Cindy L. Miller
- Stem Cells Handbook. Editor: Stewart Sell. Humana Press.
- Essentials of Stem Cell Biology. Edited by Ian Wilmut. Elsevier publication.
- Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential. Ann Kiessling and Scott C. Anderson. Jones and Bartlett Publishers
- Human Embryonic Stem Cells. Editors: Arlene Chiu, Mahendra S. Rao, Humana Press
- Stem Cells and the Future of Regenerative Medicine. Committee on the Biological and Biomedical Applications of Stem Cell Research, Board on Life Sciences, National Research Council, Board

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on Neuroscience and Behavioral Health, Institute of Medicine. National Academies Press.

- Stem Cells for Dummies. By Lawrence S. B. Goldstein, Meg Schnider. Wiley Publication.
- J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.
- Jaenisch, R. and Young, R. (2008). Stem Cells, the Molecular Circuitry of Pluripotency and Nuclear Reprogram- ming. Cell.
- Martin, G. R. (1981). Isolation of a pluripotent cell line from early mouse embryos cultured in medium condi- tioned by teratocarcinoma stem cells. Proc. Natl. Acad. Sci. U. S. A.
- Nagy, A., Gocza, E., Merentes Diaz, E., Prideaux, V. R., Ivanyi, E., Markkula, M. and Rossant, J. (1990). Embry- onic stem cells alone are able to support fetal development in the mouse. Development.
- Bilic, J. and Izpisua Belmonte, J. C. (2012). Concise review: Induced pluripotent stem cells versus embryonicstem cells: Close enough or yet too far apart? Stem Cells.
- Cohen, D. E. and Melton, D. (2011). Turning straw into gold: Directing cell fate for regenerative medicine. Nat. Rev. Genet.

MOOC/ NPTELCourses:

- **https://onlinecourses.nptel.ac.in/noc19_bt33/preview Tissue Engineering**
- **https://nptel.ac.in/courses/113108071 Biomaterials in Tissue Engineering**

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019 Course) 415465 :Biochemical Engineering Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Teaching Scheme: **PR: 4 Hrs/Week**	**2**	**Examination Scheme:** **TW: 50 Marks** **Total :- 50**

Prerequisites:- Basic techniques in microbiology

Course Objectives:

2. To demonstrate students to microbial growth kinetics
3. To study fermentative synthesis of various products using free or immobilized cells and enzymes.
4. To study and demonstrate detailed design and parameter optimization of a fermenter.

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

A. Understand various phases of microbial growth and how to estimate generation time and growth rate.

B. Learn about fermentative synthesis of products using selective enzymes and microorganisms.

C. Able to select reactor design, performance optimization for better conversion and product yield.

Suggested List of Laboratory Assignments (Any 8)

Sr. No.	Group A: Microbial Growth Kinetics
1	Study of kinetics of cell growth of any one fermentation process
2	Study of effect of Temperature on fermentation process
3	Study of effect of pH on fermentation process
Sr. No.	**Group B: Fermentative Synthesis and Product analysis**
1	Fermentation and Production of Vitamins and Antibiotics
2	Production of corn syrup using Bacterial Amylase
3	Beer Fermentation
4.	Study of enzyme immobilization by gel entrapment
Sr. No.	**Group C: Fermenter Study**

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1	Study of Laboratory fermenter

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 microbial cultures, chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents and experimental glass wares to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

Virtual LAB Link:

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

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

http://vlab.amrita.edu/?sub=3&brch=73&sim=1628&cnt=1

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

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

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SavitribaiPhule Pune University, Pune

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

415466 : Bioinformatics Lab

TeachingScheme:	Credit	ExaminationScheme:
Practical :2 Hrs. /Week	1	PR: 50 Marks Total :50Marks

PrerequisiteCourses,ifany:

Knowledge about Molecular Biology, Genetic engineering and genome sequencing.

Basic concepts of computers like algorithms, computer programs and how they function..

CourseObjectives:

1. To give an overview ofdb and various db's in the NCBI.
2. To acquaint students with various genomic databases available and How to access.
3. To introduce primary, secondary and structural databases of proteins and the way to access the database information for a specific purpose.
4. To visualised and extract structural protein info
5. To introduce sequence alignment and show how to do blast MSA & LSA.
6. To generate phylogenetic tree and change varies.

CourseOutcomes: Oncompletionofthecourse,learnerwillbeableto–

CO1: Will be able to Understand NCBI &Pubmed Platform and access different db's bioinformatics to understand and analyze genomic data

CO2:Will be able Access and retrieve genomic information of relevance from various nucleotide databases

CO3: :Will be able to retrieve protein information and acknowledge the information from secondary Primary dbs

CO4. : Will be able to protein information available in various databases and use it to understand real life case studies.

CO5: Perform an alignment of sequences using various methods & can change parameters, and optimize the alignments

CO6: Learn how to construct the phylogenetic trees and understand them for extracting relevant information.

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Suggested List of Laboratory Assignments (Any 8)	
A	
1.	Using the various databases at National Centre for Biotechnology Information (NCBI) .
2.	Retrieving articles using PubMed
3.	Using Entrez search tool to retrieve sequenceinformation fromGenBank database.
4.	Using EMBL database and other services.
B	
5.	Retrieving Protein sequences from UNIPROT-SWISSPROT
6.	Aligning sequences using BLAST.
7.	Global alignment of two sequences - Needleman-Wunsch Algorithm
8.	Local Alignment of Sequences- Smith-Waterman Algorithm
C	
9.	Retrieving structural data of a protein using PDB database
10.	Finding ORF of a Given Sequence
11.	Retrieving Motif Information of a Protein Using PrROSITE
12.	Aligning Multiple Sequences with CLUSTAL W

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

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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 microbial cultures, chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents and experimental glass wares to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

Virtual LAB Link:

Bioinformatics Virtual Lab Ihttps://vlab.amrita.edu/index.php?sub=3&brch=273

Bioinformatics Virtual Lab II https://vlab.amrita.edu/index.php?sub=3&brch=275

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019Course) 415467 : Bioprocess Equipment DesignElective-III (A)		
Teaching Scheme:	**Credit**	**Examination Scheme:**
PR: 2 Hrs./Week	**1**	**Oral : 50 Marks** **Total Marks : 50 Marks**

Prerequisite Courses, if any:

Knowledge of subjects like, Material balance and stoichiometry, Mass transfer, Heat transfer, Thermodynamics, Reaction Engineering, Fluid Flow and Unit Operation

Course Objectives:

1. The objective of this course is to acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used bioprocess equipment.
2. This course to give up-to-date knowledge for designingof bioreactor/fermenterused in chemical and biochemical process plants.
3. After undergoing this course the students will have the knowledge to analyse a problem and finding a process design method for various equipment's used in biotech industry.

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

CO1: Understand the analysis and use of Bioreactors

CO2: Able to design internal pressure vessels and reaction vessels

CO3: Understand the design Principles of Bioreactors/Reaction vessels

CO4: : Understand the use and concept of process design for distillation column for bioprocess biotech industry

CO5: Understand the process design of distillation column for bioprocess industry

CO6: Understand the engineering aspects of scale up of Bioreactor/Fermenter

Suggested List of Laboratory Assignments (Any 6)	
GroupA	
1.	Pressure vessel/Bioreactor
2.	Heat Exchange Equipment
3.	Rotary Equipment/Centrifuge
GroupB	
4	Distillation Column
5	Auto CAD Sheet 1 (any one equipment from Group A)
6	Auto CAD Sheet 2 (any one equipment from Group B)

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

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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 isnecessary to protect the eyes and face from splashes
5. All microbial cultures, chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.

SavitribaiPhule Pune University

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

415467 :- Environmental Biotechnology Elective III Lab (B)

Teaching Scheme:	Credit	Examination Scheme:
Teaching Scheme: **PR: 02 Hrs/Week**	**1**	**Examination Scheme:** **OR: 50 Marks** **Total: 50 Marks**

Prerequisites:-

Basics of Microbiology, chemistry and Mathematics

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Course Objectives:

1. To study the quality parameters of wastewater
2. To study the estimation methods for characterization of polluted water/wastewater
3. To study the ecological sampling methods for pollution measurement.

Course Outcomes:

On completion of this course, students will be able to

CO1. Students will understand the quality parameters used to characterize wastewater

CO2. Students will get hands on training to check quality of polluted wastewater

CO3.Student will learn methods of Air pollution measurement

Suggested List of Laboratory Assignments (Any 8)	
Sr. No.	**Group A**
1	To study microbial flora of wastewate
2	Determination of potability of water by MPN Test
3	Characterization of coliforms
4	Effect of treatment method on coliform/ microbial content
Sr. No.	**Group B**
5	To Study DO
6	Estimation of BOD of Polluted Water
7	Estimation of COD of Polluted Water
8	Qualitative/Quantitative Estimation for Pesticide/ Insecticide degradation

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Sr. No.	Group C
9	To study quality of air
10	To study TDS
11	Determination of Solids
12	Estimation of Physical characteristics of soil-color /texture/Water Holding Capacity

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

415467 : Genomics Lab Elective III (C)

6. Regularity and sincerity of students during lab Practicals
7. Journal presentation
8. Understanding of the experiment
9. Performance in unit tests
10. 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 isnecessary to protect the eyes and face from splashes
5. All microbial cultures, chemicals, glassware, reagents and plastic wares should be kept on their appropriate place after use.
6. Reagents and experimental glass wares to be stored should be labeled with due discarding date.
7. Instructions for proper disposal of waste material should be followed.

Virtual LAB Link:

Ecology Virtual Lab

Ecology Virtual Lab : Biotechnology and Biomedical Engineering : Amrita VishwaVidyapeetham Virtual Lab

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Teaching Scheme:	Credit	Examination Scheme:
PR/Tut : 2 Hr. / Week	1	OR : 50 Marks Total : 50 Marks

Prerequisite Courses, if any:

- Students should have the basic knowledge of Genetics and molecular Biology

Companion Course, if any: --

Course Objectives:

1. To develop skills in handling Human /Plant/ Animal DNA.

Course Outcomes: On completion of the course, learner will be able to isolate and analyze human/ Plant/Animal genomics DNA.

Suggested List of Laboratory Assignments (Any 8)	
Sr. No.	**Group A**
1	Isolation of DNA from Human blood or plant source or animal tissue/ Human Blood
2	Purity and concentration check
3	Agarose gel electrophoresis.
Sr. No.	**Group B**
4	Study of hyperchromicity
5	Designing primers
6	Genotyping/ SNP mapping
Sr. No.	**Group C**
7	DNA polymorphism/ PCR-RFLP
8	Allele and Genotype Frequency

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9	RNA isolation
10	RNA gel electrophoresis

Guidelines for Lab /TW Assessment

Lab assessment will be based on following points

1. Present / Absent
2. Completion date of journal
3. Regularity
4. Understanding
5. Presentation

Guidelines for Laboratory Conduction

The following rules must be observed at all times to prevent accidental injury to and infection of yourself and others and to minimize contamination of the lab environment:

1. Never place books, backpacks, purses, etc., on bench tops.
2. Clean your work area with dilute disinfectant at the beginning and end of each lab.
3. Wash your hands with soap and dry when entering and leaving the lab.
4. Wear a lab coat at all times while working in the lab to prevent contamination or accidental staining of your clothing.
5. Wear gloves while handling EtBr and DNA, RNA
6. Long hair must be tied back to prevent exposure to flame and contamination of cultures.
7. Do not eat or drink in the lab.
8. Report accidental cuts or burns to the instructor immediately.
9. At the end of each lab session, decontaminate and discard cultures and materials in the proper disposal area.

Virtual LAB Link:

1. Vlabs: Molecular Biology. https://vlab.amrita.edu/?sub=3&brch=77&sim=885&cnt=1
2. Vlabs: https://vlab.amrita.edu/?sub=3&brch=77&sim=218&cnt=1
3. Vlabs: https://vlab.amrita.edu/?sub=3&brch=186&sim=321&cnt=1
4. Vlabs: https://vlab.amrita.edu/?sub=3&brch=186&sim=718&cnt=1

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019 Course) 415469 :- MOOCs NPTEL, COURSERA etc		
TeachingScheme:	**Credit**	**ExaminationScheme:**
	02	**TW : 50 Marks** **Total:- Marks**

Course objective

- To offer students self-study courses
- To provide an opportunity to students to earn a certificate from renowned institute
- To introduce students quality learning material by exploiting the advances in information and communication technology

Course outcome

1. Students will learn to take control over their own learning which lead to learn more effectively, boost self-esteem and can learn at their own pace
2. Enabling students to obtain certificates to make students employable in the industry or pursue a higher education program
3. Students will refine their knowledge of technical concepts

Credits of MOOCs Courses shall be awarded based on completion of relevant course recommended by college / University) of equivalent or more credits and submission of Certificate to college. College shall submit the same to university through online process
to be followed in due course.

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SavitribaiPhule Pune University, Pune

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

415468 :- Project Stage 1

TeachingScheme:	Credit	ExaminationScheme:
PR: 4 Hrs/Week	02	OR : 50 Marks TW: 50 Marks Total : 100 Marks

PrerequisiteCourses,ifany:

Course Objectives:

1. To apply the knowledge for solving realistic problem by developing problem solving ability.
2. To study the literature thoroughly, identify the gap and define the problem to carry out the work.
3. To explore alternative approaches and methodologies and justify the use of selected tools and methods.
4. To learn various wet lab techniques to carry out experimental work.
5. To gain experience through trials and learn lessons.
6. To work in a team and learn professionalism

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

CO1: Find the gap, learn to define and solve the problems applying knowledge.

CO2: Analyze alternative approaches, apply and use most appropriate one for feasible solution.

CO3: Learn to write precise technical reports referring and extracting information from various sources.

CO4: Develop new skill sets and carry out experimentation data analysis independently.

CO5: Modify and design new approaches through trials and errors.

CO6: Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work, Inter-personal relationships, conflict management and leadership quality.

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Guidelines

Project work Stage – 1 is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, design and developed methods of experimentation or Model Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project Stage-1, the candidate shall deliver a presentation on the purpose of the selected project topic briefing literature available, gaps found and methodology developed etc. The student shall submit the duly certified progress report of Project work Stage-1 in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Follow guidelines and formats as mentioned in Project booklet.

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SavitribaiPhule Pune University
Final Yearof B.Tech. Biotechnology (2019Course)
415470 :Audit Course 5

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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 AC and that be included in thesemester grade report for that course, provided students have the minimum attendance as prescribed by the SavitribaiPhule Pune university. No grade point is associated with this "AC" 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
8. Conference/Seminar/MOOC/NPTEL certificate

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)

1. Biodiversity
2. Bioethics

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FINAL YEAR BIOTECHNOLOGY

SYLLABUS

SEM II

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019Course) 415471 : Bioprocess Modeling and Simulation		
TeachingScheme:	**Credit**	**ExaminationScheme:**
TH: 3 Hrs./Week	**3**	**In-Sem: (Theory): 30 Marks** **End-Sem: (Theory): 70Marks** **Total : 100 Marks**

- **PrerequisiteCourses,ifany:**Basics of Modeling and Simulation

CourseObjectives:

1. To introduce the concept of process modeling, types of models and their relevance to real life design problems of the industry
2. To develop a strong background of the fundamental laws governing bioprocesses and application of these laws to formulate mathematical models which mimic actual processes
3. To develop a capacity to classify processes based on various parameters, identify the boundary Conditions in the process and compare different models.
4. To impart reasonable expertise for understanding and formulating models specific to the Bioprocess industry
5. To develop expertise in characterizing and formulating models pertaining to different types of Fermenters
6. To familiarize students with modeling techniques for ancillary equipments which are usually coupled with fermenters

CourseOutcomes: Oncompletionofthecourse,learnerwillbeableto–

CO1: An understanding of the different types of mathematical models and classification of these models into categories based on the applications

CO2: Ability to formulate models mimicking the real life problems and hence using mathematical models for process design

CO3: Ability to identify the important parameters for formulating a mathematical model and then comparing these results with experimental outcomes

CO4: Ability to apply the modeling expertise to develop models for bioprocesses and applying these models for design and scale up of these processes

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CO5: Ability to combine the knowledge of processes and modeling to effectively design the different types of fermenters prevalent in common practice CO6: Ability to apply mathematical modeling to design a complete process consisting of fermenter and its ancillary equipment's and subsequent scale up

CourseContents		
Unit I		**(Hrs 6)**
Introduction to Modeling, Definitions: Model, Physical modeling, Chemical modeling, Fundamental laws: Total Continuity equation, Component Continuity equation, Energy equation, Equation of motion, Transport equation, Equation of state, Phase and chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling, scope of coverage.		
MappingofCourseOutcomes forUnitI	**CO1**:An understanding of the different types of mathematical models and classification of these models into categories based on the applications	
Unit II		**(Hrs 6)**
Models based on Mass, component, energy and force balance: Batch reactors, PFR's, CSTR's, Gravity flow systems, Reactors in series, Concept of Heated tank		
MappingofCourseOutcomes forUnitII	**CO2**:Ability to formulate models mimicking the real life problems and hence using mathematical models for process design	
Unit III		**(Hrs 6)**
Classification of mathematical modeling Classification based on variation of independent variables, classification based on state of the processes, classification based on type of the processes, comparison between rigid and stochastic processes and introduction of boundary conditions		
MappingofCourseOutcomesforUnitIII	**CO3**:Ability to identify the important parameters for formulating a mathematical model and then comparing these results with experimental outcomes	

Unit IV		**(Hrs 6)**
Modeling of fermentation Batch reactor, Fed batch reactor, Modeling a continuous culture: Chemostat, Chemostat with recycles, substrate limited growth in Chemostat, theory of fed-batch culture control, product inhibition and substrate utilization kinetics		
MappingofCourseOutcomesforUnitIV	**CO4**:Ability to apply the modeling expertise to develop models for bioprocesses and applying these models for design and scale up of these processes	

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Unit V		**(Hrs 6)**
Modeling of fermenters: Modeling of suspended growth reactors, activated sludge systems, theory on agitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors		
MappingofCourseOutcomesforUnitV	**CO5** :Ability to combine the knowledge of processes and modeling to effectively design the different types of fermenters prevalent in common practice	
Unit VI		**(Hrs 6)**
Mass Transfer Equipment: Reactor with mass transfer, Ideal binary distillation column, Multi-component Batch distillation, Two phase CSTR with heat Removal, Single component vaporizer		
MappingofCourseOutcomesforUnitVI	**CO6**:Ability to apply mathematical modeling to design a complete process consisting of fermenter and its ancillary equipments and subsequent scale up	

LearningResources

Text Books:

1. Luyben, W. L., "Process modeling simulation and control for chemical engineers", McGraw Hill, 2nd Ed.
2. Bailey, J. and Ollis, D., "Biochemical engineering Fundamentals", McGraw Hill Kogakusha Ltd. Tokyo
3. Balu, K. and Padmanabhan, K., "Modeling and analysis of Chemical Engineering processes", IK International private limited, 2007

Reference Books:

1. Dunn, I. J., et al., "Biological engineering Principles, Applications and Simulation", VCH, Weinheim
2. Bioprocess Engineering Principles, Pauline M. Doran, Publisher: Elsevier Science & Technology Books, 2nd edition.

MOOC/ NPTELCourses:

- **https://nptel.ac.in/courses/112107214**
- **https://nptel.ac.in/courses/103107096**

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019Course) 415472 :Plant Engineering and Project Costing		
Teaching Scheme:	**Teaching Scheme:**	**Teaching Scheme:**
TH:3 Hrs./Week	**3**	**In-Sem (Theory):30 Marks** **End-Sem(Theory):70 Marks** **Total: 100 Marks**

Prerequisite Courses: Knowledge of subjects like, Material Balances and stoichiometry.Mass transfer, Heat transfer, Thermodynamics, Reaction Engineering, Fluid Flow and Unit Operation, fermentation technology and Biochemical engineering

Course Objectives:

1. The subject is intended to learn various topics related to project design and costing.
2. The objective of this subject is students can learn the basic knowledge of plant design.
3. The objective is to develop the P& ID diagram forchemical/biochemical manufacturing plant.
4. The objective is to develop of layout for chemical/biochemical manufacturing plant.
5. The objective to understand theimportance of project engineering.

The objective to importance of financial management in project.

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

CO1: Understand the basic concept of process equipment design and their operational methods for different reactors.

CO2: Understand to develop the process flow diagram for the any manufacturing process for Bioprocess Industry.

CO3: Understand to develop the P & ID diagram and layout for biochemical manufacturing plant.

CO4: Understand different type of process utilities & maintenance required in manufacturing process in bioprocess industry

CO5: **Understand** optimum balance between cost, quality and time requirementsand their factors involved for the preparation of project.

CO6: Understand the importance of financial management in biotechnology project.

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Course Contents		
Unit I	**Introduction**	**(7 Hrs)**
Basic engineering in processes design, Basic considerations in chemical/biochemical plant design, basic aspects of process design, definition of process design,design constraints, design factors, preliminary techno-economic feasibility and survey,process design steps and development, Process flow Diagrams and symbols: Symbols of Process Equipments& their concepts.		
Mapping of Course Outcomes for Unit I	**CO1**:Understand the basic concept of process equipment design and their operational methods for different reactors.	
Unit II	**Process Development**	**(7 Hrs)**
Study of alternative processes, pilot plant, scale up methods, flow sheet preparation, sketching techniques, equipment numbering, stream designation, material and energy balances. Plant Design: Design basis, process selection -selection of equipment, specification and design of equipment's, material of construction, plant location, plant layout and installation, safety, start up, shutdown and operating guidelines, loss prevention and hazop study.		
Mapping of Course Outcomes for Unit II	**CO2**:Understand to develop the process flow diagram for the any manufacturing process for Bioprocess Industry.	
Unit III	**Piping Design & Layout**	**(7 Hrs)**
A brief revision covering friction factor, pressure drop for flow of non-compressible and compressible fluids, (Newtonian Fluids), pipe sizing, economic velocity. Pipe line networks and their analysis for flow in branches, Pipe supports, Isometric of piping, material selection for pipe and pipe fitting, expansion and contraction of piping,thermal insulation of piping, color code of pipeline, bill of material of piping.		
Mapping of Course Outcomes for Unit III	**CO3**:Understand to develop the P & ID diagram and layout for biochemical manufacturing plant.	
Unit IV	**Process utilities & Plant maintenance**	**(7 Hrs)**
Process water, boiler feed water, water treatment, waste treatment and disposal, disposal, steam, oil heating system, chilling plant, compressed air and vacuum. Necessity, types of plant maintenance, preventive, predictive, online, scheduled, corrective/breakdown, lubrication, plant start up and shut down procedure.		
Mapping of Course Outcomes for Unit IV	**CO4**:Understand different type of process utilities & maintenance required in manufacturing process in bioprocess industry	

Unit V	**Cost Engineering**	**(7 Hrs)**

Factors involved in project cost estimation - Total capital investment, Fixed capital and working capital, types and methods for estimation of total capital investment. Time value of money and equivalence, interest-simple, compound and continuous, present worth and discount, annuities, perpetuities and capitalized cost methods, depreciation, nature of depreciation, methods of determining depreciation, taxes and insurances, types of taxes and insurances, procedure for cost comparison after taxes.

Mapping of Course Outcomes for Unit V	**CO5**:Understand optimum balance between cost, quality and time requirements and their factors involved for the preparation of project.

Unit VI	**Project scheduling and Financial Management**	**(7 Hrs)**

Critical path method (CPM): events and activities; network diagramming; earliest start time and earliest finish time ;latest start time and latest finish time; float, advantage of CPM; cost to finish the projects earlier than normal cost; precedence diagramming. Programme evaluation and review technique (PERT): pert network and time estimates.

Profitability, alternative investments and replacement

Methods for profitability evaluation, Evaluation of Break Even Point, % rate of return, Practical factors in alternative investment and replacement studies.

Mapping of Course Outcomes for Unit VI	**CO6**:Understand the importance of financial management in biotechnology project.

Learning Resources

Text Books:

M. S. Peters & K. D. Timmerhaus, "Plant Design and economics for chemical engineers." McGrawHill (2002).
Richard Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiwitz, "Analysis, Synthesis and Design of Chemical Processes", Prentice Hall

Reference Books:

1. KSinnot," Coulson & Richardson's Chemical Engineering- Chemical Engineering Design", Vol. 6, Butterworth-Heinemann
2. Kalyanmoy Deb, "Optimization For Engineering Design-Algorithms and Examples", PHI Learning Private Limited

MOOC/ NPTELCourses:

- **https://onlinecourses.nptel.ac.in/noc20_ch31/preview**

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SavitribaiPhule Pune University, Pune

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

415473 (A) : BiomaterialsElective V

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

Prerequisite Courses, if any: Basic Knowledge of Biochemistry, Molecular Biology

Course Objectives:

1. To develop understanding of different biomaterials used in medicine, biology and dentistry by studying classification, properties and characterization techniques.
2. To study comprehensively about biopolymers with their manufacturing processes and applications of different polysaccharides.
3. To study different fermentative processes for the production of polyesters and biodegradable polymers.
4. To make students aware of applications of various biocatalysts and biotransformation in developing processes for polymer precursors and novel products.
5. To study bioadhesives, nano-biomaterials and composite biomaterials comparing their designs and applications in biological systems.
6. To develop profound vision of students towards in field research by providing information about the scope and applications of a high range of biomaterials.

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

CO1: Understand variety of biomaterials with their properties and applications.

CO2: Identify biopolymers with through knowledge of their manufacturing processes and applications.

CO3: Recognize fermentative production of processes for polyesters with special emphasis on Polyhydroxyalkanoates.

CO4: Develop or think of developing novel processes for the production of Biomaterials.

CO5: Understand mechanism of pharmaceutical products in biological systems.

CO6: Work further in the area of biomaterials by applying fundamental knowledge of variety biomaterials.

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Course Contents		
Unit I		**(6 Hrs)**
Overview of Biomaterials: General properties of materials, Classes of materials used in medicine: Metals, Polymers, Hydrogels, Bioresorbable and Biodegradable Materials, medical fibers and Smart materials Biological functional materials, textured and Porous materials.		
Mapping of Course Outcomes for Unit I	CO1: Understand variety of biomaterials with their properties and applications.	
Unit II		**(6 Hrs)**
Biopolymers: Classification (nucleic acid, protein, polysaccharide), Manufacturing, chemistry and applications of polysaccharide such as dextran, xanthan, gellan, pullulan, chitin, chitosan, etc., Methods of structural identification and characterisation		
Mapping of Course Outcomes for Unit II	CO1: Understand variety of biomaterials with their properties and applications. CO2: Identify biopolymers with through knowledge of their manufacturing processes and applications.	
Unit III		**(6 Hrs)**
Polyesters: Polyhydroxyalkanoates and biodegradable polymers such as polylactic acid, polyglycolide and polycaprolactone, Structure, physical and chemical properties with special emphasis on fermentative synthesis polyesters		
Mapping of Course Outcomes for Unit III	CO1: Understand variety of biomaterials with their properties and applications. CO3: Recognize fermentative production of processes for polyesters with special emphasis on polyhydroxyalkanoates.	
Unit IV		**(6 Hrs)**
Biocatalytic transformations of precursors: Application of biocatalyst such as enzymes and microorganisms in biotransformation process, development of polymer precursors using Biotransformations processes Precursors: aromatic hydrocarbons, biological formation of specialty hydroxylated monomers, L-homophenylalanine production using membrane bioreactor.		

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Mapping of Course Outcomes for Unit IV	CO4: Develop or think of developing novelprocesses for the production of biomaterials.

Unit V	**(6 Hrs)**

Nano-biomaterials: Types of bioadhesive, nano biomaterial, Characterize, predict, and control the biological properties of nano-biomaterials, composite biomaterial, Biodegradable plastic, design, synthesis, characterization and application of nanomaterials to biological and biomedical problems

Mapping of Course Outcomes for Unit V	CO5: Understand mechanism of pharmaceutical products in biological systems.

Unit VI	**(6 Hrs)**

Applications of materials in medicine, Dentistry and Biology: Cardiovascular medical devices, Nonthrombogenic treatments and Strategies, Dental implantation adhesive and Sealants, Ophthalmologic applications-intraocular lens implants, Case studies- Orthopedic biomaterials, Artificial organs and tissues.

Mapping of Course Outcomes for Unit VI	CO6: Work further in the area of biomaterials by applying fundamental knowledge of variety biomaterials.

Learning Resources

Text Books:

- Biomaterials Science: An Introduction to Materials in Medicine Buddy D. Ratner,
- Frederick J. Schoen, Allan S. Hoffman, Jack E. Lemons
- Hench L LEthridgc E.C. Biomaterials, an interfacial approach, Academic press 1982

Reference Books:

- Bronzino J D, The biomedical engineering handbook CRC Press

MOOC / NPTEL Courses:

- Biomaterials for bone tissue engineering applications - NPTEL
- **https://nptel.ac.in/courses/113108071**

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SavitribaiPhulePuneUniversity Final YearofB.Tech. Biotechnology(2019Course) 415473 (B): Molecular Diagnostics Elective V		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 03Hrs. / Week	**03**	**In-Sem(Theory): 30Marks** **End Sem(Theory): 70 Marks** **Total: 100 Marks**

Prerequisite Courses, if any:

Basic understanding of molecular biology techniques, analytical techniques, host-pathogen interactions

Companion Course, if any: --

Course Objectives:

1. To give overview of molecular diagnostics
2. To learn applications of molecular diagnostics in infectious non-communicable diseases and agriculture
3. To familiar students to molecular diagnostics technologies

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

CO1: Acquire knowledge of molecular diagnostics with sample requirements for diagnosis

CO2: Apply knowledge of molecular biology techniques for diagnosis

CO3: To understand immunological diagnostics.

CO4: Study sample requirements & methods for diagnosis of infectious/NCD diseases.

CO5: Learn molecular techniques for diagnosis of genetic disorders

CO6: Illustrate emerging technologies in diagnostics.

Course Contents

Unit I	Introduction to Molecular Diagnostics	(6 Hrs)

History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario.. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results

Mapping of Course Outcomes for Unit I	CO1: Acquire knowledge of molecular diagnostics with sample requirements for diagnosis.

Unit II	Molecular Biology Techniques for diagnosticss	(6 Hrs)

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.Introduction of molecular biology and technology with applications in diagnostics. PCR, Non-PCR Methods of disease/marker detection- Case studies.Molecular diagnosis of bacterial/fungal/viral pathogens for human, animal and plants, Diagnosis of infectious diseases caused by microbial pathogens		
Mapping of Course Outcomes for Unit II	**CO2:** Apply knowledge of molecular biology techniques for diagnosis	
Unit III	**Immuno Diagnostics techniques**	**(6Hrs)**
Introduction, Immunoassays – Antigen – antibody interactions- principles and applications, Fluorescent antibody test, Immunohistochemistry – principle and techniques RID, ODD, ELISA, RIA ,LFA , Monoclonal antibodies and its medical applications, Human Leukocyte Antigens (HLA) typing. Case Studies		
Mapping of Course Outcomes for Unit III	**CO3:** To understand serological techniques for diagnosis	
Unit IV	**Infectious Disease Diagnosis**	**(6Hrs)**
Traditional disease diagnosis methods and tools - Diagnosis of major bacterial, fungal diseases. Diagnosis of DNA and RNA viruses, Microbial Identification and Strain Typing, Case studies in molecular testing of food pathogens, plant-pathogens bacterial blight, fungal, viral pathogens & GMO		
Mapping of Course Outcomes for Unit IV	**CO4:** Study methods for diagnosis of Infectious/Non-communicable Diseases.	
Unit V	**Genetic Diseases and Karyotyping**	**(7Hrs)**
Cytogenetics- *In-situ* hybridization techniques – FISH and GISH , Genetic disorders: Classification of genetic disorders, Single gene Disorders Genetic disorders- Sickle cell anemia. Sex – linked inherited disorders Chromosomal Disorders, Cytogenetic evaluation-Trisomy Down's syndrome, Diagnosis of genetic disorders, Neonatal and Prenatal disease diagnostics. Preimplantation genetic diagnosis, Case Studies.		
Mapping of Course Outcomes for Unit V	**CO5:** Learn tools and techniques in diagnosis of genetic disorders	
Unit VI	**Emerging technologies in molecular diagnostics**	**(8Hrs)**
Lab on CHIP Technology, Point Of Care (POC) devices, enzyme based biosensors. Omics and Transcriptomics, Proteomics in diagnosis , High-Throughput NGS Approaches to Studying Virulence.		
Mapping of Course Outcomes for Unit VI	**CO6:** Illustrate emerging technologies in diagnostics.	

Learning Resources

Text Books:

1. Fundamentals of Molecular Diagnostics; David E Bruns, Edward R Ashwood, and Carl A Burtis; Saunders 2007 ISBN: 1416037373
2. Kuby Immunology, Judith Owen., Jenni Punt., Sharon Stranford and Patricia Jone , Seventh Ed, WH Freeman and Company, New York. ISBN13:978-1-4292-1919-8.

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Reference Books:

1. Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
2. Principles of Immunology and Immunodiagnostics, Ralph Michael Aloisi. Lippincott Williams and Wilkins
3. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
4. Molecular Testing in Laboratory Medicine: Selections from Clinical Chemistry, 1998-2001; David E. Bruns, Y.M. Dennis Lo, and Carl T. Wittwer; AACC Press 2003 ISBN: 1890883603
5. Manual of Clinical Microbiology, 9th ed. Patrick R. Murray, Ellen Jo Baron, James H. Jorgensen, Marie Louise Landry, Michael A. Pfaller, (Eds.); ASM Press 2007 ISBN:9781555813710
6. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
7. Immunology and ImmunobiotechnologyAshim K Chakravarty, Oxford University Press, 2006
8. Immunology, C Vaman Rao, Narosa Publishing House, New Delhi. 3
9. Genes IX by B. Lewin, Oxford University Press
10. KubyImmunlogy (6th edition) Thomas J Kindt, Richard A Goldsby WH Freeman & Co
11. An Introduction to Genetic Analysis (2000) by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart, W.H. Freeman, New York.
12. Genomics and Personalized Medicine (2 volumes); Huntington F. Willard, Geoffry S. Ginsburg; Elsevier 2009 ISBN: (set) 97801236942011
13. Molecular biology of the cell. Bruce Alberts, 6th Edition
14. Practical Biochemistry, Principles and Techniques (4th edition) edited by Keith Wilson and John Walker, 1994, Cambridge University Press
15. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition (2001) Blackwell science
16. Principles of Immunology and Immunodiagnostics, Ralph Michael Aloisi. Lippincott Williams and Wilkins
17. Principles of Biochemistry (Lehninger) (5th edition), MM Cox and DL Nelson, CBS Publishers
18. Scientific Foundations of Clinical Biochemistry: Ed, D.L. Williams, R.F. Nun, V. Marks; William Heinemann Medical Books Ltd.

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

1. Functional Genomics - By Prof. S. Ganesh | IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc21_bt39/preview
2. Human Molecular Genetics- By Prof. S. Ganesh | IIT Kanpur
   https://onlinecourses.nptel.ac.in/noc21_bt02/preview

For example

https://www.fda.gov/medical-devices/vitro-diagnostics/nucleic-acid-based-tests

https://jlpm.amegroups.com/article/view/4525/5548

https://jcm.asm.org/content/58/10/e01582-19

https://www.cell.com/trends/molecular-medicine/fulltext/S1471-4914(01)02259-6

https://www.mdpi.com/14220067/19/9/2731?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Int_J_Mol_Sci_TrendMD_0

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0240257

https://iopscience.iop.org/article/10.1088/2516-1091/abbf5e

https://pubmed.ncbi.nlm.nih.gov/31320315/

NPTEL course link https://archive.nptel.ac.in/courses/127/106/127106003/

Laboratory Diagnosis of Infectious Disease - Merck Manuals Professional Edition

Virtual LAB Link:

Systems Biology Virtual Lab

https://vlab.amrita.edu/index.php?sub=3&brch=276

Virtual Lab Experiments in Biotechnology: DNA Restriction Analysis - CSHL DNA Learning Center

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SavitribaiPhulePuneUniversity

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

Course Contents

415473 (C) : Bio therapeutics Technology Elective V

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

Prerequisite Courses, if any:

Students should have the basic knowledge of molecular Biology, Genetic engineering, immunology and proteins

Companion Course, if any: --

Course Objectives:

1. To introduce the concept, significance of biologics and development including pre-clinical studies and ethical aspects
2. To give overview of various systems used for production of bioltherapeutics and examples
3. To introduce monoclonal antibodies and recombinant vaccines as Biotherapeutics
4. Overview of Biopharmaceutical manufacturing process, product impurities, QA/QC
5. To introduce the concept of drug delivery and dosage forms for biotherapeutics.
6. Regulatory aspects of Biotherapeutic industry such as GLP, GMP, and IPR

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

CO1: Graduates are made aware of differences in biologics, chemical drugs and specific characteristics of biologics, their Discovery, Development, clinical trials and ethics

CO2. Graduates would be trained to understand different host systems used for production ofbiologics

CO3. Graduates are made aware of monoclonal antibodies and recombinant vaccines as biotherapeutics

CO4. Graduates are made aware of manufacturing process, requirements and QA/QC

CO5. Understand concepts of drug delivery, dosage forms and stability

CO6. Graduates are given elementary knowledge of regulatory requirements and guidelines like EU and USFDA, IPR

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Unit I		(6Hrs)

Introduction to Biotherapeutics Development

Overview of the pharmaceutical and biopharmaceutical industry. Definition of the terms: traditional pharmaceutical product, 'biologic' and 'biopharmaceutical', Advantages of producing biopharmaceuticals by recombinant means: availability and scale of production, Overview of biopharmaceutical products now approved for use, Overview of the drug development process. Pre-clinical studies – safety, efficacy, in-vitro, in-vivo, Clinical trials

Mapping of Course Outcomes for Unit I	CO1: Graduates are made aware of differences in biologics, chemical drugs and specific characteristics of biologics, their Discovery, Development, clinical trials and ethics.

Unit II		(8Hrs)

Various systems used for production of Biotherapeutics: Recombinant Proteins

Developing a recombinant therapeutic protein. Cloning in expression vector. Choices of vectors for Bacterial cells, Transfection methods for Bacterial cells. Choices of vectors for insect cell lines, Transfection methods insect cell lines. Choices of vectors for Mammalian cell lines, Transfection methods Mammalian cell lines, Examples of recombinant proteins, Production of EPO, hGH, Factor VIII

Mapping of Course Outcomes for Unit II	CO2: Graduates would be trained to understand different host systems used for production of biologics.

Unit III		(6 Hrs)

Various systems used for production of Biotherapeutics: Monoclonal antibodies (MAbs). Hybridoma technique, Examples of MAbs in market. Vaccines and immunologics, Characterization of the expressed protein, Plants and transgenic animals as potential sources of biopharmaceuticals.

Mapping of Course Outcomes for Unit III	CO3: Graduates are made aware of monoclonal antibodies and recombinant vaccines as biotherapeutics

Unit IV		(8Hrs)

The biopharmaceutical manufacturing process

The manufacturing process. Master and working cell banking systems. Clean rooms design and flow of operations. Decontamination, sanitation CDS and Generation of water for pharmaceutical / biopharmaceutical processing, WFI. Product flow through the facility and associated documentation, The QA function, Range and significance of biopharmaceutical product impurities like microorganisms, viruses, contaminant proteins, DNA and pyrogens. The range of QC tests carried out on typical biopharmaceutical products.Biopharmaceutical validation, Principles of validation, validation of chromatographic systems used in biopharmaceutical manufacture

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Mapping of Course Outcomes for Unit IV	**CO4:** Graduates are made aware of manufacturing process, requirements and QA/QC	
Unit V		**(8Hrs)**
Formulation and drug delivery system of Biotherapeutics Formulation Introduction, Types of formulation: Oral, Topical, Parentral, Slow release, Degradation Routes, Physical Stability Issues and Chemical Stability Issues,The Routes of Chemical Instability, and Modeling for Streamlining. Accelerated stability, real time stability, agents aiding increase in stability, Advanced drug Delivery Systems:liposomes, PEGyaltion,microparticles and Nanoparticles, biodegradable drug delivery system (hydrogel based)		
Mapping of Course Outcomes for Unit V	**CO5:** Understand concepts of drug delivery and dosage forms and stability	
Unit VI		**(6 Hrs)**
Biopharmaceutical regulation Regulatory requirements for Biotech product development, Hierarchal structure in Indian biotechnology, Current GMP, Role of DCGI, National & International guidelines, Toxicity studies, clinical trials, clinical research, IPR, patents, trademarks, trade secrets, Export, Import of product.		
Mapping of Course Outcomes for Unit VI	**CO6:**Graduates are given elementary knowledge of regulatory requirements and guidelines like EU and USFDA, IPR	

Learning Resources

Text Books:

1. Grewal, I. S., "Emerging Protein Biotherapeutics"
2. Walsh, G., "Biopharmaceuticals: Biochemistry and Biotechnology", 2nd Edition, Blackwell,USA

Reference Books:

1. Hillery, A. M., Lloyd, A. W. and Swarbrick, J., "Drug Delivery and Targeting: For Pharmacists and Pharmaceutical Scientists"

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

For example-

1.Drug Delivery: Principles and Engineering By Prof. Rachit Agarwal, IISchttps://onlinecourses.nptel.ac.in/noc20_bt24/preview

2.Biosimilars- **https://www.youtube.com/watch?v=P9L97K2rlTM**

3**https://www.fda.gov/drugs/drug-approvals-and-databases/approved-drug-products-therapeutic-equivalence-evaluations-orange-book**, 4**https://www.fda.gov/vaccines-blood-biologics**

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SavitribaiPhule Pune University, Pune

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

415474 (A) :Management and Entrepreneurship Elective VI

Teaching Scheme:	Credit	Examination Scheme:
TH:3Hrs./Week	3	In-Sem (Theory):30 Marks EndSem(Theory):70 Marks Total : 100 Marks

Prerequisite Courses:

Course Objectives:

1. To develop basic understanding of role and levels of management along with importance of decision making and planning.
2. To understand principle and purpose of organization by studying different types and structures of organization.
3. To make students aware of concept of leadership with required leadership qualities and importance of co-ordination while working in an organization or team.
4. To study and nurture qualities required for entrepreneurship by describing its impact on the India's changing economy.
5. To introduce scope and role of small scale industries in the economic development and government policies towards small scale industries.
6. To develop basic understanding of project planning, implementation, monitoring and control.

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

CO1:An ability to understand managerial role and levels in order to work successfully in a group of people.

CO2:An ability get acquaint with the concept of organization and different structures of organization.

CO3: An ability to work as a leader in a group by acquiring leadership qualities and good co-ordination

CO4: An abilityto gain required knowledge about entrepreneurship and its direct relation with India's changing economy.

CO5:An ability to think of developing new small scale industries by using ideas in their mind.

CO6:An ability to improve skills like project planning, implementation and project report writing

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Course Contents		
Unit I	**Management**	**(6 Hrs)**
Introduction – Meaning – Concept and features of Management, Scope and functional areas of management – Management as a science, art or profession – Management and administration – Roles of management, Levels of management, development of management thought – early management approaches – modern management approaches. Decision making – importance of planning – steps in planning		
Mapping of Course Outcomes for Unit I	**CO1**:An ability to understand managerial role and levels in order to work successfully in a group of people	
Unit II	**Organizing and Staffing**	**(6 Hrs)**
Nature and purpose of organization, principles of Organizations – Types of organization -Departmentation – Committees Centralization vs. Decentralization of authority and responsibility, span of Control, MBO, and MBE (Meaning only) Nature and importance of Staffing – process of selection and recruitment (in brief)		
Mapping of Course Outcomes for Unit II	**CO2**:An ability get acquaint with the concept of organization and different structures of organization	
Unit III	**Directing & Controlling**	**(6 Hrs)**
Meaning and nature of directing – Leadership styles and motivation theories, communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination		
Mapping of Course Outcomes for Unit III	**CO3**: An ability to work as a leader in a group by acquiring leadership qualities and good co-ordination	
Unit IV	**Entrepreneur**	**(6 Hrs)**
Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Intrapreneur – an emerging Class, Development of Entrepreneurship steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India, Challenges to woman and achievements of woman Entrepreneurs, Identification of Business Opportunities		
Mapping of Course Outcomes for Unit VI	**CO4:**An abilityto gain required knowledge about entrepreneurship and its direct relation with India's changing economy	

Unit V	Small Scale Industry	(Hrs 6)
Meaning, Nature of Support; Objectives,Definition, Characteristics, Need and rationale: Objectives: Scope, role of SSI in Economic Development, Advantages of SSI, Steps to start in SSI – Government policy towards SSI, Functions, Types of Help, Ancillary Industry and Tiny Industry (Definition only)		

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Mapping of Course Outcomes for Unit V	**CO5**:An ability to think of developing new small scale industries by using ideas in their mind.	
Unit VI	**Preparation Of Project**	**(Hrs 6)**
Meaning of Project, Project Identification, Project Selection, Project Report, Need and Significance of Report, Contents, formulation, Guidelines by Planning Commission for Project report, Network Analysis, Errors of Project Report, and Project Appraisal		
Mapping of Course Outcomes for Unit V	**CO6**:An ability to improve skills like project planning, implementation and project report writing	

Learning Resources

Text Books:

1. Principles of Management – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 2nd Edition. Dynamics of Entrepreneurial Development & Management – Vasant Desai–Himalaya Publishing House
2. Entrepreneurship Development – Small Business Enterprises – Poornima M Charantimath – Pearson Education –2006, 2nd Edition.

Reference Books:

1. Management Fundamentals - Concepts, Application, Skill Development – 1st Edition , Robert Lusier – Thomson ,
2. Innovation and Entrepreneurship- Peter F. Drucker, Harpercollins Publication
3. Management – Stephen Robbins – Pearson Education / PHI -17th Edition, 2003.
4. Management and Entrepreneurship – N.V.R. Naidu & T. Kirshna Rao, I.K. International, New Delhi – 2008.
5. Essentials of Management – Harold Koontz-TMGH-2010, 2 nd Edition

MOOC/ NPTELCourses

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SavitribaiPhule Pune University, Pune Final Year of B.Tech. Biotechnology (2019 Course) 415474 (B):Intellectual Property Rights Elective VI		
TeachingScheme:	**Credit**	**ExaminationScheme:**
TH: 3Hrs./Week	**03**	**In-Sem (Theory): 30Marks** **EndSem(Theory):70 Marks** **Total : 100 Marks**
PrerequisiteCourses,ifany: Basic understanding of different streams in Biotechnology where intellectual property play a role		
CourseObjectives: 1. To understand the basics of IPR 2. To recognize the role of International IP Regime. 3. To know the basics of trademarks and registration process 4. To know the basics of trade secrets 5. To recognize the various aspects of coy rights and registration process 6. To understand the basics of geographical indication		
CourseOutcomes: Our study in IPR is designed to help students accomplish the following outcomes: CO1: They will be aware of the Intellectual property CO2: Will know the role of International IP Regime CO3: Know the various issues involved in the trademarks CO4: Will know about the trade secrets CO5: Understand the various requirements for copy rights and its registration process CO6: Will get awareness about the geographical indication		

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CourseContents		
Unit I		**(7Hrs)**
Introduction to Intellectual property: Origin and Development of IPR – Historical and theoretical basis for protection of IPR – Analysing and understanding the Interpretation of IP laws – Need for Protecting IP, types of intellectual property, importance of intellectual property rights.		
MappingofCourseOutcomes forUnitI	**CO1:** They will be aware of the basics of Intellectual property	
Unit II		**(7Hrs)**
International IP Regime: World Intellectual Property Organisation (WIPO) – Functions of WIPO – Membership – GATT Agreement – Major Conventions on IP – Berne Convention – Paris Convention – TRIPS agreement		
MappingofCourseOutcomes forUnitII	**CO2:** Will know the role of International IP Regime	
Unit III		**(7Hrs)**
Trade Marks: Domain name and trademark, purpose of trademark, requirements for registration for a trademark, Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes		
MappingofCourseOutcomesforUnit III	**CO3:** Know the various issues involved in the trademarks	
Unit IV		**(7Hrs)**
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.**Unfaircompetition:**Misappropriation right of publicity, false advertising.		
MappingofCourseOutcomesforUnit V	**CO4:** Will know about the trade secrets	
Unit V		**(8Hrs)**
Law of copy rights: Copyright Act, 1957 Terms of Copyright conditions for grant of copyright ,Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Copyright in Literary, Dramatic and Musical, Works, Sound Recording, Cinematograph Films. Copyright in Computer Programme, Author Special Rights, Right of Broadcasting and performers. Protection of industrial design		
MappingofCourseOutcomesforUnit V	**CO5:** Understand the various requirements for coy rights and its registration process	
Unit VI		**(8Hrs)**
Geographical indication of Goods: Types, Why. and how GI need protection and GI law, Indian GI act Traditional Knowledge: Indigenous, medicinal, bioprospecting knowledge, Examples. Need for protection positive protection, defensive protection, legal aspects.		
MappingofCourseOutcomesforUnit VI	**CO6:** Will get awareness about the geographical indication	

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LearningResources

Text &Reference Books:

- Erbisch, F. H. and Maredia, K. M., "Intellectual property rights in agricultural biotechnology"
- Shahid Ali khan &RaghunathMashelkar, "Intellectual Property and Competitive Strategies in the 21stCentury", KluwerLawInternational,London.
- Prabuddhaganguli, Intellectual property right – Unleashing the knowledge economy, , Tata McGraw Hill Publishing company ltd.

MOOC/ NPTELCourses:

- Patent Law for Engineers and Scientistshttps://onlinecourses.nptel.ac.in/noc20_hs55/preview
- Intellectual property https://onlinecourses.nptel.ac.in/noc22_hs59/preview
- Intellectual property rights and competition law https://archive.nptel.ac.in/courses/110/105/110105139/

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SavitribaiPhule Pune University, Pune

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

415474 :Nanotechnology Elective-VI(C)

Teaching Scheme:	Credit	Examination Scheme:
TH: 3 Hrs./Week	3	In-Sem (Theory): 30 Marks EndSem(Theory): 70 Marks Total Marks :- 100 Marks

Prerequisite Courses, if any:

Course Objectives:

1. To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization of nanotechnology in biotechnology
2. To miniaturized biotechnology with specific application of nanotechnology
3. Promote the design and development of safe and environmentally benign manufacturing processes for engineered nanomaterial
4. To promote advance research and innovation through applications of nanobiotechnology

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

CO1: Understand to design the processing conditions to engineer with functional nanomaterials.

CO2: Understand advanced quantum techniques to describe the nano systems.

CO3: Understand to identify and compare state-of-the-art nanofabrication methods and perform a critical analysis

CO4: Understand the fundamentals of Nanodevices

CO5: Understand fundamentals of Biosensors &Nanosensors

CO6: Understand the different Biological and fundamental techniques.

Course Contents

Unit I	Introduction to Nanomaterials	(7 Hrs)

Introduction to nanomaterials, Properties of materials &nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state. Synthesis of nano materials-Physical, chemical and Biological methods.

Mapping of Course Outcomes for Unit I	CO1: Understand to design the processing conditions to engineer with functional nanomaterials.

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Unit II	Characterization of Nanostructures	**(7 Hrs)**
Characterization of Nanostructures-Structural CharacterizationX-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Spectroscopic characterizations		
Mapping of Course Outcomes for Unit II	CO2: Understand advanced quantum techniques to describe the nano systems.	
Unit III	Applications of Nanotechnology in Biotechnology	**(7 Hrs)**
Applications of nanobiotechnologyin early medical diagnostics, drug targeting, drug delivery,nanosurgery and other biomedical field.		
Mapping of Course Outcomes for Unit III	CO3: Understand to identify and compare state-of-the-art nanofabrication methods and perform a critical analysis	
Unit IV	Nanodevicesin Biotechnology	**(7 Hrs)**
Nanodevices- Functionalization of Sensing Substrates, Biochip, Sensor for bio-medical applications: Cardiology, Neurology and as diagnostic tool, generation of biosensors, immobilization, characteristics, applications, Polymer based sensor.		
Mapping of Course Outcomes for Unit IV	CO4: Understand the fundamentals of NanosensorsBiosensors.	
Unit V	Nanosensors	**(7 Hrs)**
Nanosensors-Miniaturization of Biosensors, Nanomaterial Based Biosensors. Electron Transferof Bimolecules, Nanoparticle-Biomaterial Hybrid Systems for Sensing and Electronic Devices. DNA Biosensors, optical sensors. Biochips.		
Mapping of Course Outcomes for Unit V	CO5: : Understand fundamentals of Biosensors &Nanosensors	
Unit VI	Biological and Physicochemical techniques	**(7 Hrs)**
Biosensor in biological and physicochemical techniques MEMS, Fuel Cells, Ethical Considerations. Respect for life, Potential dangers		
Mapping of Course Outcomes for Unit VI	CO6: Understand the different Biological and fundamental techniques.	

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Learning Resources

Text Books:

1. Niemeyer and Mirkin ed. Nanobiotechnology: concepts, applications & perspectives,
2. Jain, KK. Nanobiotechnology in molecular diagnostics: current techniques and Applications
3. Springer Handbook of Nanotechnology - Bharat Bhusan
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

Reference Books:

2.A.Nabok, Organic and Inorganic Nanostructures, Artech House 2005
3. C. Dupas, P. Houdy, M. Lahmani, Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg 2007
4. Jeremy Ramsden, Essentials of Nanotechnology, ISBN 978-87-7681-418-2
5. Carl C. Koch, Nanostructured Materials, Second Edition: Processing, Properties and Applications William Andrew Publishing Norwick, NY, USA, 2006. ISBN 10:0-8155-1534-0(0-1855)
6. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002
7. G.L.Hornyak, J.Dutta, H.F.Tibbals, A.K.Rao, Introduction to Nanoscience, CRC Press, 2008, ISBN: 978-1-4200-4805-6
8. **Ozin**, Geoffrey A., **Arsenault**, André C., **Cademartiri**, Ludovico, Nanochemistry, Springer, 2nd ed., 2009, ISBN 978-1-84755-895-4
9. Elements of X –ray Diffraction, B. D. Cullity
10. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM - Ray F. Egerton

MOOC/ NPTEL Courses:

https://onlinecourses.nptel.ac.in/noc22_bt46/preview

https://onlinecourses.nptel.ac.in/noc22_bt25/preview

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SavitribaiPhule Pune University, Pune

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

415475 :Bioprocess Modeling & Simulation and Plant Engineering and Project Costing Lab

Teaching Scheme:	Credit	Examination Scheme:
PR: 2Hrs./Week	1	TE: 25 Marks Oral : 50 Marks Total : 75 Marks

Prerequisite Courses: Knowledge of subjects like, Material Balances and stoichiometry.Mass transfer, Heat transfer, Thermodynamics, Reaction Engineering, Fluid Flow and Unit Operation, fermentation technology, Biochemical engineering

Course Objectives:

1. To design plant and process layouts and carry out costing
2. To characterize, develop and formulate models pertaining to various processes

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

CO1- Apply knowledge of PEPC to design plant and processes.
CO2- Apply mathematical modeling to design processes based on various parameters

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Suggested List of Laboratory Assignments (Any 8) (Any 2 from A, B, C, D)	
A	
1	Drawing of Process Equipment Symbols
2	Drawing of Process flow diagram and block diagram
3	Drawing of Piping and instrumentation diagram
B	
4	Drawing of Plant layouts and elevations
5	Drawing of Piping GA drawing on AutoCAD
6	Drawing of isometrics drawing of piping AutoCAD
C	
7	Reaction equilibrium for multiple gas phase reactions
8	Material and energy balances for a batch reactor
9	Steady state material balance, molar flow rates and compositions on a separation tray
D	
10	Study of characteristics of multicomponent distillation column
11	Study of multi component absorption column
12	Steady state two stage extractions

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SavitribaiPhule Pune University, Pune

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

415476 :Elective V and VI TW/Oral

Teaching Scheme	Credits	Examination Scheme
Tutorial 1 Hour/Week	**1**	**Ele V-TW: 50** **Ele VI-OR: 25** **Total : 75**

Prerequisite Courses, if any:

Course Objectives:

1. To develop basic understanding of the concepts in Elective V and VI
2. **To know latest developments in the field**

Course Outcomes: On completion of the course ,learner will be able to–
Understand the concepts and stay abreast with latest developments in the field

Suggested List of tutorials to be carried out

1. To design molecular diagnostic kit/ Biotherapeutic/application of biomaterial
2. To search for IPR on Biotech products
3. To take a market review and prepare a business plan for Biotech product

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SavitribaiPhule Pune University, Pune

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

415477 :Project Stage 2

Teaching Scheme:	Credit	Examination Scheme:
PR: 12Hrs/Week	**6**	**PR: 12Hrs/Week** **TW: 100 Marks** **OR: 50 Marks** **Total : 150 Marks**

Prerequisite Courses, if any:

Course Objectives:

1. To follow the approaches/methods developed and meet the objectives of proposed work.
2. To carry out wet lab experiments at least in triplicates and analyze results obtained for different data sets.
3. Reproduce the results with developed methods and validate the work undertaken.
4. Compile experimental findings in term of proper technical report discussing the reason for results obtained systematically.

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

CO1: Meet the objectives defined showing results of independent investigation.

CO2 :Analyse the results and their interpretation

CO3 : compare data sets obtained and analyze results statistically using appropriate statistical approach.

CO4: Report and present the original results in an orderly manner discussing the right reasons for obtained results.

Guidelines

In Project Work Stage-2, students shall complete the remaining project work by using proposed methods systematic experimentation using various equipment's and lab techniques, comparing different data sets of results obtained and detailed interpretation of results giving certain conclusions. The students shall prepare and submit the report of Project work in a standard format for satisfactory completion of the work which will be further certified by the concerned guide and head of the Department/Institute.

Follow guidelines and formats as mentioned in Project booklet recommended.

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