Savitribai Phule Pune University, Pune

B.E. (Biotechnology) Structure and Syllabus for 2015 Course

(W.e.f. Academic Year 2018-19)

B.E. (Biotechnology) Syllabus Structure for 2015 Course

Subject Code	Subject	Teaching Scheme Hrs/Week			Theory		Examination Scheme (Marks)				
		Lect	Tut	Pr	In Sem.	End Sem	TW	Pr	Or	Total	Credit
415461	Bioprocess Equipment Design	4	-	2	30	70	--	-	50	150	5
415462	Bioseparation II	3	-	2	30	70	-	50		150	4
415463	Biochemical Engineering	3	-	2	30	70	--	-	50	150	4
415464	Elective - I	3	-	2	30	70	50	-	--	150	4
415465	Elective - II	3	-	-	30	70	--	-	--	100	3
415466	Project	-	2	-	---	--	50	--		50	2
Total →		16	02	08	150	350	100	50	100	750	22

W.e.f. Academic Year 2018-19
SEM I

Elective I	Elective II
1. Environmental Biotechnology	1. Bioenergy and Renewable Resources
2. Computational Biology	2. Biomaterials
3. Bio-therapeutics Technology	3. Stem Cell Biology and Regenerative Medicine

SEM-II

Subject Code	Subject	Teaching Scheme Hrs/Week			Theory		Examination Scheme (Marks)				
		Lect	Tut	Pr	In Sem	End Sem	TW	Pr	Or	Total	Credit
415467	Plant Engineering & Project Costing	3	-	2	30	70	--	-	50	150	4
415468	Bioprocess Modeling & Simulation	3	-	2	30	70	-	--	50	150	4
415469	Elective - III	3	-	2	30	70	50	-		150	4
415470	Elective - IV	3	-	-	30	70	--	-	--	100	3
415471	Advanced Biotechnology Practices		-	2			50	--	--	50	1
415472	Project	-	6	-			100	--	50	150	6
Total →		12	06	08	120	280	200		150	750	22

Elective III	Elective IV
1. Food Biotechnology	1. Management and Entrepreneurship
2. Agricultural Biotechnology	2. IPR, Bioethics and Regulations
3. Genomics	3. Industrial Organization and Management

BE BIOTECHNOLOGY SYLLABUS

SEM I

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
BIOPROCESS EQUIPMENT DESIGN (415461)
Credit: 5

Teaching Scheme:
Theory: 4 hr/week
Drawing: 2 hr/week

Exam Scheme:
In Sem: 30 Marks
End Sem : 70 Marks
Oral: 50 Marks

Prerequisites: -

Knowledge of subjects like, Material Balances 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 process equipment.
2. This course to give up-to-date knowledge for designing s heat and mass transfer equipment used in chemical and biochemical process plants.
3. After undergoing this course the students will have the knowledge to analyze a problem and finding a process design method.

Course outcomes:

1. Getting Knowledge of basics of process equipment design and important parameters of equipment design
2. Ability to design internal pressure vessels and reaction vessels
3. Ability to design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads)
4. Knowledge of equipment fabrication and testing methods,
5. Able to process design of shell & tube heat exchanger.

Course Contents

UNIT 1 **[7 Hrs]**

Basic Principles of design

Design Factors, Design procedure, Codes and Standards, Optimization, Design Loads, Combined Loading in Equipments, Concept of Stress and Strain, Theories of Failure.

UNIT 2 **[8 Hrs]**

Pressure Vessels and bioreactors

Design of unfired pressure vessels: 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.

UNIT 3 **[8 Hrs]**

Reaction vessels - Introduction, classification, heating systems, various types of jackets like plain, half coil, channel, and limpet oil. Study and design of internal coil of reaction vessels, Heat transfer coefficients in coils, Study of various types of agitators, power requirement.

UNIT 4 **[8 Hrs]**

Heat Exchange Equipments

Introduction, types of 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

UNIT 5 **[7 Hrs]**

Design of distillation column

Design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors and plate hydraulic design - Plate design, weir dimensions, weep point, hole size, and Plate pressure drop.

UNIT 6 **[8 Hrs]**

Bioreactors

Design principles of bioreactors, geometric configuration, accessories for bioreactors, material for construction of bioreactors and selection criteria, Scale up of bioreactors, safety measures in bioreactors. Economic consideration for scale up.

Text Books:

1. Process Equipment Design. S. D. Dawande, Dennet and Company.
2. Process Equipment Design, M. V. Joshi. McMillan India.
3. Plant Design and Economics for Chemical Engineers. M. Timmerhouse, McGraw Hill and Co.
4. Bioprocess Engineering-Systems, Equipment and Facilities" Edited by Bjorn K. Lydersen, Nancy A D'elia and Kim L. Nelson, A Wiley Interscience Publication.
5. Introduction to Chemical Equipment Design" by B.C. Bhattacharya, C.B.S. Publications.

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, Pergamon Press.
3. Chemical Engineering volume 2" by J.M. Coulson, J.F. Richardson, and R.K. Sinott Pergamon 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.

Practical's (Minimum 6):

Process and Mechanical design and drawing of any five equipments from UNIT 1 to 5 which should include at least two sheets based on AUTOCAD/Autodesk or design software.

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
BIOSEPARATION II (415462)
Credit: 4

Teaching Scheme:
Theory: 3 hr/week
Practical: 2hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks
Practical: 50 Marks

Prerequisites: -

Basic knowledge of Biomolecules and UNIT Operations

Course Objectives:

1. To study importance of downstream processing. Learn to apply principles of downstream processing to various classes of products.
2. To introduce with spectrophotometry. To demonstrate instrumentation of spectrophotometers.
3. Help develop process of chromatography.
4. To study instrumentation of chromatography.
5. To learn advanced bioseparation techniques
6. To apply knowledge of subject to learn different class product purification.

Course Outcomes:

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

1. Students will learn to apply basics of downstream processing to various classes of products. They will understand the basic problems of bio product purification.
2. Students will learn to apply technique of spectrophotometer and its different types for analysis of laboratory samples.
3. Students will be familiar with types and application of chromatography with understanding of case studies.
4. Students will understand functioning of various parts of chromatography system. They will learn to study chromatograms and resolve problems related to it.
5. Students will grasp new and advanced methods of separation which will increase yield of products with less batch time.
6. Students will learn to correlate with theoretical principles and practical application of downstream processing.

Course Contents

UNIT1 **[6 Hrs]**

Downstream Processing in Biotechnology

Role and importance of downstream processing in biotechnological processes, Problems and requirements of bio-product purification, Process design criteria for various classes of bio-products high volume, low value products and low volume, high value products, Characteristics of biomolecules and their differences.

UNIT2 **[5 Hrs]**

Spectrophotometry

Introduction, Beer-Lambert's law, Instrumentation

Spectrofluorometry – Principle, Instrumentation, Applications, Case studies, Quantitative spectrophotometric analysis, Basic principles of spectroscopy, Introduction to atomic absorption spectroscopy and NMR

UNIT 3 **[6 Hrs]**

Chromatography – Types and applications

Principles, retention, procedures, materials and applications of – Gel permeation chromatography, Ion exchange chromatography, Chromatofocussing, affinity chromatography, Reversed phase and hydrophobic interaction chromatography

UNIT 4 **[6 Hrs]**

Chromatography – Types and applications

Gas Chromatography, Liquid chromatography, Introduction to GC-MS and LC-MS, Instrumentation: Pumps, degasser, mixer, guard column, column and detectors, Chromatograms

UNIT 5 **[6 Hrs]**

Other separation techniques

Zone refining, Molecular sieves, Adductive crystallization, Supercritical fluid extraction, Reactive extraction, Precipitation, Aqueous two phase systems, Introduction to SEP box and Hyphenated techniques.

UNIT 6 **[6 Hrs]**

Applications of Bio-separations – Case studies

Health care products - Production of penicillin, peptide antibiotics

Food and Beverages – Beer, Citric acid

Bio-chemicals – Ethanol, Butanol

Specialty products – Microbial polysaccharides, Surfactant

Text Book:

1. B.Shivshankar, " Bioseparations: Principles and Techniques", Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
2. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill International Editions, 1980

3. Coulson J.M. and |Richardson J.F., "Chemical Engineering", Vol I & II –McGraw Hill International Editions, 1980
4. Pauline Doran, " Bioprocess Engineering Principles", Elseveir Publications, New Delhi,2010
Michael R. Ladisch, " Biosepration Engineering, Principles, practice and economics", Wiley-Blackwell Publishers ,2001

Reference Books:

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

Practical's:

Guidelines for Instructor's Manual

- Students should be briefed with risk assessment and Biosafety levels
- All the instruments to be validated before use
- All the experiments should be standardized
- The instructor is responsible for seeing that consequences of student are rectified, including correction of damages and violations and take-down of experiments

Guidelines for Student's Lab Journal

- Use provided templates of experiment write ups
- Follow the sequence of experiments as per the index, while arranging journal file
- Draw necessary diagrams with pencil and fill other fields like observations, calculations, conclusion etc. with Pen
- Paste Images e.g. of specialized equipment, Observed results etc.
- Avoid overwriting and copying of results, conclusions etc.

Guidelines for Lab /TW Assessment

Each experiment will be assessed based on following terms

- Student should attend each practical in scheduled batch to gain full marks for that practical
- Regularity will be assessed throughout the semester for practical.

- Presentation of students in laboratory during practical will be assessed.
- Understanding and application of steps involved in practical to achieve good results will contribute in term work/lab assessment.
- For final term work assessment along with above all points, UNIT test marks, theory lecture attendance will also be considered.

Guidelines for Laboratory Conduction

- Wearing laboratory coats and gloves is compulsory to enter into the laboratory
- Practicals should be conducted in 3 or 4 batches from total students strength for the course
- One practical should be conducted per week for all batches
- Students should be made aware of equipments present in the respective laboratory
- Students should be made aware about chemicals to be handled during performing practicals
- Cleanliness and discipline should be followed during performance of practical course
- Disinfect work surfaces to decontaminate before and after each work session
- Ensure that loose hair and loose flowing parts of your apparel are properly tied before you commence working
- Glassware/Plastic ware Biological material should be labeled appropriately with due discarding date
- Plates/Flasks/Tubes containing microbial material should be autoclaved before discarding

Suggested List of Laboratory Assignments

Sr. No.	
	Group A
	Basic Spectrophotometric Methods
1	i. Verification of Beer Lambert's law ii. Determination of λ_{max} for proteins
2	**Group B** **Protein isolation and purification Techniques-I** i. Determination of protein concentration in fermentation broth ii. To study gel filtration chromatography iii. Determination of Void volume of Gel Filtration Chromatography system
3	**Group C** **Protein Purification Techniques -II** i. Separation of casein protein from milk using isoelectric point ii. Study of tangential flow filtration iii. Demonstration of Liquid chromatography (HPLC)

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
BIOCHEMICAL ENGINEERING (415463)
Credit: 4

Teaching Scheme:
Theory: 3hr/Week
Practical: 2hr/Week

Exam Scheme:
In Sem Exam : 30 Marks
End Sem Exam: 70 Marks
Oral: 50 Marks

Prerequisites: - Knowledge of subjects like Microbiology, Material Balances and Stoichiometry, Mass transfer, Heat transfer

Course Objectives:

- To study detailed fermentation process kinetics.
- To study modes of operation and types of fermenters with its applications
- To make students aware of detailed design of fermenter with its auxiliaries and operating parameters.
- To study comprehensively importance of aeration and agitation in bioprocesses.
- To give brief idea and standards procedures of scale up and scale down of fermentation.
- To introduce students about advanced and recent fermentation techniques used in an industries.

Course Outcomes:

On Completion of course students will

- Have an ability to evaluate process kinetics.
- Students will be able to choose and design an appropriate type of fermenter based on its application.
- Assemble fermenter auxiliaries and able to set the required process parameters.
- Built an ability to understand need and general considerations of process scale up and scale down.
- Gain knowledge about biotransformations and recent fermentation techniques.

Course Contents

UNIT 1 **[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.

UNIT 2 **[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.

UNIT3 **[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.

UNIT 4 **[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

UNIT 5 **[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.

UNIT 6 **[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.

List of Books:

Text Books:

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

Reference Books:

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

Suggested List of Laboratory Assignments

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

Group B- Fermentative Synthesis and Product analysis

4. Fermentation and Production of Vitamins and Antibiotics
5. Production of corn syrup using Bacterial Amylase
6. Beer Fermentation

Group C- Enzyme Immobilization

7. Study of enzyme immobilization by gel entrapment

Group D- Fermenter Study

8. Study of Laboratory fermenter

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE I: ENVIRONMENTAL BIOTECHNOLOGY (415464)
Credit: 4

Teaching Scheme:
Theory : 3 hr/week
Practical: 2 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks
Term work: 50 Marks

Prerequisites:

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

Course Objectives:

- To introduce various concerns regarding the environment, including various types of pollutants, human factors contributing to environmental issues.
- To present the environmental roles of biotechnology in environmental studies.
- 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–

- Understand the factors that lead to environmental pollution and the need for responsible practices to avoid this.
- Give examples of how biotechnology can help in monitoring and/or removing the pollutants.
- Understand the new trends such as bioremediation to clean up the environment.

Course Contents

UNIT 1 **[6 Hrs]**

Introduction to water and waste water management

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.

UNIT 2 **[6 Hrs]**

Methods of waste water treatment

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 rotatingbiological

contactors(RBC); aerated lagoons, oxidation ditches, Fluidized bed reactor (FBR), packed bed reactors air- sparged reactors; UASB, photo catalytic reactors, wet-air oxidation.

UNIT 3 **[6 Hrs]**

Industrial waste waters

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.

UNIT 4 **[7 Hrs]**

Air Pollution- Sources, Effects and Measurement

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. CO_2 sequestration by algae.

UNIT 5 **[6 Hrs]**

Hazardous and Solid Waste Management

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

UNIT 6 **[7 Hrs]**

Bioremediation

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.

Practical (any 8):

A]

1. To study microbial flora of waste water
2. Determination of potability of water by MPN Test
3. Characterization of coliforms
4. Effect of treatment method on coliform/ microbial content
5. To study quality of air

B]

6. To study BOD
7. To study COD
8. To study DO

C]

9. Conductivity measurement of water
10. To study TDS

Text books:

1. Wastewater Engineering: Treatment and Disposal, Second edition, Metcalf and Eddy, Inc Tata McGraw-Hill publishing Company, New Delhi, 1987
2. Wastewater Engineering: Treatment and Disposal fourth edition,Metcalf and Eddy, Inc McGraw-Hill Companies, 2002
3. Environmental engineering – Peavy, Rowe – Mc Graw 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

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
INTRODUCTION TO COMPUTATIONAL BIOLOGY (415464)
Credits: 4

Teaching Scheme:
Theory: 3 hr/week
Practical : 2 hr/week

Examination Scheme:
In Sem-30 Marks
End Sem- 70 Mark
Total -100 Marks

Prerequisites:

- Students should have the basic knowledge of Bioinformatics

Course Objectives:

- To provide an understanding about computational biology
- To make students acquainted with different computational programming languages and tools
- To bring students to the interphase of biology and informatics

Course Outcomes:

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

- Students will understand and be ready for working in computational biology research
- Students will get exposure and will know about programming languages and tools used in industries
- Students will get firsthand experience of informatics in biology research

Course Contents

UNIT 1 **[7 Hrs]**

Introduction to Programming languages in Computational Biology Introduction – Programming languages – Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked List concepts, Linux operating system - Introduction and applications, command line, R language – introduction, programming in computational biology, advantages, Python – introduction, programming concepts, application in biology.

UNIT 2 **[6 Hrs]**

Structural biology: Determination of protein structures by X-ray and NMR methods, Prediction of secondary structure- PHD and PSI-PRED methods. Tertiary Structure: homology modelling, fold recognition and ab-initio approaches. Structures of oligomeric proteins and study of interaction interfaces. *In silico* study of biological structures. Structural genomics-concepts and significance. Structural databases.

UNIT 3 **[6 Hrs]**

Introduction to mathematical modelling and simulation of biological systems

Biological systems and their complexity, use of mathematics to model biological systems, types of models (mathematical perspective), types of model (biological perspective), gene regulatory networks, population models. Gene finding, Bayesin network, Hidden markov models

UNIT 4 **[6 Hrs]**

Systems Biology

Concepts and working principles of Systems Biology - Practical applications of System Biology in Life Sciences - Introduction to Systems Biology platforms, Introduction to principles of Microarray technology - Microarray data analysis - Microarray analysis platforms - Application of Microarrays in Life Sciences Different. Introduction to NGS technology.

UNIT 5 **[7 Hrs]**

Molecular Modelling

Introduction, inter-atomic forces, Poly atomic Molecules, bond potentials, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Dipole interactions. Drug design: Drug discovery process. Target identification and validation, lead optimization and validation. Methods and Tools in Computer-aided Drug Design, Ligand based drug design: QSAR, Structure based drug design: Molecular Docking, de novo drug designing

UNIT 6 **[6 Hrs]**

Applications of Computational tools for Metabolic engineering: flux balance analysis, Study of biological networks, Reconstruction of biological networks from High throughput data, designing new technologies for synthetic biology, personalized medicines, production of recombinant toxins for developing new age vaccines, SAXS, SANS, Cryo EM

Text Books:

1. Systems Biology: Definitions and perspectives by L. Alberghina H.V. westerhoff, Springer. 2005
2. Protein structure, stability and folding Ed KP. Murphy, Humana press. 2001.
3. Molecular Modeling and Simulation – An interdisciplinary Guide by Tamar Schlick, Springerverlag. 2000

Reference Books:

1. Introduction to protein architexcture Arthur M.Lesk., Oxford University Press. 2001.
2. Computational systems biology by A. Kriete, R. Eils, Academic Press. 2005
3. Molecular Modelling for Beginners, (2nd Edition) by Alan Hinchliffe, John Wiley & Sons Ltd. 2008

Suggested List of Laboratory Experiments

Computational Biology:

Group A

1. R software basics and programming
2. Linux and basic installation and commands
3. Python programming

Group B

1. Microarray data analysis
2. Kegg pathway database for analysis

Group C

1. Structure based Drug Design: Molecular Docking
2. Ligand based Drug Design
3. Defining and Designing a function in MATLAB

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE I: BIO-THERAPEUTICS TECHNOLOGY (415464)
Credit: 4

Teaching Scheme:
Theory : 3 hr/week
Practical : 2 hr/week

Exam Scheme:
In Sem: 30 Marks
End Sem : 70 Marks
Term work: 50 Marks

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

Course Objectives:

1. To introduce the concept, significance of biologics and development including clinical trials and ethical aspects
2. To give overview of various types of biologics and their production,
3. To address physical and chemical stability issues of Biotherapeutics
4. To introduce the concept of drug delivery and dosages during the development and use of biotherapeutic agents.
5. Characterization of Biotherapeutics, impurity and bioactivity measurements
6. Regulatory aspects of Biotherapeutic industry such as GLP, GMP, QA/QC and IPR

Course Outcomes:

1. Graduates are made aware of differences in biologics, chemical drugs and specific characteristics of biologics, their Discovery, Development, clinical trials and ethics
2. Graduates would be trained to understand different systems used for production of biologics
3. Graduates are made aware of analytical methods for characterization of biologics and its importance
4. Graduates are made aware of stability issues and mapping of Structural and functional changes in protein product
5. Graduates are given elementary knowledge of regulatory requirements and guidelines like EU and USFDA, IPR
6. Basic techniques used to study Biotherapeutics

Course Contents

UNIT 1 **[8 Hrs]**

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

UNIT 2 **[6 Hrs]**

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

UNIT 3 **[6 Hrs]**

Various systems used for production of Biotherapeutics: Recombinant Proteins Hybridoma technique, monoclonal antibodies, Examples of MAbs in market Vaccines and immunologics, Production of recombinant proteins in bacterial/animal cells, characterization of the expressed protein, recombinant production, Plants and transgenic animals as potential sources of recombinant biopharmaceuticals.

UNIT 4 **[8 Hrs]**

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

UNIT 5 **[6 Hrs]**

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:l iposomes, PEGyaltion, microparticles and Nanoparticles, biodegradable drug delivery system (hydrogel based)

UNIT 6 **[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, Rules & Regulations for start up companies

References:

Text Books:

1. Elmer, G. W., Farland, L. V. and Surawicz, C. M., "Biotherapeutic Agents and Infectious Diseases", Humana Press Inc., Totowa, NJ, USA, 1999

2. Grewal, I. S., "Emerging Protein Biotherapeutics" Reference Books

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

2. Walsh, G., "Biopharmaceuticals: Biochemistry and Biotechnology", 2nd Edition, Blackwell, USA

Guidelines for Instructor's Manual :

1. Students to be familiarized with Biosafety and Bioethics
2. All the instruments to be validated before use
3. All the experiments should be standardized
4. Students should be instructed for handling of hazardous chemicals like Ethidium Bromide and UV

Guidelines for Student's Lab Journal

Please read these instructions now and refer to them regularly!

These instructions must be followed carefully

1. Use a bound notebook.
2. Lab notebooks should be done in pen and no erasing or white-out is allowed
3. Title and underline each lab experiment at the top of the page and date it.
4. Briefly explain the lab exercise objectives in a few sentences.
5. Record observations, diagrams and results from the exercise.
7. Student should take signature of the instructor Lab notebook

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results

Guidelines for Lab /TW Assessment

Lab assessment will be based on following points

1. Present / Absent
2. Completion date of journal
3. Regularity, self motivation

4. Understanding/ team work

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 acrylamide and proteins

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.

Practicals (any 8):

Group 1

1. Seperation of protein of interest using conventional methods/ Ultrafiltation (amicon Filters)

2. Preparation of Poly acrylamide gel and detection of protein impurity

3. Stability study of proteins at 37^0C, 55^0C, 65^0C, check integrity using SDS PAGE.

4. Stability study of proteins at check integrity using native PAGE

Group 2

5. Writing an SOP and performing experiment

6. Sterility testing

7. Study of effect of temperature on efficacy of lysozyme: enzyme assay

8. Bioactivity testing

9. Western blot

Group 3

10. Formulations: Tablet

11. Formulations: syrup

12. Formulations: Ointment

13. Preparation of label

14. Visit to Pharma company/ animal house

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE II - BIOENERGY AND RENEWABLE RESOURCES (415465)
Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme
In Sem : 30 Marks
End Sem : 70 Marks

Prerequisites: -
Basic knowledge of Biology.

Course Objectives:

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

Course Outcomes:
At the end of the course the student will be able to:

- List and generally explain the main sources of energy and their primary applications in the India, and the world.
- Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
- 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.

Contents

UNIT 1 **[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

UNIT 2 **[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

UNIT 3 **[6 Hrs]**

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, Domestic and industrial

UNIT 4 **[6 Hrs]**

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

UNIT 5 **[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

UNIT 6 **[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

Textbooks:

Renewable Energy Resources: Basic Principles and Applications, G N Tiwari and M Ghosal

Narosa Publishing House, India, 2004

1. Non-Conventional energy Source, Rai G.D Khanna Publishers, New Delhi, 2004
2. Bansal Keemann, Meliss," Renewable energy sources and conversion technology", Tata Mc Graw Hill.
3. Renewable energy resources and emerging technologies, Kothari D.P, Prentice Hall of India Pvt. Ltd., 2008

Reference books:

1. Renewable Energy Resources 2nd Ed. - John Twidell and Tony Weir, New York, 2006
2. Solar Energy - Principles of Thermal Collection and Storage, S.P. Sukhatme and J. K. Nayak, third edition, Tata McGraw Hill Publishing Company Ltd, 2008
3. Solar Power Engineering / B.S Magal Frank Kreith & J.F Kreith.
4. Principles of Solar Energy, D. Yogi Goswami, Frank Kreith and Jan F. Kreider, second edition, CRC press, 2000
5. Non-Conventional Energy Systems, K M Mital, A H Wheeler Publishing Co Ltd , 1999
6. 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
8. Bioenergy: Realizing the Potential, S. Silveira, (Ed), Elsevier Science, 2005
9. Non-Conventional Energy, Ashok V Desai, New Age International (P) Ltd, New Delhi, 2003
10. 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

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE II – BIOMATERIALS (415465)
Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks

Prerequisites: - 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, nanobiomaterials 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 course students will be able to

1. Understand variety of biomaterials with their properties and applications.
2. Identify biopolymers with through knowledge of their manufacturing processes and applications.
3. Recognize fermentative production of processes for polyesters with special emphasis on polyhydroxyalkanoates.
4. Develop or think of developing novel processes for the production of biomaterials.
5. Understand mechanism of pharmaceutical products in biological systems.
6. Work further in the area of biomaterials by applying fundamental knowledge of variety biomaterials.

Course Contents

UNIT I **[6 Hrs]**

General properties of materials, Classes of materials used in medicine: Metals, Polymers, Hydrogels, Bioresorbable and Biodegradable Materials, Ceramics, Natural materials, composites thin films, grafts, Coatings medical fibers and Smart materials Biological functional materials, textured and Porous materials.

UNIT 2 **[6 Hrs]**

Biopolymers: Classification (nucleic acid, protein, polysaccharide), Manufacturing, chemistry and applications of polysaccharide such as dextran, xanthan, gellan, pullalane, chitin, chitosan, etc., structural characterization using protein sequencing by Edman degradation, mass spectrometer, optical tweezer (or atomic force microscopy)

UNIT 3 **[6 Hrs]**

Fermentative production of polyesters with special emphasis on polyhydroxyalkanoates, and biodegradable polymers such as polylactic acid, polyglycolide and polycaprolactone, lactoyllactic acid, Structure, physical and chemical properties including production of the above polymers

UNIT 4 **[6 Hrs]**

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.

UNIT 5 **[6 Hrs]**

Types of bioadhesive, nano biomaterial, Characterize, predict, and control the biological properties of nanobiomaterials, composite biomaterial, Biodegradable plastic, design, synthesis, characterization and application of nanomterials to biological and biomedical problems

UNIT 6 **[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 study- Orthopedic biomaterials, Case Study-Artificial organs and tissues.

Text Books:

1. Biomaterials Science: An Introduction to Materials in Medicine Buddy D. Ratner, Frederick J. Schoen, Allan S. Hoffman, Jack E. Lemons

2. Hench L L Ethridgc E.C. Biomaterials, an interfacial approach, Academic press 1982

2. **Reference Books:**

1. Bronzino J D, The biomedical engineering handbook CRC Press

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE II - STEM CELL BIOLOGY AND REGENERATIVE MEDICINE
(415465)
Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks

Prerequisites

The students should be aware of basics of the cell biology and the presence of various tissue.

Course Objectives:

1. To introduce to the concept of stem cells and offer basic understanding of how they function and their significance
2. To identify and know the functionality of different Stem Cell types
3. To study the different techniques used to isolate and study stem cells
4. Application of stem cell biology in cure of various degenerative diseases.
5. To give information about the different regulations and the different guidelines governing the stem cell research in India and in the world.

Course Outcomes:

1. Be aware of the unique set of cells present in the body – The STEM Cells.
2. The functionality and significance of stem cells will be shared with the students
3. Understand and learn the various techniques to identify and study the Stem Cells
4. Get awareness towards the various rules and regulations and guidelines for stem cell research
5. Be able to apply the knowledge of stem cell isolation and characterization and would be able to understand their application in various degenerative diseases.

Course Contents

UNIT 1 **[6 Hrs]**

History and introduction to stem cell biology and regenerative medicine. Terms: stem cell, progenitor cells, precursor cells, transit amplifying cells. General properties of stem cells.
Terms: Totipotent, pluripotent, multipotent, unipotent stem cells. Differentiation and transdifferentiation. Stem cell niche, growth and differentiation factors.

UNIT 2 **[6 Hrs]**

Techniques used in stem cell biology. Lineage – tracing technique, gene knock-out and knock-in studies, inducible gene expression or repression, transfection, DNA sequencing, Chromatin immunoprecipitation, fluorescent-activated cell sorting, confocal microscopy.

UNIT 3 **[8 Hrs]**

Stem cell types: Gastrointestinal , Liver, Pancreas, Kidney, Heart, Spinal Cord or neural stem cells, embryonic stem cells, hematopoietic stem cells, Mesenchymal Stem Cells, Characteristics, Isolation, Culture and Characterization protocols for the above stem cell types. Somatic cell nuclear transfer, induced pluripotent stem cells their need and application.

UNIT 4

[6 Hrs]

Guidelines for stem cells research and therapy in India: introduction, general mechanisms, aim and scope, categorization of research on stem cells, clinical application of umbilical cord blood stem cells, criteria on use of placental / fetal stem cells for research, approval of procurement. Banking or distribution of hESCs. International collaboration and patent issues.

UNIT 5 **[6 Hrs]**

Extra Cellular Matrices, Morphogenesis and Tissue Engineering, Principles of Tissue Culture Three-Dimensional Cell Culture, Organ Culture, Organotypic Culture, In Vitro and In Vivo Synthesis of Tissues and Organs, Micro-Scale Patterning of Cells and their Environment, Three-Dimensional Scaffolds, Tissue Engineering and Transplantation Techniques

UNIT 6 **[8 Hrs]**

Understanding of cell replacement and regeneration. Application of stem cells in degenerative Medicine, including Parkinson disease, diabetes, burn, retinal replacement therapy, cardiomyopathies, etc. Application of different stem cell types in gene therapy, New technologies for genetic modification in stem cell – CRISPR/CAS9, Viral and non-viral vectors Genome editing in stem cells Genetically corrected stem cells and their use for gene therapy

Reference Books:

1. Methods in Molecular Biology: Basic Cell Culture Protocols. Editors: Cheryl D. Helgason and Cindy L. Miller

2. Stem Cells Handbook. Editor: Stewart Sell. Humana Press.

3. Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential. Ann Kiessling and Scott C. Anderson. Jones and Bartlett Publishers

4. Human Embryonic Stem Cells. Editors: Arlene Chiu, Mahendra S. Rao, Humana Press

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

6. Stem Cell Biology. Editors: Daniel R. Marshak, Richard L. Gardner and David Gottlieb. Cold Spring Harbor Laboratory Press.

7. Essentials of Stem Cell Biology. Edited by Ian Wilmut. Elsevier publication.

8. Essentials of Stem Cell Biology. By Robert Paul Lanza. Elsevier Academic Press.

9. Stem Cells for Dummies. By Lawrence S. B. Goldstein, Meg Schnider. Wiley Publication.

10. Insight: Stem Cell Biology". Nature. 2006; 441:1059-1102.

11. Insight: Regenerative Medicine". Nature. 2008; 453:301-352.

12. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue Engineering & Regenerative Medicine 2008, Artech House, INC Publications.

13 Robert Lanza et al. Principles of Tissue Engineering, 3rd Edition. Academic Press; 3 edition (August 21, 2007)

14. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual.Wiley-Blackwell; 1 edition (January 4, 2011)

15. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1- Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press (September 28, 2004)

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
PROJECT (415466)
Credit: 2

Teaching Scheme: 2 Hrs **Exam Scheme:**
Tutorial: 6 hr/week **Term Work: 50 Marks**

During the first term the students are required to:

Students should submit a spiral bound type *Project Report* at the end of the term in the format given by the department.

(Reference numbers should be mentioned in the main text as a superscript)

The *Project Report* should contain:

1. The cover page –must mention: Project title, Name of the student(s), Name of the guide, Exam seat number and Year.

2. Certificate from guide

3. Certificate from industry (if any)

4. Index

5. Detailed *Project Report*

B.E. BIOTECHNOLOGY

SEM II

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
PLANT ENGINEERING AND PROJECT COSTING (415467)
Credit: 4

Teaching Scheme:	**Exam Scheme:**
Theory: 3 hr/week	**In Sem : 30 Marks**
Drawing: 2 hr/week	**End Sem : 70 Marks**
	Oral: 50 Marks

Prerequisites: - Knowledge of subjects like, Material Balances and stoichiometry. Mass transfer, Heat transfer, Thermodynamics, Reaction Engineering, Fluid Flow and UNIT Operation

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. It includes mainly importance of project engineering and financial management

Course Outcomes:

1. Understand the basic concept of plant design and their operational methods.
2. Develop the process flow diagram for the any process and, P & ID diagram and layout for plant.
3. Also learn the financial management system for plant

Course Contents

UNIT 1 **[6Hrs]**
Introduction

Basic engineering in processes design, thermodynamic and kinetic feasibility, Basic considerations in chemical/biochemical plant design, project identification, preliminary techno-economic feasibility. Process flow Diagrams and symbols: Symbols of Process Equipments & their concepts, Process Design Aspects, Process Design, Process Selection.

UNIT2: **[7 Hrs]**
Process Development

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.

UNIT 3 **[7 Hrs]**

Piping Design & Layout

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.

UNIT 4 **[6 Hrs]**

Process utilities & Plant maintenance

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.

UNIT 5 **[7 Hrs]**

Cost Engineering

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.

UNIT 6 **[6 Hrs]**

Project scheduling and Financial Management

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.

Reference Books:

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

3. R.K Sinnot," Coulson & Richardson's Chemical Engineering- Chemical Engineering Design", Vol. 6, Butterworth-Heinemann
4. Kalyanmoy Deb, "Optimization For Engineering Design-Algorithms and Examples", PHI Learning Private Limited

Suggested List of Practical Assignments

Minimum six drawings of following preferably on Auto CAD/Autodesk

1. Standard symbols as per IS code/ Process Equipment Symbols
2. Process flow diagram.
3. Piping and instrumentation diagram.
4. Utility diagram.
5. Plant layouts and elevations.
6. Piping GA drawing.
7. Piping isometrics.

Minimum two assignments based on practical to be solved on Auto CAD

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
BIOPROCESS MODELING AND SIMULATION (415468)
Credit: 4

Teaching Scheme:
Theory : 3 hr/week
Practical: 2 hr/week

Exam Scheme:
In Sem: 30 Marks
End Sem: 70 Marks
Oral: 50 Marks

Prerequisites: -

- Familiarize students with the basics of Modeling and Simulation

Course Objectives:

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

Course Outcomes:

1. An understanding of the different types of mathematical models and classification of these models into categories based on the applications
2. Ability to formulate models mimicking the real life problems and hence using mathematical models for process design
3. Ability to identify the important parameters for formulating a mathematical model and then comparing these results with experimental outcomes
4. Ability to apply the modeling expertise to develop models for bioprocesses and applying these models for design and scale up of these processes
5. Ability to combine the knowledge of processes and modeling to effectively design the different types of fermenters prevalent in common practice

6. Ability to apply mathematical modeling to design a complete process consisting of fermenter and its ancillary equipments and subsequent scale up

Course Contents

UNIT 1 **[6 Hrs]**

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

UNIT 2 **[6 Hrs]**

Models based on Mass, component, energy and force balance: Batch reactors, PFR's, CSTR's, Gravity flow systems, Reactors in series, Concept of Heated tanks

UNIT 3 **[6 Hrs]**

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

UNIT 4 **[8 Hrs]**

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

UNIT 5 **[7 Hrs]**

Modeling of fermenters: Modeling of suspended growth reactors, activated sludge systems, theory on agitated and sparged bioreactor, tower-aerobic and anaerobic bioreactors

UNIT 6 **[7 Hrs]**

Mass Transfer Equipment: Reactor with mass transfer, Ideal binary distillation column, Multi-component Batch distillation, Two phase CSTR with heat Removal, Single component vaporizer

Practicals:

1. Evaluation of Molar volume and compressibility factor from Vander Waals equation.
2. Steady state material balance on a separation train and calculating molar flow rates and compositions of the train.

3. Calculation of terminal velocity of falling particles.

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.
8. Study of characteristics of multicomponent distillation column.
9. Study of multicomponent absorption column.
10. Steady stages tow stage extraction.

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.

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ADVANCED BIOTECHNOLOGY PRACTICES (415471)
Credit: 1

Teaching Scheme: **Exam Scheme:**
Practical: 2 Hr/week **Term Work: 50 Marks**

Prerequisites: -

- Students should have the basic knowledge of Microbiology, Biochemistry and Fermentation Technology

Course Objectives:

- To introduce students about production of any one biomolecule by solid state fermentation processes
- To introduce basic concepts of type of enzyme inhibition
- To provide an understanding about separation of proteins by two/three phase partitioning
- To make students acquainted about bioassay for antibiotic

Course Outcomes:

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

- Understand the fundamentals of solid state fermentation process.
- Explain the functioning of enzyme in different modes of inhibition
- Give an explanation about separation of proteins
- Make a strategy to isolate antibiotic producers

List of Practicals (Any Seven):

1. Bioassay for antibiotics :
   i. Screening of antibiotic producer.
   ii. Determination of MIC.
   iii. To determine the potency of an antibiotic by agar diffusion method.

2. Aqueous two phase extraction :
   i. To isolate the given protein by ATPS
   ii. To find the partition coefficient of the protein.

3. Media design and inoculum preparation :
   i. To study media preparation of solid state fermentation system

ii. To study inoculum preparation process of solid state fermentation system.

4. Solid state fermentation – I
   To study the biomolecule production using solid state fermentation with emphasis on upstream processing.

5. Solid state fermentation – II
   To study downstream processing of biomolecules produced in solid fermentation.

6. Downstream processing using steam distillation/column distillation.
   To study production of ethanol in submerged liquid fermentation (SMF) & downstream processing using distillation.

7. Fermentation efficiency and yield analysis:
   To study the fermentation efficiency of alcohol production to determine the yield.

8. Study of types of enzyme inhibition:
   To study the inhibition of enzyme by any one type (Competitive/non-competitive/uncompetitive).

9. HPLC demonstration.

Reference Books:

1. Laboratory Microbiology 2nd Edition, L. Jack Bradshaw
2. An Introduction to Practical Biotechnology, 1st Edition 2006, S. Harishe
3. Experimental Biotechnology, Practical manual Series, SUNITa Dutta
4. Basic Biotechnology, 3rd Edition,Colin Ratledge, Cambridge university Press

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
PROJECT (415472)
Credit: 6

Teaching Scheme:
Tutorial: 6 hr/week

Exam Scheme:
Term Work: 100 Marks
Oral: 50 Marks

During the second term the students are required to:

1. Carry out detailed experimental work on previously defined (Phase I) research problem.

2. Write a *Project Report*, which should be broadly divided into the following sections –

a. Abstract

b. Introduction

c. Experimental Methodology

d. Results and Discussion

e. Conclusion

f. References

Students should submit a neatly typed and bound *Project Report* at the end of the term in the following format given by the department.

(Reference numbers should be mentioned in the main text as a superscript)

The *Project Report* should contain:

1. The cover page –must mention: Project title, Name of the student(s), Name of the guide, Exam seat number and Year.

2. Certificate from guide

3. Certificate from industry (if any)

4. Index

5. Detailed *Project Report* having sections 'a' to 'g' from above.

The student is required to prepare a month wise work plan (for both semesters) immediately after the allotment of the project and the department is required to maintain a progress report of every student/project. The progress report should reflect monthly progress done by the student as per

the work plan. The progress report is to be duly signed by the respective project guide by giving the remarks/marks/grades etc. on the periodic progress done by the student at the mid of the term and should be submitted along with project report at the end of respective terms to the examiners as a supporting document for evaluation.

Each student is required give presentation of his work for 10 minutes using 10-12 slides. The presentation will be followed by question answer session of 5 min. Every student will be examined orally for 50 marks based on the topic of his/her project and relevant area to evaluate his understanding of the problem. Term work assessment for 100 marks will be based on student's workup, performance and progress (depth and quality of work) during the term.

The department should prepare a template of the format of the project report and supply it to the students so as to maintain the uniformity in the project reports. 44

Students are encouraged to participate and present their project work in various events, competitions, conferences and seminars etc. in consultation with their guide.

Note: The project guides are required to educate the students about antiplagiarism policy of SPPU and apply the same while doing the project.

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE III - FOOD BIOTECHNOLOGY (415469)
Credit: 4

Teaching Scheme:	**Exam Scheme:**
Theory: 3 hr/week	**In Sem Exam: 30 Marks**
Practical: 2hr/week	**End Sem Exam: 70 Marks**
	Term Work: 50Marks

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

Course Objectives:

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

Course Outcomes:

1. Ability to apply principles of biotechnology to food industry with a clear understanding of role of micro-organisms, the mechanisms and effects of food spoilage and methods to prevent the same
2. Ability to select the best possible processing and/ or preservation technique based on the characteristics of food and the requirements along with an understanding of the intricacies associated therein
3. An ability to apply engineering principles to effectively design most commonly used processing equipments in food industry
4. A clear understanding of the process and the salient characteristics of systems involving micro-organisms and an ability to design new processes based on similar principles
5. An understanding of the role and important applications of enzymes in the food industry

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

Course Contents

UNIT 1 **[6 Hrs]**

Introduction to Food Biotechnology and Spoilage of Food

Biotechnology in relation to the food industry, Food Biotechnology- Scope and applications, classes of industrially important food, Characteristics of food - Nutritional value and sensory characteristics, spoilage of food –Mechanisms and types of spoilage, Intrinsic and extrinsic factors affecting spoilage: water activity, pH, temperature, redox potential etc., major spoilage micro organisms and their growth conditions, effect on food

UNIT 2 **[9 Hrs]**

Introduction to Food Processing

Preliminary processing methods – need and types, Raw material preparation: Cleaning, sorting, grading, peeling etc Principles and methods of food preservation – Low temperature techniques: Refrigeration, Freezing and freeze drying, High temperature techniques: Blanching, HTST pasteurization, canning, UHT treatment, dehydration, drying, extrusion cooking, Irradiation techniques: UV light, microwave processing, gamma rays, hydrostatic pressure cooking, use of additives, modified atmosphere packaging and storage

UNIT 3 **[7 Hrs]**

Design of Food Preservation Equipments

General engineering aspects and processing methods, types of equipments and their design: Refrigerator, freezer, dryer, thermal death kinetics of micro organisms, calculation of pasteurization time, time and temperature calculation for HTST sterilization

UNIT 4 **[8 Hrs]**

Microbial and Fermentation Biotechnology

Technologies used for microbial production of food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology of food flavor production, microbial production of oils and fats, food applications of algae, Process developments in solid state fermentation for food applications, solid state bio- processing for functional food ingredients, Fermentation biotechnology of traditional foods of the Indian subcontinent

UNIT 5 **[6 Hrs]**

Role of Enzymes in Food Processing

Classes of industrially important enzymes in food industry, Role of enzymes in bakery industry, cereal and beverage industry, meat processing, beer mashing and chill-proofing, production and application of pectinases, proteases etc.

UNIT 6 **[8 Hrs]**

Processes for the treatment of food processing waste

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

Practicals: (Any 8):

1. SPC count of bacteria in Foods (e.g. Chuteny, souce etc.)
2. SPC count of Fungi in Foods
3. MPN test of food for E.coli (e.g. Pedha)
4. MBRT test of Milk.
5. Study of fats and oils a) Iodine Value b) Peroxide Value
6. Qualitative analysis of : a) Glucose b) Fructose c) Starch d) Proteins
7. To study effect of pasteurization on Milk
8. Analysis of milk for total solid content.

Text Books:

1. Shetty, K., Paliyath, G., Pometto, A. and Levin, R. E., "Food Biotechnology", Taylor and Francis
2. Frazier, "Food Microbiology"
3. Fellows, P. , Ellis, H., "Food Processing Technology Principles and Practice", Wiley, New York

Reference books:

1. Johnson-Green, Perry, "Introduction to Food Biotechnology"
2. Roger, A., Gordan, B. and John, T., "Food Biotechnology", 1989
3. George, J. B., "Basic Food Microbiology", CBS Publishers Distributors, 1987
4. James, M .J., "Modern Food Microbiology", CBS Publishers & Distributors, 19875
5. Lindsay and Willis, "Biotechnology, Challenges for the flavor and food Industries", Elsevier Applied Science, 1988
6. Desrosier, "Technology of food preservation", CBS Publishers
7. Jay, "Modern Food Microbiology", CBS Publishers, 1987
8. Reed, G., "Prescott and Dunn's Microbiology", CBS Publishers, 1987

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE III - AGRICULTURAL BIOTECHNOLOGY (415469)
Credit: 4

Teaching Scheme:
Theory : 3 hr/week
Practical: 2 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks
Term work: 50 Marks

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

Course Objectives:-

1. To introduce students to scope of Biotechnology in agriculture.
2. To emphasize advantages of biofertilizers, biopesticides and organic agriculture.
3. To address ethical issues and regulatory aspects of biotechnology in agriculture.
4. To get experience of handling PMB & PTC techniques

Course Outcomes:-

1. Students will understand advanced technologies used for crop improvement.
2. Students will get expose to ethics and regulation in GMO
3. Students will get know how of basic techniques in agri biotech

UNIT 1 **[6 Hrs]**

Introduction to agriculture biotechnology.

Scope and future. Conventional methods of crop improvement, Types of plant breedings, Ploidy, hybrid varieties. Improvement of selected crops- important cereals, pulses, oil seeds, fibre, sugar and cash crops. Livestock, feed and fodder. Global scenario of GE crops, Green revolution. Agricultural Biotechnology Sector in India.

UNIT 2 **[6 Hrs]**

Plant Genetic Engineering Isolation of genes of economic importance.

Gene constructs for tissue-specific expression. Different methods of gene transfer to plants, viz.direct and vector-mediated. Ti, Ri plasmids. Molecular analysis of transformants. Protoplast transfer, electroporation, gene guns, Potential applications of plant genetic engineering for crop improvement, i.e. insect -pest resistance (insect, viral, fungal and bacterial disease resistance), abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality, Current status of transgenics, biosafty norms and controlled field trials and release of transgenics (GMOs).

UNIT 3 **[6 Hrs]**

Plant Tissue Culture

Basic techniques in cell culture and somatic cell genetics. Regulation of cell cycle and cell division.. Clonal propagation. Concept of cellular totipotency. Anther culture, somaclonal and gametoclonal variations. Hybrid embryo culture and embryo rescue, somatic hybridization and cybridization. Application of tissue culture in crop improvement. Secondary metabolite production. In vitro mutagenesis, cryopreservation and plant tissue culture repository.

UNIT 4 **[6 Hrs]**

Advanced technology for crop improvement.

DNA molecular markers: Principles, type and applications; restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), randomly amplified polymorphic DNA sequences (RAPD), Simple sequence repeats (SSR), Single nucleotide polymorphism (SNP), QTL, Molecular marker assisted selection. Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and applications, Metabolic engineering

UNIT 5 **[6 Hrs]**

Microbe based biofertilizers/ biopesticides, Cyanobacterial biofertilizers. Azolla and Anabena symbiotic association. Bacteria (Rhizobium) biofertilizers, Fungal (Mycorhiza) bio-fertilizers. Nitrogen fixation-asymbiotic and symbiotic, nodule formation. Genetics and biochemistry of nitrogen fixation. Nif genes. Transfer of nif genes. Soil microbes releasing plant growth substances. Organic agriculture

UNIT6 **[8 Hrs]**

Ethics and Biosafety

Ethical issues in biotechnology, Biosafety and Risk assessment of GMOs, Public perception. IPR and Trade related aspects, Methods for producing transgenic plants and animals, Important genes of agronomic interest, Current trends in finding useful genes, GMO Act 2004. Traceability, Legislative aspects.Introduction, Historical Backround, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals, Biosafety guidelines - Government of India, Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs, Risk Analysis, Risk Assessment, Risk management and communication, Overview of National Regulations and relevant International Agreements including Cartegana Protocol

Practicals (Any 8):

1. Isolation of plant DNA
2. RE digestion of Plant DNA
3. Leaf disc method
4. RAPD or RFLP: PCR
5. RAPD/RFLP: agarose gel and scoring bands
6. Study of seed storage proteins
7. PTC facility and set up
8. Preparation of media for PTC
9. Somatic embryogenesis
10. Induction of callus
11. Suspension culture
12. Development of somatic embryos
13. Germination of embryos
14. Visit to PTC facility
15. Biofertilizers

Text books

1. Keshavachandran.R and K V Peter. 2008 .Plant Biotechnology: Tissue culture and Genetransfer. Orient and Longman, (Universal Press) Chennai.
2. Gresshoff, Peter M. (Ed). Plant biotechnology and development. 1992.
3. Jones, MGK & Lindsey, K. "Plant Biotechnology" in Molecular biology and biotechnology, Walker, JM & Gingold, EB (Eds). 2000.
4. Kumar H D, Agricultural Biotechnology, India ,2005

Reference books:

1. Esau's Plant Anatomy, Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development, 3rd Edition, John Wiley & Sons, 2006.
2. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
3. M. J. Chrispeels and D.F. Sadava (eds), Plants, Genes and Crop Biotechnology, 2nd Edition, Jones and Barlett Press, 2003

4. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg. 2000
5. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
6. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
7. Encyclopedia of ethics, legal and policy issues in biotechnology. 2000
8. Rodney B. Harrington, Animal Breeding: An Introduction, October 1995
9. Newman, S, Rothschild, MF (2002). Intellectual Property Rights in Animal Breeding and Genetics. Wallingford, Oxon, UK CABI Pub. ISBN 0-85199-641-8.
10. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition (2001) Blackwell science.
11. S.S. Purohit: Agricultural Biotechnology (2003) Agribio in India. Y.P.S. Bajaj: Biotechnology in Agriculture and forestry, Vol. 22 Springer Verlas.
12. Biotechnology in Agriculture, Mac Millon India Ltd., 1992, Edn. M.S.Swaminath.

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE III – GENOMICS (415469)
Credit:4

Teaching Scheme:
Theory : 3 hr/week
Practical: 2 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks
Term work: 50 Marks

Prerequisites: Students should have the basic knowledge of Genetics and molecular Biology

Course Objectives:

1. To familiarize students with the study of whole genomes or the products of these genomes.
2. To provide the methodology and applicability to this rapidly evolving field of research.
3. To introduce students to genome databases; modern sequencing methods, global gene expression analysis methods such as microarray, and epigenetics methods
4. How these techniques are used to understand disease, drug response or nutrition.

Course Outcomes:

1. Graduates are made aware of differences in genome size, human genome project and its outcome.
2. Familiarization with genomic methods such as sequencing, NGS and strategies and their importance
3. Elementary knowledge of gene expression, epigenetic changes, methods to measure epigenetic changes and their role in diseases
4. Graduates are given introduction to personalized medicine and application of pharmacogenomics, nutrigenomics and metagenomics in health and disease.
5. Students are given practical training in basic methods of handling genome.

Course Contents

UNIT 1 **[6 Hrs]**

Introduction to genomics

Genome organization, C value paradox, repetitive DNA, gene families, structural genomics, human genome project, HAPMAP, 1000 Genome project, ENCODE

UNIT 2 **[6 Hrs]**

Genome analysis

Sequencing strategies for whole genome analysis, Shotgun method, Sequencing methods, capillary electrophoresis, Next Gen sequencing methods, Comparative genomics, genome annotation, YAC, BAC libraries

UNIT 3 **[6 Hrs]**

Functional genomics

Global analysis of gene expression, Transcriptomics and microarray, Microarray-Types, Analysis, Applications, RNA interference, siRNA, miRNA

UNIT 4 **[8 Hrs]**

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

UNIT 5 **[5 Hrs]**

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

UNIT 6 **[5 Hrs]**

Omics 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

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

3. 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. Creighton TE, Proteins, Freeman WH, Second Ed, 1993.
3. Denis Noble (2006). The Music of Life: Biology beyond the genome. Oxford University Press. ISBN 978-0199295739. p21
4. Hiroaki Kitano, ed (2001). Foundations of Systems Biology. MIT Press. ISBN 0-262-11266-3.
5. Proteomics Today: Protein Assessment and Biomarkers Using Mass Spectrometry, 2D Electrophoresis,and Microarray Technology (Wiley - Interscience Series on Mass Spectrometry)

References:

1. Allen Roses, Pharmacogenetics and the practice of medicine. NATURE, VOL 405, 15 JUNE 2000, 857-865. www.nature.com
2. 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
3. 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. Lucock M. Is folic acid the ultimate functional food component for disease prevention?. BMJ. 2004; 328:211-14. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC318492/
4. Corella D, Ordovás JM. Interactions between dietary *n-3* fatty acids and genetic variants and risk of disease. Br J Nutr. 2012; 107 Suppl 2:S271-83.
5. Kaput J, Noble J, Hatipoglu B, Kohrs K, Dawson K, Bartholomew A. Application of nutrigenomic concepts to Type 2 diabetes mellitus. Nutr Metab Cardiovasc Dis. 2007; 17:89-103. http://www.nmcd-journal.com/article/S0939-4753(06)00255-9/fulltext
6. Reszka E, Wasowicz W, Gromadzinska J. Genetic polymorphism of xenobiotic metabolising enzymes, diet and cancer susceptibility. Br J Nutr. 2006; 96:609-19. http://journals.cambridge.org/download.php?file=%2FBJN%2FBJN96_04%2FS0007114506002704a.pdf&code=1a1a7b8dd35bc3d814e1b68b258da7cd
7. Ross SA Evidence for the relationship between diet and cancer. Exp Oncol. 2010; 32:137-42. http://exp-oncology.com.ua/wp-content/uploads/magazine/857.pdf?upload=

8. McKay JA, Mathers JC. Diet induced epigenetic changes and their implications for health. Acta Physiol. 2011; 202:103-118. http://www.grochbiology.org/flyepigeneticsdiet.pdf

9. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3550857/

10. John C. Wooley, Adam Godzik, Iddo Friedberg , A Primer on Metagenomics. Published: February 26, 2010, PLOS ONE, https://doi.org/10.1371/journal.pcbi.1000667

Guidelines for Instructor's Manual

1. Students to be familiarized with Biosafety and Bioethics

2. All the instruments to be validated before use

3. All the experiments should be standardized

4. Students should be instructed for handling of hazardous chemicals like Ethidium Bromide and UV

Guidelines for Student's Lab Journal

Please read these instructions now and refer to them regularly! These instructions must be followed carefully

1. Use a bound notebook.

2. Lab notebooks should be done in pen and no erasing or white-out is allowed

3. Title and underline each lab experiment at the top of the page and date it.

4. Briefly explain the lab exercise objectives in a few sentences.

5. Record observations, diagrams and results from the exercise.

7. Student should take signature of the instructor Lab notebook

Note: The purpose of the lab notebook is to encourage students to compile and organize their laboratory notes and to understand the purpose of the laboratory exercises and the meaning of their results

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.

Practicals: (Any 8)

Group A

1. Isolation of DNA from blood or plant source or animal tissue
2. Purity and concentration check
3. Agarose gel electrophoresis
4. Study of hyperchromicity

Group B

5. Designing primers
6. Genotyping/ SNP mapping
7. DNA polymorphism/ PCR-RFLP
8. Allele and Genotype Frequency

Group C

9. RNA isolation
10. RNA gel electrophoresis
11. Demonstration of sequencing/ Real Time PCR

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE IV – MANAGEMENT AND ENTERPRENEURSHIP (415470)
Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem: 70 Marks

Prerequisites: Knowledge of subjects like management, communication.

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:

1. An ability to understand managerial role and levels in order to work successfully in a group of people.
2. An ability get acquaint with the concept of organization and different structures of organization.
3. An ability to work as a leader in a group by acquiring leadership qualities and good co-ordination
4. An ability to gain required knowledge about entrepreneurship and its direct relation with India's changing economy.
5. An ability to think of developing new small scale industries by using ideas in their mind.
6. An ability to improve skills like project planning, implementation and project report writing.

Course Contents

UNIT 1 **[7 Hrs]**

Management

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

UNIT **[7 Hrs]**

Organizing and Staffing

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)

UNIT 3 **[7 Hrs]**

Directing & Controlling

Meaning and nature of directing – Leadership styles and motivation theories, communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination

UNIT 4 **[7 Hrs]**

Entrepreneur

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

UNIT 5 **[6 Hrs]**

Small Scale Industry

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)

UNIT 6 **[6 Hrs]**

Preparation of Project

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

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

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE IV – ETHICS, IPR AND REGULATIONS (415470)
Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme:
In Sem : 30 Marks
End Sem : 70 Marks

Prerequisite: Basic understanding of different streams in Biotechnology where ethics and intellectual property play a role

Course Objectives:

Our study in the Ethics and IPR and regulations is designed to help students accomplish the following objectives:

1. Recognize legal and ethical issues when making business decisions.
2. Gain an enhanced understanding of legal rules and ethical constraints in filing a Patent.
3. Improve analytical problem solving and ethical decision making skills along with getting to know the basics of Bioethics.
4. Apply knowledge and skills to address and manage potential problems before they become actual, expensive problems by understanding the various leagal issues involved in the Trademark and copyright issues.
5. Understand the various requirements for starting of a setup of Biotechnology industry
6. Will get awareness about the various QA QC requirements for biotechnology based products.

Course outcomes:

Our study in the Ethics and IPR and regulations is designed to help students accomplish the following outcomes:

1. They will be aware of the Intellectual property and the various ethical issues when making business decisions.
2. Will know the process of filing a patent and will be aware of patenting .
3. Know the various issues involved in the bioethics.
4. Will know the different types of Trademark and other such important business terms for the protection of intellectual property.
5. Understand the various requirements for starting of a setup of Biotechnology industry
6. Will get awareness about the various QA QC requirements for biotechnology based products.

Course Contents

UNIT 1 **[6 Hrs]**

Ethics, definition, composition of ethics committee, Ethics at workplace, various scenarios, defining the moral standards of right and wrong, Morals and laws, Variety of moral issues – Types of inquiry, Moral dilemmas, Moral Autonomy – Kohlberg's theory, discuss moral righteous and wrongness of an action. Safety and Risk – Assessment of Safety and Risk - Chernobyl and Bhopal Case Studies, Importance of ethics in business, Legal vs ethical, ethics and profits, business Ethics, CSR and ethics.

UNIT 2 **[6 Hrs]**

Bioethics, Case studies: ethics in life sciences, in medicine, in biotechnology, recombinant DNA, in food biotechnology, in agricultural biotechnology, in environment concerns, in use of animals for research and production.

UNIT 3 **[6 Hrs]**

Patent, objects of patent law, benefits of patenting, remedies against infringement, requirements of patentability, rights of patentee, patent application procedure, patenting in biotechnology, patent search, patents from an international perspective, study of patents, -

UNIT 4 **[6 Hrs]**

Plant genetic resources Agreement – GATT (General Agreement on Tariffs and Trade) and TRIPS (Agreement on Trade-Related Aspects of Intellectual Property Rights) Cooperation and implications - Patents of Higher plants, Transgenic organisms, Isolated genes and DNA sequences, Plant variety protection and UPOV - Terminator and Traitor technologies for seed protection, uses and implications.

UNIT 5 **[6 Hrs]**

Domain name and trademark, purpose of trademark, requirements for registration for a trademark, copyright, assignment and transfer of copyright, copyright infringement, registration and piracy.

UNIT 6 **[6 Hrs]**

Quality Assurance, Quality control requirement for Biotech product, Toxicity, clinical trials, studies, clinical research & clinical data management, Export, Import of product, Rules & Regulations for start up companies, Regulatory requirements for Biotech. product development, Hierarchal structure in Indian biotechnology, Current GMP, Role of DCGI, National& International guidelines

Text Books:

1. Erbisch, F. H. and Maredia, K. M., "Intellectual property rights in agricultural biotechnology"

2. Jonathan Morris, "The ethics of biotechnology"

Reference Books:

1. K. C. Shippey, "A short course in international intellectual property rights"

Savitribai Phule Pune University, Pune
Final Year of B.Tech. Biotechnology (2015 Course)
ELECTIVE IV – INDUSTRIAL ORGANIZATION AND MANAGEMENT (415470)

Credit: 3

Teaching Scheme:
Theory : 3 hr/week

Exam Scheme:
In Sem: 30 Marks
End Sem: 70 Marks

Prerequisites: Knowledge of subjects like management, communication.

Objective:

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

Outcomes:

Student shall be able to:

1. Demonstrate the concepts of Management and organisational structure
2. Understand the economic and operations management concepts useful in the production process.
3. Apply the project management tools in effective development and implementation of the business activities.
4. Develop the entrepreneurial spirit and plan to start their own enterprise.

Contents

UNIT 1 **[6 Hrs]**

Management Science

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

UNIT 2 **[6 Hrs]**

Personnel Management

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

UNIT 3 **[6 Hrs]**

Purchase and stores management

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

UNIT 4 **[7 Hrs]**

Marketing management

Concepts of selling, marketing, definition of marketing, market research and of pricing, penetration, pricing, skimming pricing, distribution of product, advertising and promotion

UNIT 5 **[7 Hrs]**

Export and import management

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

UNIT 6 **[7 Hrs]**

Management Laws

Concepts of contract act, offer, and acceptance, types of contracts, Void contract, concept of guarantee and warranty, Introduction of MRTP and FERA

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,Third Edn.,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,Fifteenth Edn., 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, Dhanpat Rai Publishers.