Department of
BIOTECHNOLOGY

4 Years B.Tech Degree Programme

REGULATION & SYLLABUS 2017

Choice Based Credit System
Outcome Based Assessment

SEMESTER-V & VI

AUTONOMOUS
Accredited by NBA
Accredited by NAAC with 'A' Grade (3.28 out of 4.00 CGPA)

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
Affiliated to UGC New Delhi &Biju Patnaik University of Technology, Odisha
GUNUPUR – 765022, Odisha, India

COURSE STRUCTURE

V SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	QP
THEORY							
1	**BBTPC5010**	Immunology &Immunotechnology	3	-	-	3	
2	**BBTPC5020**	Upstream Process Engineering	3	-	-	3	
3	**BBTPC5030**	Genetic Engineering and r-DNA Technology	3	1	-	4	
4	**BBTPE4041**	Bio kinetics and Thermodynamics	3	-	-	3	
	BBTPE4042	Fermentation Technology					
	BBTPE4043	Industrial Microbiology and Enzyme Technology					
5	**OE1**	---------	3	-	-	3	
6	**BBSHS5061**	Optimization in Engineering	3	-	-	3	
	BMGHS5062	Organizational Behavior					
PRACTICAL / SESSIONAL							
7	**BBTPC5110**	Immunology &Immunotechnology Lab	-	-	2	1	
8	**BBTPC5120**	Upstream Process Engineering Lab	-	-	2	1	
9	**BBTPC5130**	Genetic Engineering and r-DNA Technology Lab	-	-	2	1	
10	**BTPPC5140**	*Skill development project & hands on training	-	-	2	1	
11	**BTPPC5150**	**Summer Internship	-	-	-	1	
Total						**24**	

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC5010	**Immunology &Immuno technology**	**3**	**-**	**-**	**3**	**-**

Pre -Requisite:

Course Educational Objective

CEO1: To study about the process of immunity and organs and cells of lymphoid system.

CEO2: To study about complement system, major histocompatibility Hybridoma technology and various immune responses.

Course Outcome

CO1	Student will obtain knowledge in immunology, the structure and function of lymphoid organs and cells.
CO2	Students will obtain knowledge in Majorhistocompatibility,antibody diversity and complement response in the blood.
CO3	Student will understand immune response, hypersensitive reactions, and organ transplantations and also obtain knowledge in various auto immune diseases.
CO4	Student will obtain knowledge in the development of vaccines and immunological techniques.

UNIT:1 (11 Hours)

Basic concepts of immunology: Immunity, types of immunity, humoral and cell mediated immunity, Cells of immune system and Haematopoiesis, Lymphoid organs, Primary and secondary lymphoid organs, antigen-properties of antigen,antigenity,immunogencity, immunoglobulin and antibodies.

UNIT:2 (13 Hours)

Major Histocompatibility Complex (MHC), Antigen processing and presentation, synthesis and secretion of antibody, Molecular basis of antibody diversity, polyclonal, monoclonal antibody and Hybridoma Technology, complement system, antigen-antibody reaction.

UNIT:3 (11 Hours)

Immune response and tolerance: Regulation of immune response, immune tolerance, Hypersensitivity, autoimmunity,Transplantation immunology,Immuno- deficiency and immuno- proliferate diseases. Dysfunctions of immune system and their modulation, Approaches for correcting immune dysfunction, Vaccinology.

UNIT:4 (10 Hours)

Immunobiotechnology: Vaccines, viral, bacterial peptides, genetically engineered production of lymphokines, second generation generation antibodies. Immunological techniques: immunodiffusion, immunoprecipitation, agglutination and ELISA

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1 Immunology: Lydyard, P.M., Whelan, A., Fanger, M.W., 1st Ed., Viva Books.

2. Essential Immunology: Roitt, I.M., 9th Ed.(1997) Blackwell Scientific, Oxford, UK.

Ref. Books 1 Immunology: Kuby, J. 3rd Ed. (1997) Freeman W. H., oxford.

4. Immunotechnology by A Khan, Pearson Publication

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC5020	**Upstream Process Engineering**	**3**	**-**	**-**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide the knowledge on fluid mechanics and their properties

CEO2: To understand the basic law of heat transfer

Course Outcome

CO1	Describe the operation, as well as constriction and exploitation characteristics of machines for mechanical operations.
CO2	Solve simple radiation heat transfer problems
CO3	Make use of empirical equations to solve forced and natural convection heat-transfer problems
CO4	Design the distillation column

UNIT:1 (10 Hours)

Processing of particulates Properties and handling of particulate solids, size reduction equipments-working principles of crusher, grinder and pulveriser, screening and particle size distribution.

UNIT:2 (10 Horus)

Methods of analysis and description - fluid as a continuum, Classification of fluid. Fluid statics – basic equation - equilibrium of fluid element – Hydrostatic Pressure, Pressure measuring Devices. Flow in boundary layers. Its formation & growth in tubes & plates. Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices; Venturi, Orifice, Pitot tube &Rotameter.

UNIT:3 (10 Hours)

heat transfer, basic laws of heat transfer, Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, critical insulation of thickness. Introduction to convection: Natural and forced convection, Natural Convection: Grashoff number, natural convection from vertical and horizontal surfaces. Forced convection, The convective heat transfer coefficient, Types of heat exchangers, log-mean temperature difference, energy balances, overall heat transfer coefficients

UNIT:4 (12 Hours)

Introduction to Mass transfer operations, moleculardiffusion in fluids, binary solutions, Fick's law, equation of continuity, steady state equimolal counter current diffusion, Stefan-Maxwell equation, diffusivity of gases and liquids,application of molecular diffusion, mass transfer coefficients, in laminar and turbulent flow, Interphase mass transfer, Film theory, Penetration theory, surface-renewal theories, analogy between mass, heat and momentum transfer. relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation steam distillation, azeotropic and extractive distillation. Continuous distillation

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1:.McCabe, Smith and Harriot, Unit Operations of Chemical Engineering

2.Foust et al, Principles of Unit Operations.

Ref. Books 1: Badger and Banchero. Introduction to Chemical Engineering.

2:Foust, Wenzel, Clump, Maus and Andersen, Principles of Unit Operations.

Title of the subject

Subject Code		L	T	P	C	QP
BBTPC5030	**Genetic Engineering and r-DNA Technology**	**3**	**1**	**-**	**4**	-

Pre -Requisite:

Course Educational Objective

CEO1: To introduce the basic of Genetic Engineering and its application

CEO2: To understand the functions gene transfer to organisms

Course Outcome

CO1	Students will obtain knowledge in digestion of DNA, vector system for cloning and expression.
CO2	Students will understand the cloning strategies and expression of recombinant molecules
CO3	The students would be aware of gene, genome sequencing and DNA finger printing techniques.
CO4	Students will acquire knowledge in molecular markers, genome mapping and apply genetic engineering principles for biotechnological and biomedical applications.

UNIT:1 (15 Hours)

Basic principle of DNA isolation and purification; Restriction endonuclease, Ligase and other modifying enzymes; DNA& RNA Markers, Linker, Adapter and MCS; Gene cloning vectors-Plasmid, bacteriophage, cosmid, BAC, YAC; Expression vectors: basic concept, bacteria and yeast based expression vector.

UNIT:2 (13 Hours)

Basic concept of gene cloning;Gene library- genomic and c-DNA, contig library; Polymerase Chainreaction, Cloning of interacting gene: two hybrid and three hybrid assay;
Cloning of differentially expressed gene; DNA micro arrays and Chips - principle and Manufacturing process.

UNIT:3 (12 Hours)

DNA finger printing and DNA foot printing; DNA Sequencing; Site-directed mutagenesis; Expression of heterologous gene; In vitro transcription and translation; Gene knock out strategies; RNA interference: Antisense RNA, si RNA and mi RNA; RibozymeTechnology.

UNIT:4 (15 Hours)

Molecular markers- Types (RFLP, RAPD, AFLP, SCAR, SSR, SNP, EST), Principle and methodology; Application of molecular markers: in diagnostics, gene tagging, gene mapping, Physical mapping of the genome. Genome analysis using 16S rRNA typing/ sequencing, Genome.projects: Human, Rice; Gene therapy and its applications; DNA vaccines and rDNAproducts;Genetic engineering regulations and safety guidelines.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Principles of Mol. Biology - OS Prim Rose
2 Genetic Engineering by B D Singh, Rastogi Publication

Ref. Books Molecular Biology. By Turner.
2.Molecular "Biology of Gene" – Watson

Subject Code		L	T	P	C	QP
BBTPE4041	**Bio kinetics and Thermodynamics**	**3**	**-**	**-**	**3**	-

Pre -Requisite:

Course Educational Objective	
CEO1: To introduce the basic of Biokinetics and its application	
CEO2: To understand the functions gene transfer to energy	
Course Outcome	
CO1	Students will understand the theoretical concepts of thermodynamics and how it applies to energy conversion and applications in biological systems.
CO2	Students will learn about biothermodynamics of energy used by plants and animals and thermodynamics of proteins.
CO3	Students will understand the concept of Gibbs free energy and energy transfer in various metabolism processes.
CO4	Students will have the idea on free energy in chemical reaction and its effect on enzyme kinetics and metabolism.

UNIT:1 (10 Hours)

Basic concepts of thermodynamics: First Law of Thermodynamics, Second law of thermodynamics, Zeroth Law and Third Law of thermodynamics, Laws of thermodynamics and biology, Thermodynamics of macromolecular processes in cells, Thermodynamics of energy interactions in ecosystems, Conservation of energy.

UNIT:2 (12 hours)

Distribution of energy; Carbon, energy and life – Molecular level energy storage, Biothermodynamics of energy use by plant and animals, Methods for measuring the thermodynamic stability of membrane proteins, Protein folding, Modeling the native state ensemble of proteins using statistical thermodynamics, Energetic profiles of proteins derived from thermodynamics of the native state ensemble.

UNIT:3 (10 Hours)

Theory and derivation of Gibbs free energy, Free energy of reactions, Lipid membrane phase transitions, Thermodynamics of cellular metabolism, Sugar metabolism, Energy transport in ATP and NAD, Substrate recycling, Donnan Equilibrium, Enzyme-substrate interaction, Free energy of transfer of amino acids, Differences between heat engines and biological energy processes, Temperature regulation in organisms, Humidity and temperature effects on organisms, Non-equilibrium thermodynamics and life.

UNIT:4 (10 Hours)

Free energy analysis of chemical reactions, Chemical coupling to drive reactions in biological systems, First order and second order reactions, Collision theory, Transition state theory, Free energy of activation, Temperature and concentration effects on enzyme kinetics, Reaction mechanism of lysozyme, Kinetic identification of reaction intermediates, Sequential enzyme reactions in metabolism and analysis.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books: 1. D. J. Haynie, Biological thermodynamics, Cambridge, 2008.
2. Johnson, M.L., Holt, J.M. and Ackers, G.K., "Bio thermodynamics", Part 1, Academic Press, 2009
3. Timasheff, S.N., "Protein Hydration, Thermodynamic Binding, and Preferential Hydration, Biochemistry", 13473-13482, 2002.

Ref. Books 1. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd.
2. Biochemical Engineering Fundamentals, Bailey &Olis. MGH.

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE4042	**Fermentation Technology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide knowledge on different of fermentation process

CEO2:To have theory and practicle knowledge on purification of products

Course Outcome

CO1	Under graduate will get idea on different fermentation technologies
CO2	They understand the importance on enzyme in fermentation process
CO3	Importance of microorganism in fermentation processes.
CO4	T o get knowledge of downstream processing

UNIT:1 (8 Hours)

Range of Fermentation processes, Microbial growth kinetics, Microbial biomass, Microbial enzymes, Microbial metabolites, Recombinant products, Batch culture, continuous culture, Microbial culture selection for fermentation processes. Media formulation and process optimization.

UNIT:2 (10 Hours)

Industrial production of proteases, cellulases, amylase, lipase; Process parameters that influence enzyme production during submerged and solid state fermentation, production of biofuel.

UNIT:3 (10 Hours)

Isolation, preservation and improvement of industrial micro organism, development of media for industrial fermentation. Development of inoculums for yeast and bacterial processes.

UNIT:4 (10 Hours)

Removal of microbial cells, Precipitation, filtration, centrifugation. Cell disruption, extraction and chromatography, Drying and crystallization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Principles of Fermentation Technology by P.F. Stanbury, A. Whitaker, and S.J Hall, Pergamon
2 Basic Fermentation Technology by S.M.Reddy, New Age International Pvt.ltd.s

Ref. Books 1Bioprocess Engineering by Bjorn K. Lydersen, et. al ,Wiley India Edition
2 2 Bioprocess Engineering by M.L. Shuler and F.Kargei Person

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE4043	**Industrial Microbiology and Enzyme Technology**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1:To study about fermentation process and to study the culturing of micro organisms and maintenance of cultures.

CEO2:To study about the preparation of alcohol using yeast cells and sugars by fermentation process.

Course Outcome

CO1	Students will obtain knowledge in microbial growth, kinetic and fermentation technology.
CO2	Students will obtain knowledge in the production of commercially important products by using fermentation technology.
CO3	Students will learn the formulation and selection of media, strain development and improvement.
CO4	Students will obtain knowledge in the methods of enzyme stabilization and its applications

UNIT:1 (12 Hours)

Microbial Processes and fermentation technology: Introduction to fermentation technology, Microbial growth and product formation kinetics in batch, continuous and feed batch fermentation, Large scale production: submerged, solid and semi-solid fermentation,

UNIT:2 (15 Hours)

A brief outline of microbial processes for the production of some commercially important Organic acids (e.g. citric acid); Amino acid (Glutamic acid); and Alcohol (ethanol, 2, 3-butanediol). Antibiotics (beta-lactams, penicillin's, and cephalosporin's),enzymes(Proteases, Lipases),polysaccharides(cellulose, starch**)**; lipids (Triglycerides,Steroids); recombinant protein (Insulin), production of vaccines (Hepatitis-B).

UNIT:3 (12 Hours)

Commercial media and strain development: Media selection and development for industrial production, Isolation, selection, characterization of microorganisms, stock culture, development of inoculum, strain improvement: induced mutation, over producing decontrolled mutants, genetically engineered strain and fermentation.

UNIT:4 (14 Hours)

Stability of enzyme: Enzyme stabilization by selection and genetic engineering, protein engineering. Application of enzymes in industry, analytical purpose and medical therapy. Application of Biocatalyst, Group transfer redox, Elimination, isomarization and rearrengement, C-C bond cleavage, Reaction environment rebuilding, chemical modification, intramolecular cross linking and immobilization.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Principle of Fermentation Technology , P.F. Stanbury, A. Whitaker and S.J. Hall, Elsevier

1. Industrial Microbilogy, Prescot and Dunn,

Ref. Books 1. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd.

3. Biochemical Engineering Fundamentals, Bailey &Olis. MGH.

Title of the subject						
Subject Code		L	T	P	C	QP
BBSHS5061	**Optimization in Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide basics of optimization in engineering.

CEO2: To introduce linear and non linear programming

Course Outcome

CO1	To make use of the concepts of operations research modelling approaches
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as Transportation and Assignment problems.
CO4	Determine average queue length and waiting times of queuing models.
CO5	

UNIT:1 (10 Hours)

Introduction: Historical overview of operations research, fundamentals of OR Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 (14 Hours)

Transportation and Assignment Problems: Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models, branch-and-bound technique, cutting-plane method..

UNIT:3 (14 Hours)

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 (14 Hours)

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010.
2.Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books

3. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and Company Ltd
4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.
5. Kalyanmoy Deb, “Optimization for Engineering Design”, PHI Learning Pvt Ltd

Title of the subject						
Subject Code		L	T	P	C	QP
BBSHS5061	**Optimization in Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide basics of optimization in engineering.

CEO2: To introduce linear and non linear programming

Course Outcome

CO1	To make use of the concepts of operations research modelling approaches
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as Transportation and Assignment problems.
CO4	Determine average queue length and waiting times of queuing models.

UNIT:1 (10 Hours)

Introduction: Historical overview of operations research, fundamentals of OR Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 (14 Hours)

Transportation and Assignment Problems: Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models, branch-and-bound technique, cutting-plane method..

UNIT:3 (14 Hours)

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 (14 Hours)

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010.
2.Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books

3. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and Company Ltd
4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.
5. Kalyanmoy Deb, “Optimization for Engineering Design”, PHI Learning Pvt Ltd

Title of the subject						
Subject Code		L	T	P	C	QP
BMGHS5062	**Organizational Behavior**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To provide knowledge in organizational behavior.

CEO2:To provide knowledge on leadership quality and managerial skill.

Course Outcome

CO1	Student should understand the importance of organization and its sustenance.
CO2	Have knowledge on theories of motivation and perception.
CO3	Should know the culture of organization.
CO4	Understand the importance of organizational change.
CO5	

UNIT:1 (12 Hours)

The study of Organizational Behaviour : Defination and Meaning, Why Study OB
Learning – Nature of Learning, How Learning occurs, Learning and OB. Foundations of Individual Behaviour : Personality – Meaning and Defination, Determinants of Personality, Personality Traits, Personality and OB. Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Herzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations

UNIT:2 (15 Hours)

Organizational Behaviour Process : Communication – Importance, Types, Gateways and Barriers to Communication, Communication as a tool for improving Interpersonal Effectiveness, Groups in Organizations – Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision-making Managerial Implications, Effective Team Building. Leadership-Leadership & Management, Theories of Leadership-Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Followership, How to be an effective Leader, Confict-Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA).

UNIT:3 (10 Hours)

Organization: Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management-Selection, Orientation, Training and Development, Performance Appraisal, Incentives

UNIT:4 10 Hours)

Organizational Change – Importance of Change, Planned Change and OB techniques. International OrganisationalBehaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, K. Awathappa,HPH.

Ref. Books 1. ntroduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
2. Organizational Behaviour, Hitt, Miller, Colella, Wiley
3. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson

Subject Code	Course Title	L	T	P	C	QP
BBTPC5110	**Immunology & Immunotechnology Lab**	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid
Course Educational Objective
In this laboratory, students will have the opportunity to learn the various techniques of Immunology
Various kinds of immunoprotein present in blood and their interactions with relate to disease analysis.

Course outcomes: At the end of the course, the student will be able to:	
CO1	Students will study the morphology and structure of nucleus of various blood cells.
CO2	Antigen and antibody reaction study by diffusion techniques
CO3	Blotting of blood proteins
CO4	Student will understand the technique and mechanism of identification of blood group.

LIST OF EXPERIMENT

1. Preparation of blood film and identification of different leucocytes
2. Ouchterlony double diffusion technology
3. Radial immunodiffusion technology
4. Rocket immuno-electrophoresis
5. Immunoelectrophoresis
6. Dot ELISA and Sandwich ELISA
7. Immunoblotting
8. Purification of immunoglobulin from blood serum by column chromatography
9. Determination of blood group by agglutination
10. Localization of specific antigen by immunocytochemistry

Subject Code	Course Title	L	T	P	C	QP

BBTPC5120	**Upstream Process Engineering Lab**	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid
Course Educational Objective
In this laboratory, students will have the opportunity to know the techniques of upstream processing.
The machines and equipment used to determine experimental data include closed conduit using Venturimeter, Orifice meter, Rotameter.

Course outcomes: At the end of the course, the student will be able to:	
CO1	The student will understand the flow regime and construction of friction factor.
CO2	The student will know the Pressure drop for flow by various theories.
CO3	Determine the various heat and mass transfer coefficient.
CO4	The under graduate will understand the operation of various reactors.

LIST OF EXPERIMENT (Minimum 8 experiments)

1. Experiments on Reynold's Apparatus-Determination of flow regime and construction of friction factor against NRe.
2. Experiments on flow measuring devices - in closed conduit using (a) Venturimeter, (b) Orifice meter (c) Rotameter.
3. Study and verification of conservation of energy of a flowing liquid in a Bernoulli's apparatus.
4. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny-Karman equation, Blake-Plummer Equation.
5. To Determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside diameter of the tube.
6. To calculate the heat loss in a lagged pipe made of various insulating materials.
7. Determination of volumetric mass transfer coefficient (Kla) of gas-liquid system.
8. Determination of mixing time in stirred tank reactor.
9. To determine the coefficient of absorption/adsorption in packed bed columns.
10. To separate the solute from one phase to another (aqueous to solvent) phase by liquid-liquid extraction.
11. Double Pipe Heat Exchanger.
12. Shell and Tube Heat Exchanger.

Subject Code	**Course Title**	L	T	P	C	QP

BBTPC5130	Genetic Engineering and r-DNA Technology Lab	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid
Course Educational Objective
In this laboratory, students will have the opportunity to study the techniques of gene cloning
Understand the basic principle and techniques of PCR and hybridization of DNA and Protein

Course outcomes: At the end of the course, the student will be able to:	
CO1	The student will know the isolation of plasmid DNA and its importance in gene cloning.
CO2	The undergraduate will do the various ligation methods and transformation techniques.
CO3	Students will learn the screening techniques of recombinant cells.
CO4	Students will know the basic principle of PCR and hybridization techniques.

LIST OF EXPERIMENT

1. Isolation and Restriction enzyme digestion of bacterial genomic DNA
2. Isolation and Purification of plasmid DNA
3. Purification of digested DNA-column purification
4. Preparation of target DNA by linker/adapters/alkaline phosphatase treatment for cloning
5. Ligation of DNA fragment with cloning vector
6. Preparation of competent cells
7. Transformation in *E.coli* with recombinant vector
8. Isolation of recombinants and confirmation of insert DNA in vector
9. Preparation of DNA probe by nick translation /PCR
10. Amplification of DNA sample by PCR
11. Southern Hybridisation
12. Western Hybridisation
13. DNA profiling by RAPD

COURSE STRUCTURE

VI SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	QP
THEORY							
1	**BBTPC6010**	Bioinformatics	3	-	-	3	
2	**BBTPC6020**	Plant Biotechnology	3	1	-	4	
3	**BBTPC6030**	Downstream processing	3	-	-	3	
4	**BBTPE6041**	Environment Biotechnology	3	-	-	3	
	BBTPE6042	Bioprocess Engineering					
	BBTPE6043	Proteomics and Genomics					
	OE2	----	3	-	-	3	
6	**BBSHS5061**	Optimization in Engineering	3	-	-	3	
	BMGHS5062	Organizational Behavior					
PRACTICAL / SESSIONAL							
7	**BBTPC6110**	Bioinformatics Lab	-	-	2	1	
8	**BBTPC6120**	Plant Biotechnology Lab	-	-	2	1	
9	**BBTPC6130**	Advanced Lab – I	-	-	2	2	
10	**BBTPC6140**	Soft skills & Employability skills	-	-	2	1	
Total						**24**	

Title of the subject						
Subject Code		L	T	P	C	QP
BBTOE6052	**Bioinformatics**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: Objectives of this course essentially focuses on the development of skills of students for a successful career in industry or research. The course emphasizes enough effort on theory.

CEO2: The course emphasizes on the delivery of the state of the art technologies in Genomics, Proteomics and Drug discovery.

Course Outcome

CO1	Students will understand the types of biological databases available in open source domain and their uses.
CO2	Students will acquire knowledge in pairwise, multiple sequence alignments and phylogenetic analysis
CO3	Students will able to analyse secondary and tertiary structure of proteins using bioinformatics tools.
CO4	Students will understand the principles of protein modeling ,drug designing and its applications.

UNIT:1 (15 Hours)

Sequence data banks- Introduction to sequence data banks- protein sequence data bank. NBFR-PIR, SWISSPORT, Signal peptide data bank, Nucleic acid sequence data bank –Gen bank, EMBL nucleotide sequence data bank, AIDS Virus sequence data bank. RRNA data bank, structural data banks- protein Data bank (PDB), The Cambridge Structural Database (CSD) : Genome data bank – Metabolic pathway data : Microbial and Cellular Data Banks.

UNIT:2 (12 Hours)

systems of microbes, Hybridoma data Bank Structure, Virus Information System, Cell line Information system; other important Data Banks in the area of Biotechnology/life sciences/biodiversity.

Sequence Analysis : Analysis Tools for Sequence Data Banks: Pair wise alignment-NEEDLEMAN AND Wunsch algorithm, Smith Waterman, BLAST, FASTA algorithms to analyze sequence data: Sequence patterns motifs and profiles

UNIT:3 (13 Hours)

Secondary Structure Predictions prediction algorithms, Chao-Fasman algorithm, Hidden-Markov model, Neural Networking.

Tertiary Structure predictions: prediction algorithms, Chao-Fasman algorithm, Hidden-Markov model, Neural Networking.

UNIT:4 (10 Hours)

Protein classifications, Fold libraries, Protein structure prediction; Fold recognition (threading), Protein structure predictions: Comparative Modeling (Homology, Advanced topics: Protein folding, Protein-ligand interactions, Molecular Modeling & Dynamics, Drug Designing.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Bryan Bergeron, Bioinformatics computing, Prentice Hall Inc.

2. Baxevanis AS and Ouellette BF, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley International Science.

Ref. Books
1. Tao Jiang, Ying Xu, Michael Q. Zhang, Current Topics in Computational Molecular Biology, MIT press.
2. Thomas lengauer,Bioinformatics from genome to drug .WILLEY-VCH press.
3. Mount DW, Bioinformatics: Sequence and Genome Analysis, Spring Harbor Press.

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPC6020	**Plant Biotechnology**	3	1	-	4	

Pre -Requisite:

Course Educational Objective

CEO1: To provide the practical oriented theory on plant tissue culture

CEO2: To have knowledge on gene transfer to plants

Course Outcome

CO1	The students will acquire knowledge in various types of plant tissue culture techniques and various components of plant tissue culture media, e.g. minerals, growth factors and hormones.
CO2	Students will understand the importance of Micro propagation and somatic hybridization.
CO3	Students will learn the technology of plant transformation including vector and vector less gene transfer methods.
CO4	Students will acquire knowledge in biosynthesis of plant primary and secondary metabolites and their importance.

UNIT:1 (10 Hours)

Concept of totipotency and plasticity of plant cell; Tissue culure media- preparation, composition and plant growth regulators; Initiation and establishment of culture: Explant preparation, Callus culture, Single cell culture, Suspension culture, Microspore culture, Embryo rescue.

UNIT:2 (10 Hours)

Micropropagation: Organogenesis, Somatic embryogenesis, Artificial seed; Protoplast technology: Isolation and culture of protoplast, Somatic hybridization, Screening and selection of somatic hybrid.

UNIT:3 (15 Hours)

Concept of genetic transformation: Vector based (*Agrobacterium*, Virus) and Direct transformation (Gene gun, Electroporation, Microinjection, etc.); Application of genetic transformation: promoter tagging, activation tagging, herbicide resistance, insect resistance, disease resistance, terminator seed technology; Products of genetic transformation: Case studies for golden rice, Bt cotton and FlavrSavr tomato.

UNIT:4 (12 Hours)

Primary and secondary metabolic products (phytochemicals) of plant cells, biosynthesis of secondary metabolites of biotechnological importance, biotransformation for product development and selection of cell culture

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Introduction to Plant Biotechnology by H S Chawal, Science Publisher Inc.
2. Plant Biotechnology by Adrian Slater, Oxford press

Ref. Books 1Introduction to Plant Biotechnology by M.K.Razdan, Science Publisher Inc.
2 Plant Biotechnology by Agnes Ricroch ,S.Chopra, S.J.Fleisher, Springer

Subject Code	Title of the subject	L	T	P	C	QP
BBTPC6030	**Downstream processing**	3	-	-	3	

Pre -Requisite:

Course Educational Objective

CEO1:. Learn the fundaments of downstream processing

CEO2: Understand the principle, working and application of major unit operations in Bioprocessing of industrially important products.

Course Outcome

CO1	Students will understand the principles of major downstream operations used in a bioprocess industry such as filtration, centrifugation, extraction and chromatography.
CO2	Students will design and optimize the cost effective biosepation techniques.
CO3	Students will understand techniques such as precipitation, coagulation and flocculation in downstream processing.
CO4	Students will learn product recovery and product polishing methods.
CO5	

UNIT:1 (12 Hours)

Introduction; An overview of bioseparation. Role and importance of Bioseparation process in biotechnological processes. Problems and requirements of bioproduct purification. Cost-cuttingstrategies Characteristics of biological mixtures – Process of Classification of Bioproducts -Biological activity Analysis of purity-Process economics-Capital and operating cost analysis

UNIT:2 (14 Hours)

Separation of cells and other insolubles from fermented broth. Foam separation, Precipitation, Filtration and microfiltration, centrifugation (batch, continuous, basket).Chromatography in bioseparation.

UNIT:3 (10 Hours)

Cell disruption: Physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), Chemical methods (alkali, detergents), Enzymatic methods, RO, Ultra-filtration: Semipermeablemembranes, membrane geometry and ultrafiltration module configuration.

UNIT:4 (14 Hours)

Separation of soluble bio-products: Liquid-liquid extraction, Distillation, Absorption, Adsorptionprecipitation,.Other bioseparation techniques like Dialysis, electro-dialysis, LiquidElectrophoresis. Products polishing : Crystallization and drying.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and DemetriPetrides, Bioseparations Science and Engineering, Oxford University Press, USA (October 31, 2002)
2. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.

Ref. Books 1. Wankat P.C, " Rate controlled separations ", Elsevier, 1990
2. Asenjo J.M., " Separation processes in Biotechnology " Marcel Dekker Inc. 1993.
3. Belter PA and Cussler E, " Bioseparations ", Wiley 1985

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE6041	**Environment Biotechnology**	3	-	-	3	

Pre -Requisite:

Course Educational Objective

CEO1: To introduce the environmental biotechnology and its importance

CEO2: To have knowledge on biodegradation processes

Course Outcome

CO1	Students will acquire the basic knowledge in environmental pollution and source of pollution.
CO2	Students will learn on biological treatment of waste water.
CO3	Students will understand the types of Xenobiotic compounds and their adverse effect on environment.
CO4	Students will learn about the pollution control mechanisms by the application of Biotechnology.

UNIT:1 (10 Hours)

Introduction to environmental biotechnology, Environmental monitoring bioreporter, biomarker.Bioprospecting, Biomicroelectronics and biosensor technology; Introduction to environmental pollutants: Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal accumulation, Biosorption & detoxification mechanisms.

UNIT:2 (12 Hours)

Microbiology and biochemistry of wastewater treatment: Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic,acetogenic, and fermentative bacteria- technical process and conditions; Use of GeneticallyEngineered Organisms. emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial wastewaters.

UNIT:3 (14 Hours)

Biodegradation of xenobiotic compounds: Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbialtreatment of oil pollution. Biotransformation and biocatalysts: Basic organic reaction mechanism, Common prejudices against Enzymes. Advantages & Disadvantages of Biocatalysts, Isolated enzymes versus whole cell systems. Mechanistic Aspects and Enzyme Sources. BiocatalyticApplication, Catalytic Antibodies; Stoichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants

UNIT:4 (12 Hours)

Bio-oxidation & microbial leaching: Biooxidation – Direct and Indirect Mechanisms, Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal. Clean technologies: Composting Technology and Organic farming, biofertilizers, biopesticides,microbial polymer production and bio plastic technology. Biotechnology of fossil fuels: Desulfurization of coal, oil shales, microbial enhanced oil recovery (MEOR). Biofuels: Biogastechnology, biohydrogen, bioethahnol production.

Biotechnology of mineral processing. Ethicalissues in environmental biotechnology and regulatory framework.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS
Text Books 1 Text book of Environmental Biotechnology by P.K.Mohapatra, I.K.International 2. of Environmental Biotechnology concept and application by Hans Joachim, Jordening, J.winter, Wiley- Vch
Ref. Books 1 Advanced Environmental Biotechnology by S.K. Agarwal, A P H Publishing corporation 2 Environmental Biotechnology by D.K.Markandey and. Rajvaidya A P H Publishing Corporation

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE6042	**Bioprocess Engineering**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To understand the importance of bioprocess engineering and the role of bioprocess engineer and the importance of regulatory constraints.

CEO2: To understand the mechanism of enzyme action, their kinetics and about stoichiometry of microbial growth.

Course Outcome

CO1	Students will learn the screening, culture, preservation and applications of microorganism in bioprocess engineering.
CO2	Students will understand the design and principle of different bioreactors used in biotechnology industries.
CO3	Students will acquire knowledge in optimization of growth parameters of microorganisms.
CO4	Students will understand techniques such as precipitation, coagulation, flocculation and crystallization used in product purification.

UNIT:1 (14 Hours)

Introduction to bioprocess technology: Screening preservation and improvement of industrially important micro organisms, raw material and media formulation for formentation process, air and media sterilization, primary and secondary metabolites. Influence of environmental facts on growth and product formation.

UNIT:2 (13 Hours)

Concept of bioprocess, bioreactor designing, mixing and residence time distribution in bioreactor,, Anlysis of batch , fed-batch and continuous bio reactions, pulse bioreactors, fluidized bioreactors and photo bioreactors, pneumatic and hydro dynamic fermentations, solid substrate, surface, submerged fermentations, fermentations economics. Bioreactor design for animal cell culture and for waste treatment, growth models.

UNIT:3 (10 Hours)

Growth kinetics: Microbial growth cycle, measurement of growth, control of process parameters: measurement of process parameters likes' pH, temperature, dissolved oxygen, foam. Scale up and scale down process.

UNIT:4 (12 Hours)

Downstream processing: cell separation, cell disintegration, foam separation, precipitation, centrifugation, drying, crystallization and product purification, effluent treatment. Bioprocess economics. Use of microorganism in mineral beneficiation and oil recovery, microbial leaching of minerals.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books 1Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986. Press.

Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach

Ref. Books 1. Bailey &Olis, Biochemical Engg. Fudamentals, MGH.,1990
2Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.

Title of the subject						
Subject Code		L	T	P	C	QP
BBTPE6043	**Proteomics and Genomics**	**3**	**0**	**0**	**3**	

Pre -Requisite:

Course Educational Objective

CEO1: To understand the protein interaction, tools and application of Proteomics

CEO2: To know about the tools and techniques of genomics

Course Outcome

CO1	Students will learn protein interaction and various tools used in proteomics
CO2	Students will understand the 2-D electrophoresis and Peptide fingerprinting
CO3	Students will acquire knowledge in application of proteomics
CO4	Students will understand techniques such as Genome sequencing , accessing and retrieving genome and functional genomics and comparative genomics .

UNIT:1 (14 Hours)

Mapping protein interaction and applications: Global expression profiling, comprehensive mutant libraries, mapping protein interactions, applications of genome analysis and genomes. Introduction and tools of proteomics: Proteomics and Proteomes, Various tools used in proteomics (N-terminal sequencing of proteins, 2-D electrophoresis Differential display proteomics, Yeast two hybrid and three hybrid system, phage display, isoelectro focusing, Peptide fingerprinting. LC/MS-MS for identification of proteins and modified proteins, SAGE, Protein micro array).

UNIT:2 (12 Hours)

Applications of proteomics: Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics, structural proteomics; Proteomics and Drug delivery. Transcriptomics.

UNIT:3 (10 Hours)

Introduction to genomics: Orientation and structure of genomes, subdividing the genome, assembling a physical map of a genome. Sequencing methods and strategies, genome annotation and information from web, bioinformatics.

UNIT:4 (10 Hours)

Genome sequencing projects- Microbes, plants and animals; Accessing and retrieving genome project Reverse genetics, Structural genomics, Functional genomics and Comparative genomics; High throughput screening in genome for drug discovery identification of gene targets, Pharmaco-genomics and drug development.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books : 1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley
2. Introduction to Genomics by Lesk AM, Oxford University Press (2008)
3. Proteomics: from protein sequence to function by Pennington, S.R. and Dunn, M. J., Viva Books (2001)

Ref. Books :1. Brown TA, Genomes, 3rd Edition. Garland Science
2. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings

Title of the subject						
Subject Code		L	T	P	C	QP
BBSHS5061	**Optimization in Engineering**	**3**	**0**	**0**	**3**	
Pre -Requisite:						

Course Educational Objective	
CEO1: To provide basics of optimization in engineering.	
CEO2: To introduce linear and non linear programming	
Course Outcome	
CO1	To make use of the concepts of operations research modeling approaches
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as Transportation and Assignment problems.
CO4	Determine average queue length and waiting times of queuing models.

UNIT:1 (No of Hours)

Introduction: Historical overview of operations research, fundamentals of OR Modeling Approach. Linear Programming: Basic assumptions, formulation, graphical method, simplex method, duality theory, primal-dual relationships, sensitivity analysis.

UNIT:2 (No of Hours)

Transportation and Assignment Problems: Specific features of transportation problem, streamlined simplex method for solving transportation problems, special features of assignment problems, Hungarian method for solving assignment problems. Integer programming: Special features, binary integer programming models, branch-and-bound technique, cutting-plane method..

UNIT:3 (No of Hours)

Dynamic Programming: Characteristics, principle of optimality, solution procedure, deterministic problems. Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.

UNIT:4 (No of Hours)

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert/MOOCS

Text Books

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010.
2.Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books

3. P.K.Gupta, D.S.Hira, “Operations Research”, S.Chand and Company Ltd
4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.
5. Kalyanmoy Deb, “Optimization for Engineering Design”, PHI Learning Pvt Ltd

Subject Code	**Course Title**	L	T	P	C	QP
BBTPC6110	Bioinformatics Lab	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid

Course Educational Objective

In this laboratory, students will have the opportunity to understand the biological database used in Bioinformatics for biotechnological analysis.

Study of various bioinformatics tools to designing of genome, protein for biological applications.

Course outcomes: At the end of the course, the student will be able to:	
CO1	The student will understand about the various genome and protein database and its applications in biotechnology.
CO2	The student can learn to design the phylogenetic tree for genome analysis.
CO3	Students will be familiar with various bioinformatics software.
CO4	They will learn the technique of molecular docking, receptor analysis and Molecular Dynamics simulation.

LIST OF EXPERIMENT

1. Retrieving Human genome data, OMIM, SNP databases to understand genetic and metabolic disorders. (At least 2 each)
2. Mining genomic data to identify genomic features: codon usage, repeats, Homologous sequences etc.
3. Making Phylogenetic tree of given sequences by using ClustalW and PHYLIP.
4. Gene and promoter prediction for Prokaryotes and eukaryotes (comparative analysis by using different tools: at least 3)
5. Learning about molecule visualisation software like Rasmol, Pymol etc.
6. Primary Structural databases: pdb, ndb, csd and Derived databases of structures: DSSP, FSSP, CATH & SCOP.
7. Prediction of secondary structures of proteins: at least 3 methods
8. Prediction of Tertiary structure of proteins and Validation of model protein structure: Energy minimization, Procheck, verify 3D, Prosa II, ERRAT etc.
9. Molecule drawing. Conversion of 2D structure to 3D structure.
10. Molecular docking and analysis of receptor with ligand
11. Molecular Dynamics simulation

Subject Code	**Course Title**	L	T	P	C	QP
BBTPC6120	Plant Biotechnology Lab	**0**	**0**	**2**	**1**	

Pre -Requisite: Mechanics of Solid
Course Educational Objective
In this laboratory, students will have the opportunity to understand the techniques of plant tissue culture and establishment of plantlet.
The establishment of plant tissue culture laboratory for micropropagation and generation of transgenic plants.

Course outcomes: At the end of the course, the student will be able to:	
CO1	The student will learn about the preparation of various plant tissue culture media and their sterilization.
CO2	Students will know about the establishment of callus culture.
CO3	They will learn about agrobacterium mediated gene transfer technique.
CO4	Students will acquire the skill for protoplast isolation and somatic hybridization.

LIST OF EXPERIMENT (Minimum 8 experiments)

1. Media preparation, sterilization, explant preparation and establishment of meristem culture
2. Study of organogenesis and multiple shoot generation
3. Somatic embryogenesis in carrot and encapsulation somatic embryo
4. Anther culture of Datura
5. Establishment of suspension culture
6. Agrobacterium mediated transformation (Co-cultivation & GUS expression)
7. Embryo/Endosperm Culture
8. Isolation of protoplasts