DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH, LUCKNOW

EVALUATION SCHEME & SYLLABUS

FOR

B.TECH. (BIOTECHNOLOGY) 3RD YEAR

BASED ON

AICTE MODEL CURRICULUM & NEP2020

[Effective from the Session: 2024-25]

SEMESTER V												
Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme			End Semester		Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	BBT501	Genetic Engineering	3	1	0	20	10	30	70		100	4
2	BBT502	Fermentation Biotechnology	3	1	0	20	10	30	70		100	4
3	BBT503	Bioinformatics I	3	1	0	20	10	30	70		100	4
4	BBT051-054	Departmental Elective-I	3	0	0	20	10	30	70		100	3
5	BBT055-058	Departmental Elective-II	3	0	0	20	10	30	70		100	3
6	BBT551	Genetic Engineering Lab	0	0	2	20	30	50		50	100	1
7	BBT552	Fermentation Biotechnology Lab	0	0	2	20	30	50		50	100	1
8	BBT553	Bioinformatics-I (Virtual Lab)	0	0	2	20	30	50		50	100	1
9	BCC551	Mini Project or Internship Assessment*	0	0	2		50	50		50	100	1
10	BNC501/ BNC502	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	20	10	30	70			NC
11		MOOCs (Essential for Hons. Degree)										
		Total	**17**	**3**	**8**						**1000**	**22**

**The Mini Project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.*

DEPARTMENTAL ELECTIVE-I

BBT051	Pharmaceutical Biotechnology
BBT052	Nano Biotechnology
BBT053	Biomedical Instrumentation
BBT054	Metabolic Engineering

DEPARTMENTAL ELECTIVE-II

BBT055	Biofuel & Alcohol Technology
BBT056	Descriptive Statistics & Process Control
BBT057	3D Printing Techniques
BBT058	Molecular Modeling & Drug Design

SEMESTER VI												
Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme			End Semester		Total	Credit
			L	T	P	CT	TA	Total	TE	PE		
1	BBT601	Bioprocess Engineering II	3	1	0	20	10	30	70		100	4
2	BBT602	Plant Biotechnology	3	1	0	20	10	30	70		100	4
3	BBT603	Bioinformatics II	3	1	0	20	10	30	70		100	4
4	BBT061-064	Departmental Elective-III	3	0	0	20	10	30	70		100	3
5		Open Elective-I	3	0	0	20	10	30	70		100	3
6	BBT651	Bioprocess Engineering II Lab	0	0	2	20	30	50		50	100	1
7	BBT652	Plant Biotechnology Lab	0	0	2	20	30	50		50	100	1
8	BBT653	Bioinformatics II Lab	0	0	2	20	30	50		50	100	1
9	BNC601/ BNC602	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	20	10	30	70			NC
10		MOOCs (Essential for Hons. Degree)										
		Total	**17**	**3**	**6**						**800**	**21**

DEPARTMENTAL ELECTIVE-III

BBT061	Animal Biotechnology
BBT062	Biomarker & Diagnostics
BBT063	Food Biotechnology
BBT064	Entrepreneurship in Biotechnology

B.Tech.

(Biotechnology)

3rd Year

5th Sem

Syllabus

1	**SUBJECT CODE:** BBT501	**COURSE TITLE:** Genetic Engineering
2	**EXAM DURATION: 3** HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 1 : 0 **CREIDTS :** 4	**PREREQUISITES:** Knowledge of Molecular Biology

COURSE OBJECTIVES:

To Provide knowledge of manipulation of Genetic Material and Recombinant Technology
To teach the construction of genomic c-DNA libraries, cloning and strain improvement
To develop understanding of DNA sequencing, Molecular markers and related techniques.
Application of Genetic Engineering and its application
To impart knowledge of cell signaling and Ethical issues

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	To be able to appraise the appropriate use of host and vector for gene cloning
CO2	Identification of appropriate method for DNA delivery into the host
CO3	Use of gene library for screening of desired gene sequence/protein
CO4	Cloning process of whole organism and its application
CO5	Process of recombinant protein expression, cell signaling and ethical issues related to Gene transfer
CO6	To be able to use acquired knowledge for commercial products

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	2	1	2	1	3	1	2	2	2	3
CO-2	1	2	2	1	1	2	1	1	1	2	1	3
CO-3	1	2	1	2	1	2	1	1	2	1	2	3
CO-4	1	2	1	2	1	1	2	2	1	2	2	3
CO-5	3	2	2	3	2	2	2	1	1	2	1	3
CO-6	1	1	3	1	2	3	2	2	2	1	1	3

REFERENCE BOOKS:

1. T.A Brown (2006). Gene cloning and DNA analysis, WILEY-BLACKWELL
2. Molecular Biology of the Cell (2006) Bruce Alberts.6th edition
3. Molecular Cloning, (2001) A laboratory Manual. Sambrook, J., Fritsch,E.F., Mariatis.3rd edition (Vol.1,2,3)
4. S.B Primrose (2001). Molecular biotechnology. Panama Publishing corporation, 2nd edition
5. Genetic Engineering (2009) Dr Smita Rastogi & Dr Neelam Pathak, Oxford University Press

COURSE DETAILS: GENETIC ENGINEERING		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors basedon plasmid and bacteriophage, Vectors for yeast, insect and mammalian systems, Prokaryotic and eukaryotic expression host systems, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA foot printing); Introduction of recombinant DNA in to host cells and selection methods.	**8**
II	Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosome walking, Screening of DNA libraries using nucleic acid probes and antisera., strain improvement of industrially important organisms, CRISPER / Cas system of gene editing.	**8**
III	Maxam Gilbert's and Sanger Coulson's and automated methods of DNA sequencing, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, TaqMan assay, Molecular beacons, Applications of PCR; Site directed mutagenesis.; molecular markers (RAPD, RFLP, AFLP, SNP)	**8**
IV	Applications of genetic engineering; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.	**8**
V	Basic concepts of cell signaling, Extracellular signal molecule and their receptors, Operation of Signaling molecules over various distances, Cellular response to specific combinations of extracellular signal molecules; Nuclear receptor; Ion channel linked, G-protein mediated receptors, Relay of signal by activated cell surface receptors via intracellular signaling proteins, Intracellular Signaling proteins as molecular switches.	**8**
		40

1	**SUBJECT CODE:** BBT502	**COURSE TITLE:** Fermentation Biotechnology
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 1: 0 **CREIDTS :** 4	**PREREQUISITES:** Basic Knowledge of elementary microbiology and basic bioprocessing

COURSE OBJECTIVES:

provide knowledge of fermentation technology and its industrial application.
teach the inoculums development, microbial kinetics and its measurement.
develop understanding of media component, sterilization and types of fermentation processes.
provide knowledge of regulation, control and overproduction of metabolites.
impart knowledge related to production and application of metabolites.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1	derstanding of the concepts and process technologies of fermentation.
CO2	plication and use of different raw materials and its use in industrial scale production.
CO3	gulatory system in the microorganism.
CO4	ain improvement technologies and its role in Fermentation.
CO5	ncepts of the scale up and scale down criteria of fermentation process and production of metabolites.
CO6	Concepts about the processing and industrial manufacturing of antibiotics.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	2	2	2	1	2	1		1	2	3
CO-2	3		3	2	2	2	3	2	1	2		3
CO-3	3	3	2	2	1	1	2	1	2	1	2	2
CO-4			3	3		2	3	2		1		3
CO-5			2	3	1	2	2	2	2	1		2
CO-6	1		1	3	3	2	1	2		2	2	2

REFERENCE BOOK:

1. O Levenspeil (2006) Chemical Reaction Engineering, 3rd Edition, Wiley India.
2. D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring HarbourLab press.
3. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education (in press)
4. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication.
5. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1st Ed
6. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press

Course Details: Fermentation Biotechnology		
Unit	**Content**	**Contact Hours**
I	Introduction to fermentation technology: Interaction between Bio-chemical engineering, Microbiology and Biochemistry. History and development of fermentation industry: Microbial culture selection for fermentation processes, Strain development; Preservation and improvement of industrially important microorganisms.	8
II	Inoculum development for industrial fermentation & Microbial Kinetics: Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples.	9
III	Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Media sterilization, Batch Process (thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries, filter sterilization of air and media.	9
IV	Different regulatory mechanisms involved in controlling the catabolic and anabolic processes of microbes. Induction, nutritional repression, carbon catabolite repression, crabtree effect, feedback inhibition and feedback repression; Concept for overproduction ofprimary and secondary metabolites.	8
V	Details of the process, parameters and materials -for the industrial manufacture of Antibiotics (β-lactum), Solvents (acetone) Amino acid (Lysine), Organic acids (Citric acid), Alcohols (Ethanol), Ind. Enzymes (Protease/Amylase) and Biopharmaceuticals (Insulin/Interferon etc.)-Microbial Transformations, Microbial leaching.	8

1	**SUBJECT CODE:** BBT503	**COURSE TITLE: Bioinformatics I**
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 1 : 0 **CREIDTS :** 4	**PREREQUISITES:** Basic Knowledge of Molecular Biology, Mathematics & Computer

COURSE OBJECTIVES:

Teach the basic concept of Bioinformatics, databases & Sequence analysis.
Develop the understanding of sequence analysis.
Provide knowledge of scoring matrix and detection of functional sites etc.
To impart knowledge related to phylogenetic analysis protein structure prediction.

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Understand concepts and application of Bioinformatics, types of databases, sequence similarity, sequence patterns and profiles.
CO2	Use sequence alignment techniques, database searching, pair wise and multiple sequence alignment using various tools.
CO3	Understand scoring matrices and its types including PAM, BLOSUM series and matrices for nucleic acid and protein sequences.
CO4	Apply phylogeny and its concepts in molecular evolution and different methods of Phylogenetic tree construction.
CO5	Understand and apply the protein structure prediction and application of bioinformatics in drug designing.
CO6	Identify and utilize various biomolecular sequence file formats such as GenBank, EMBL, FASTA, GCG, and others.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	1	1	1	1	2	1	1	1
CO-2	3	1	2	1	1	1	1	1	2	1	1	1
CO-3	2	1	1	1	1	1	1	1	2	1	1	1
CO-4	1	1	1	1	1	3	1	1		1	1	1
CO-5	1	1	1	1	1	1	1	1	2	1	1	1
CO-6	1	2	1	1	2	1	2	1	1	1	1	2

REFERENCE BOOK:

1. D.W.Mount; Bioinformatics-Sequence and genome analysis; Cold Spring HarbourLab press.
2. B.N.Mishra; Bioinformatics: Concept and application, Pearson Education (in press)
3. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication.
4. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd
5. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press

COURSE DETAILS: BIOINFORMATICS I		
Unit	**Content**	**Contact Hours**
I	Introduction to Bioinformatics; Biological databases: Nucleotide databases, Protein databases, Specialized databases; Laboratory data submission and data retrieval; Various file formats for biomolecular sequences: Genbank, EMBL, FASTA, GCG, msf, nbrf-pir etc.; Basic concepts of sequence similarity: identity and homology, definitions of homologues, orthologues, paralogues; Sequence patterns and profiles	8
II	Sequence Alignment And Database Searching: Introduction, Evolutionary Basis of Sequence Alignment, Optimal alignment method, Statistical Significance of Alignment. Database searching Artifacts; Database similarity searching: FASTA, BLAST, Various versions of basic BLAST and FASTA, Advance version of BLAST: PHI-BLAST and profile-based database searches using PSIBLAST; Multiple sequence alignment: progressive method and Iterative method; Applications of pairwise and multiple sequence alignment; Tools for multiple sequence alignment: CLUSTALW and Pileup (Algorithmic concepts).	7
III	Scoring Matrices: Basic concept of a scoring matrix, Similarity and distance matrix, Substitution matrices: Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, Principles based on which these matrices are derived and Gap Penalty; Predictive Method using Nucleotide Sequence: Introduction, Marking repetitive DNA, Database search, Codon bias detection, detecting functional site in DNA.	7
IV	Phylogenetics: Phylogeny and concepts in molecular evolution; nature of data used in taxonomy and phylogeny; definition and description of Phylogenetic trees and various types of trees; Different methods of Phylogenetic tree construction: UPGMA and Fitch-Margoliash Algorithm; case studies in phylogenetic sequence analysis.	8
V	Protein identification based on composition, Physical properties based on sequence, Motif and pattern, Secondary structure (Statistical method: Chou Fasman and GOR method, Neural Network and Nearest neighbor method) and folding classes, specialized structure or features, Tertiary structures (Homology Modeling); Structure visualization methods (RASMOL, CHIME etc.); Protein Structure alignment and analysis. Application of bioinformatics in drug discovery and drug designing.	10

1	**SUBJECT CODE:** BBT051	**COURSE TITLE:** Pharmaceutical Biotechnology
2	**EXAM DURATION: 3 HOURS**	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic Knowledge of Molecular Biology, Biochemistry

COURSE OBJECTIVES

To teach the basic concept of Pharmaceutical products and other therapeutic agents.
To develop understanding of drug manufacturing process, storage packaging and storage of APIs.
To provide knowledge of regulatory knowledge, approval of new drug and economics of drug development.
To develop understanding of marketing, regulation and control and scope of pharmaceutical industry.

COURSE OUTCOMES (COS): Upon completion of this course, the students will be able to:

CO1	Understand concepts and application of pharmaceutical industry, Therapeutic agents, biopharmaceuticals.
CO2	Understand the process off drug manufacturing, processing, preservation, analytical methods and quality management.
CO3	Apply the knowledge of new drug development, GMP.
CO4	Use knowledge of Drug regulation and control.
CO5	Scope and applications of biotechnology in pharmacy.
CO6	Economics of drug development in pharma industry.

CO-PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	-	1	1	1	-	-	-	1	-	1
CO2	3	1	1	-	1	1	1	2	-	1	-	1
CO3	3	2	2	-	1	1	2	1	-	-	1	-
CO4	3	-	-	3	-	1	-	-	-	2	-	-
CO5	3	-	2	-	1	1	-	1	-	2	1	-
CO6	2	-	1	-	1	1	-	1	-	-	-	1

REFERENCES

1. Walsh, G., (1998) Biopharmaceuticals: Biochemistry and Biotechnology, Wiley.
2. Leon Lachman et al (1986) Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger
3. Remington's (1971) Pharmaceutical Science, Mark Publishing and Co

COURSE DETAILS: PHARMACEUTICAL BIOTECHNOLOGY		
UNITS	**CONTENTS**	**LECTURE HOURS**
Unit I	Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. Introduction: Therapeutic categories such as Analgesics, Anticancer, Antiviral, Anticoagulant, Analgesics, Antibiotics, Use of therapeuticagents, Biopharmaceuticals.	**5**
Unit II	Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Specialrequirement for bulk drug manufacture.	**3**
Unit III	Compressed table, wet granulation-dry granulation or slugging-direct compression-tablet presses,coating of tablets, capsules, sustained action dosage forms-parental solution-oral liquidsinjections-ointment-topical applications, Preservation, analytical methods and test for variousdrug and pharmaceuticals, packing-packing techniques, quality management.	**15**
Unit IV	New drug development and approval process: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials, GMP, Economics of drug development.	**9**
Unit V	The business and the future of Biopharmaceuticals. Drug regulation and control.Scope and applications of biotechnology in pharmacy.	**10**

1	**SUBJECT CODE:** BBT052	**COURSE TITLE:** Nano Biotechnology
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0: 0 **CREIDTS :** 3	**PREREQUISITES:** Basic knowledge of Chemistry and Analytical Techniques.

COURSE OBJECTIVES:

teach the concept of nanobiotechnology and nanofabrication techniques.
develop understanding synthesis of metallic nanoparticles.
provide knowledge of biological synthesis of nanoparticles.
teach the analytical techniques used in nanotechnology and its application in characterization of nanomataterials of biomedical importance.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:

CO1	plain and demonstrate the basics of nanoscience, nanobiotechnology and its techniques.
CO2	derstand the synthesis of metal nanoparticles by chemical process.
CO3	rform the biological synthesis of metal nanoparticles.
CO4	timate the toxicity, antibacterial property of metal nanoparticles.
CO5	derstand the synthesis of carbon nanotubes from carbon source.
CO6	plain the nano characterization tools and techniques.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	1	1	1	2	2	1	1	2	1	3
CO-2	1	3	2	2	3	1	2				2	3
CO-3		3	2	2	2	1	2	2	2		2	2
CO-4		3	2	1	3	2	1	3			2	3
CO-5				3	2	1	1	2	2		1	1
CO-6	3		2	2	1	1	2	1	1		1	2

Reference Book:

7. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
8. Guozhong Cao ,"Nanostructures and Nanomaterials , synthesis , properties and applications" , Imperial College Press ,2004.
9. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press,2002.
10. Microfabrication and Nanomanufacturing- Mark James Jackson.
11. MEMS and Nanotechnology – Based sensors and devices communication, Medical and Aerospace applications - A.R.Jha.
12. Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman.

Course Details: Nano Biotechnology		
Unit	Content	Contact Hours
I	Nanobiotechnology, History, Origin, Fundamental Concepts, Bottomup versus Top-down approaches, Discussion on Micro and Nanofabrication, Current research, Tool and Techniques,Applications and Implications and Nanofabrication.	
II	Carbon nanotubes and related structures, Properties, Synthesis, Applications, Metal nanoparticles types and their synthesis, Application of Gold, Silver and Zinc oxide nanoparticles and Nano chemicals.	
III	Atomic force microscopy (AFM), Scanning tunneling microscopy (STM), improved nanodiagnostic devices, Drug delivery tools through nanotechnology	
IV	Synthesis and characterization of different classes of biomedical polymers-their uses inpharmaceutical, cardiovascular ophthalmologic orthopedic areas.	
V	Micro and Nano biosensor, Bioavailability, Nanoimaging agents, Tumor Targeting through nanotechnology, Quantam dots technology and its applications	

1	**SUBJECT CODE:** BBT053	**COURSE TITLE:** BIOMEDICAL INSTRUMENTATION
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic Knowledge of analytical techniques

COURSE OBJECTIVES:

To teach the concept and application of Biomedical instrumentation
To develop understanding of biomedical instruments and its process involved in cardiovascular measurements.
To provide knowledge non-invasive diagnostic instrumentation, ultrasonic measurement and biotelemetry etc.
To teach the instruments involved in clinical laboratory, biomedical instruments in surgery and medical imaging

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Explain and demonstrate the instrumentation involved in biomedicals.
CO2	Understand the working and application of plethymography, electrocardiography and pacemakers etc.
CO3	Explain the ultrasonic measurements, biotelemetry and other related instrumentation.
CO4	Applications of Instrumentation for the clinical laboratory.
CO5	Explain the Medical Imaging equipment.
CO6	Explain the electrical safety of medical equipment.

CO-PO MAPPING (1 TO 3 SCALE)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2	1									
2	2			3		1						
3	1	2	3			-						
4	3	1	2			2						
5	1	2				1						
6	1	2				3						

REFERENCES

1. Cromwell, L., Weibell, F.J. and Pfeiffer, E.A. (1980) Biomedical instrumentation and measurements. Englewood Cliffs, N.J: Prentice-Hall.
2. Khandpur, R.S. (2005) Biomedical instrumentation: Technology and applications. New York: McGraw-Hill.

3. Northrop, R.B. (2004) Analysis and application of analog electronic circuits to biomedical instrumentation Robert B. Northrop. Boca Raton, Fla: CRC.
4. Cromwell, L. (1976) Medical Instrumentation for Health Care. Englewood Cliffs, N.J: Prentice-Hall.

Course Details: BIOMEDICAL INSTRUMENTATION		
Unit	**Content**	**Contact Hours**
I	History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, transducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromyogram and other bioelectric potentials. Biopotential Electrodes: types of electrodes surface, needle and microelectrodes, biochemical transducers.	9
II	The Cardiovascular system, Cardiovascular measurements: electrocardiography, measurement of blood pressure, measurement of blood flow and cardiac output, plethymography, measurement of heart sounds; Patient care and monitoring: elements of intensive care unit, pacemakers and defibrillators ,Measurements in the respiratory system: mechanics of breathing, gas exchange and distribution, respiratory therapy equipment.	6
III	Non-invasive diagnostic instrumentation: Temperature measurements ultrasonic measurements, the nervous system and neuronal communication measurement in nervous systems, Instrumentation for sensory measurements and the study of behaviors, pshycophysiological measurements, Biotelemetry.	7
IV	Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.	6
V	Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.	7

1	**SUBJECT CODE:** BBT054	**COURSE TITLE: Metabolic Engineering**
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic Knowledge of Biochemistry

COURSE OBJECTIVES:

To teach the concept and application of metabolic engineering
To develop understanding metabolites production in different pathways and regulatory mechanism.
To provide knowledge biosynthesis of metabolites
To teach the bioconversions, product inhibition and factors affecting bioconversions.

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Explain basic concepts of metabolism and importance of metabolic engineering
CO2	Understand the production of metabolites and its regulatory mechanism
CO3	Explain the applications, specificity and product inhibition of bioconversion.
CO4	Regulation of enzyme production and strain improvement
CO5	Understand the general principles of intermediary metabolism, including the regulation of metabolic pathways at both the enzyme and cellular levels.
CO6	Explore mixed or sequential bioconversions and the conversion of insoluble substances.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	2	2	1	1	2	3	1	2
CO-2	1	1	1	2	2	1	2	1	1	2	1	1
CO-3	1	1	2	1	1	2	1	1	1	2	1	1
CO-4	1	1	1	1	1	1	1	2	1	3	1	1
CO-5	1	2	1	1	1	1	1	1	2	2	1	1
CO-6	1	2	1	1	1	2	1	1	1	1	1	1

REFERENCE BOOK:

1. G. Stephanopoulos, A. Aristidou and J. Nielsen, Metabolic Engineering Principles and Methodologies, Academic Press, 1998
2. Daniel I. C. Wang, Malcolm D. Lilly, Arthur E. Humphrey, Peter Dunnill, Arnold l.Demain, Fermentation and Enzyme Technology,1st edition John Wiley& Sons, Reprint, 2005
3. Christina Smolke, The Metabolic Pathway Engineering Handbook (Two Volume) Set 1st edition CRC press, 2009.
4. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press,1984.

COURSE DETAILS: METABOLIC ENGINEERING		
Unit	**Content**	**Contact Hours**
I	Basic concept of metabolism, anabolism & catabolism, Importance of metabolic e ngineering, General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. Understanding the role of Bioinformatics in the study of metabolic pathways	6
II	Synthesis of primary metabolites: Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feedback regulation, Limiting accumulation of end products	8
III	Biosynthesis of secondary metabolites: Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, producers of secondary metabolites, applications of secondary metabolites.	12
IV	Bioconversions: Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Product inhibition, mixed or sequential bioconversions, Conversionof insoluble substances	7
V	Regulation of enzyme production: Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities.	09

1	**SUBJECT CODE:** BBT055	**COURSE TITLE: Biofuel & Alcohol Technology**
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic Knowledge of Fermentation and Bioconversion

COURSE OBJECTIVES:

To teach the concept and application biofuels and alcohol technology
To develop understanding different alcoholic fermentation techniques.
To provide knowledge Biochemistry of alcohol production, recycling and quality control.
Concepts of Biomass conversion to heat and power

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Explain basic concepts of metabolism and importance of metabolic engineering
CO2	Understand the production of metabolites and its regulatory mechanism
CO3	Explain the applications, specificity and product inhibition of bioconversion.
CO4	Regulation of enzyme production and strain improvement
CO5	Identify and evaluate various raw materials used in the alcohol industry, and understand their storage and handling requirements to ensure quality and safety.
CO6	Understand the production of yeast as a single-cell protein and its applications in the industry.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	1	1	1	2	1	2	1	1	1	1	1
CO-2	1	1	1	2	1	2	1	1	1	1	1	1
CO-3	2	1	1	1	2	1	2	1	2	3	1	1
CO-4	1	2	1	1	1	2	1	1	1	1	1	1
CO-5	1	2	1	2	1	1	1	1	1	3	1	1
CO-6	1	2	1	1	1	1	1	1	1	3	1	1

REFERENCE BOOK:

1. Chemical Process Principles – Part I, (1995) Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors.
2. He alcohol text book by Kathryn AnnJacques, T. P. Lyons, D. R. Kelsall
3. Product Recovery in Bioprocess Technology ", 1990 BIOTOL Series, VCH,
4. Shreve's Chemical Process Industries , 5th Ed. Reference
5. Out lines of Chemical Technology by Charles E. Dryden

COURSE DETAILS: BIOFUEL & ALCOHOL TECH.		
Unit	**Content**	**Contact Hours**
I	Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.	9
II	Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modem techniques of Continuous fermentation, Bio still fermentation, Encillium process, Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcoholproduction, Scaling in distilleries, Fusel oil separation	9
III	Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol. Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry	10
IV	Various biofuels/ bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion. Biomass conversion to biofuel:thermochemical conversion, syngas fermentation.	10

1	**SUBJECT CODE:** BBT056	**COURSE TITLE: Descriptive Statistics & Process Control**
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic Knowledge of Mathematics

COURSE OBJECTIVES:

To teach and demonstrate the representation of numerical data.
To develop understanding different and concept of probability, Binomial distribution and testing of significance.
Understand the Correlation and Regression analysis.
Concepts of Design of Experiments and statistical process control and capability analysis.

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Diagrammatic and graphical representation of numerical data.
CO2	**Analyze Data Dispersion.**
CO3	Apply concept of probability, binomial distribution and other statistical tools in solving complex scientific problems.
CO4	Understand the regression analysis.
CO5	Design the experiment using statistical methods.
CO6	Explain statistical process control and capability analysis.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2			2					1		2
CO-2	3	3								1		2
CO-3	3	3	2	2	3							2
CO-4	3	3	2	2						1		2
CO-5	3	3	3	3							2	2
CO-6	3	3	2	3	3		2					2

REFERENCE BOOK:

1. C. Montgomery Douglas (1994) Applied Statistics and Probability for Engineers, 4th Edition.
2. C. Montgomery Douglas (2013) Statistical Quality Control, 7th Edition.
3. G. W. Snedecor & W.G. Chochran (1989) Statistical Methods.
4. T. T. Soong (2004) Fundamentals of Probability and Statistics for Engineers.

COURSE DETAILS: DESCRIPTIVE STATISTICS & PROCESS CONTROL		
Unit	**Content**	**Contact Hours**
I	Descriptive Statistics: Diagrammatic and graphical representation of numerical data, Formation of frequency distribution, histogram, cumulative frequency distribution, polygon and O-give curve, measures of central tendencies – mean, median, mode. Measures of dispersion: mean deviation, standard deviation, variance, quartile deviation and coefficient variance, Moments (up to 4^{th}), Measures of skewness and kurtosis for grouped and ungrouped data.	8
II	Probability & Hypothesis Testing: Concept of Probability – Classical definition, Basic theorems of probability, Types of probability, Conditional probability, Theorem of total probability, Normal Distribution, The Central Limit Theorem, Binomial distribution, Poisson's Distribution, The Poisson's approximation to the Binomial Distribution. Testing of significance, large sample test for population mean and proportions, Test of population means-single, two samples, and paired t-test, chi square test. ANOVA.	9
III	Correlation and Regression analysis: Product moment and rank, correlation coefficient, simple regression, method of least squares for estimation of regression coefficients, concept of sampling and sampling distribution, sampling from nominal distribution, standard error.	6
IV	Design of Experiments (DOE): Design of Experiments (DOE) approach to optimization - traditional (linear) approach (OFAT) and multi-dimensional approach (Box-Bhenken Design, central composite design, Plackett-Burman Design, Downhill Method, Full factorial, Fractional factorial design).	8
V	Control Charts: Introduction to statistical process control and capability analysis: Chance and assignable cause of quality variation, Statistical basis of process monitoring: control chart, choice of control charts, analysis of control chart, variable of control charts, X bar and R chart, Attribute control chart, Determining process and measurement capability.	7

1	**SUBJECT CODE:** BBT057	**COURSE TITLE:** 3D Printing Techniques
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic knowledge of instrumentation, CAD CAM and statistics

COURSE OBJECTIVES:

To teach the concept and application prototyping fundamental.
To develop understanding models and specifications, stereo lithography apparatus and layeringtechnology
To provide knowledge of laminated object manufacturing and related techniques and process.
Concepts of selective laser sintering, fused deposition modeling

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Explain basic concepts of 3-D printing technology.
CO2	Understand the application, case studies, working, principles of 3-D printing technology
CO3	Explain the laminated object manufacturing and fused deposition modeling.
CO4	Apply the knowledge of 3-D Printing techniques to develop novel engineering models
CO5	To be able to use acquired knowledge for designing of prototypes
CO6	Apply the knowledge of 3-D Printing techniques to develop novel prototypes

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	1	2	1	2	1	2	2	3	1	3	3
CO-2	2	1	2	2	2	1	2	1	1	1	2	3
CO-3	2	2	1	2	2	2	1	3	2	2	2	3
CO-4	2	3	2	2	2	2	1	1	2	2	1	3
CO-5	2	1	2	1	1	2	1	2	2	2	1	3
CO-6	2	2	1	2	2	1	1	3	3	1	1	3

REFERENCES:

1. Chua C.K., Leong K.F. and LIM C.S(1997) Rapid prototyping: Principlesand Applications, World Scientific publications, 3rd Ed.
2. D.T. Pham and S.S. Dimov, (2001) “Rapid Manufacturing”, Springer, 2001
3. Terry Wohlers, “Wholers Report 2000”, Wohlers Associates
4. Paul F. Jacobs (1996) “Rapid Prototyping and Manufacturing”–, ASME Press
5. Ian Gibson, Davin Rosen, Brent Stucker (2014) “Additive Manufacturing Technologies, Springer, 2nd Ed

COURSE DETAILS: 3D Printing Techniques		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction, Prototyping fundamentals, Historical development, Advantages of AMT, commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields	**8**
II	Liquid based systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.	**12**
III	Solid based systems: Laminated object manufacturing (LOM): Models andspecifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration	**10**
IV	Powder Based Systems: Selective laser sintering (SLS): Models and specifications,process, working principle, applications, advantages and disadvantages, case studies. Three-dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.	**10**
		40

B.Tech. (Biotechnology) 3rd Year

1	**SUBJECT CODE:** BBT058	**COURSE TITLE:** Molecular Modeling & Drug Design
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 3 : 0 : 0 **CREIDTS :** 3	**PREREQUISITES:** Basic knowledge molecular biology, computer& mathematics

COURSE OBJECTIVES:

To teach the fundamental concept of molecular modeling and drug design.
To develop understanding molecular mechanisms and protein folding
To provide knowledge of homology modeling, model optimization & validation of protein models.
Concepts of drug designing including QSAR modeling and molecular docking

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Explain basic concepts and application of molecular modeling and drug development.
CO2	Understand the application of molecular dynamics, molecular mechanism and its application inprotein folding
CO3	Explain the concept and application of homology modeling.
CO4	Apply the knowledge of molecular modeling in drug designing.
CO5	Apply the knowledge of molecular modeling in drug development
CO6	To be able to use acquired knowledge for commercial products

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	2	1	1	2	2	1	2	2	3
CO-2	2	2	2	1	1	2	1	1	1	2	1	3
CO-3	1	1	1	2	2	2	1	1	2	1	2	3
CO-4	1	2	2	1	1	3	2	2	1	2	2	3
CO-5	2	1	2	3	3	2	3	3	3	2	1	3
CO-6	1	2	2	2	2	2	2	2	2	1	1	3

REFERENCE BOOKS:

1. **Molecular Modelling (2013) Principles and applications, A. Leach**
2. **Molecular Modelling (2011) , Hans Peter, Heltje & Gerd Folkens, VCH.**
3. **Chemical Applications of Molecular Modelling (2000) , Jonathan Goodman.**

B.Tech. (Biotechnology) 3rd Year

COURSE DETAILS: Molecular Modeling & Drug Design		
UNITS	**CONTENTS**	**LECTURE HOURS**
I	Introduction to Molecular Modeling; What are models used for? Areas of application – Single molecule calculation, Assemblies of molecules; Reaction of the molecules; Drawbacks of mechanical models as compared to graphical models; Co-ordinate systems two – matrix, potential energy surface; Postulates of quantum mechanics, electronic structure calculations, Ab initio, Semi-empirical and Density functional theory calculations, Molecular size versus accuracy; Approximate molecular orbital theories.	**8**
II	Molecular Modeling by Homology, construction of frame work, selecting variable regions, Back bone and side chain placement and refinement, Optimization and validation of protein models. Threading and Ab-initio modeling, Ramchandran plot.	**8**
III	Introduction to QSAR for lead module: Linear and nonlinear modeled equations, Biological activities, Physicochemical parameters and Molecular descriptors, Application of QSAR modeling in drug discovery.	**8**
IV	Molecular Mechanisms: Introduction to Force field, Use of various parameters for force field calculation (Bond length, angle angle, torsion angle, Electrostatic interaction, Vander waals interactions, Miscellaneous interaction); Introduction Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics, Conformation searching, Systematic search, Applications to protein folding.	**8**
V	3D pharmacophores modeling, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies; 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching,combinatorial libraries – generation and utility.	**8**
		40

1	**SUBJECT CODE:** BBT551	**COURSE TITLE:** Genetic Engineering Lab
2	**EXAM DURATION:** 2 HOURS	**SEMESTER:** V
3	**L:T:P::** 0 : 0 : 2 **CREIDTS :** 1	**PREREQUISITES:** Genetic Engineering theory course

COURSE OBJECTIVES:

To isolate the various biomolecules and genetic materials from cells and tissues
To develop understanding of estimation of Genetic material
To provide practical knowledge restriction digestion, transformation, screening and verification of cloning
Practical knowledge of ligation, blotting and cloning.

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Demonstrate the isolation genetic materials
CO2	Perform experiments related to cloning, ligation, restriction digestion and transformation etc.
CO3	Demonstrate the Southern Blotting for identification of desired DNA in a pool DNA samples
CO4	Perform the bacterial cell competent for transformation
CO5	To be able to express foreign protein
CO6	To be able to use acquired knowledge for commercial products

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	-	-	-	3	3	-	-	-	-	-	-	3
CO-2	-	-	-	3	3	-	-	-	-	-	-	3
CO-3	-	-	-	3	3	-	-	-	-	-	-	3
CO-4	-	-	-	3	3	-	-	-	-	-	-	3
CO-5	-	-	-	3	3	-	-	-	-	-	-	3
CO-6	-	-	-	3	3	-	-	-	-	-	-	3

REFERENCE BOOKS:

1. Laboratory manual on Molecular Biology & geneticEngineering-A new approach (2012), R.S. Sengar

2. Laboratory Manual for Genetic Engineering (2009) S. john Vennison.Prentics hall publication

COURSE DETAILS: Genetic Engineering Lab	
S. NO.	**LIST OF EXPERIMENT**
1	Isolation of RNA and its estimation by orcinol method
2	Isolation of plasmid DNA and its estimation by diphenylamine reaction
3	Elution of plasmid DNA from agarose gel
4	To perform restriction digestion of λ DNA
5	Dephosphorylation of restriction enzyme digested vector pUC18
6	To make bacterial cells competent for transformation
7	To perform of transformation of the desired bacterial strain with plasmid DNA
8	Screening of transformed colonies by X gal and IPTG
9	Verification of cloning by colony PCR and screening of the positive colonies
10	To perform a Southern Blotting for identification of desired DNA in a pool DNA samples
11	To perform ligation of λ EcoRI digest using T4DNA ligase

1	**SUBJECT CODE:** BBT552	**COURSE TITLE:** Fermentation Biotechnology Lab
2	**EXAM DURATION:** 2 HOURS	**SEMESTER:** V
3	**L:T:P::** 0 : 0: 2 **CREIDTS :** 1	**PREREQUISITES:** Fermentation Biotechnology theory course

COURSE OBJECTIVES:

determine the growth pattern of microbial cell.
rform the production of antibiotics, enzymes and acids through fermentative process
provide practical knowledge for production of ethanol, and down streaming.
actical knowledge of solid state fermentation & submerged fermentation

COURSE OUTCOME: Upon completion of this course, the students will be able to:

CO1	monstrate the growth pattern of *E. coli.*
CO2	rform experiments related to production of antibiotics, enzymes and acids through fermentation process.
CO3	monstrate the downstream processing of fermentative products.
CO4	rform the solid state fermentation and submerged fermentation.
CO5	rform experiments related to production of antibiotic.
CO6	fect of carbon source on microbes.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3			1	1		2	2	2		2	3
CO-2		3	2	2	1		1	2	1		1	3
CO-3			3	1	2		2	1	2		2	2
CO-4		1	2	3	1		1	2	1	1	2	3
CO-5		3			2		2	1			1	2
CO-6			2	3	1		2	1	2		2	3

REFERENCE BOOK:

- Practical Manual on Fermentation Technology by S. Kulandaivelu, S. Janarthanan.
- J.Jayaraman , “Laboratory Manual in Biochemistry”, New Age International Publications.
- Fermentation-A practical Approach by G T Banks-FEBS Press.

Course Details: Fermentation Technology Lab		
Unit	**Content**	**Contact Hours**
I	Determine the growth patterns and specific growth rate of *E. coli*	2
II	Determine the effect of peptone concentration on *E .coli* growth	2

III	Fermentative production of Penicillin Antibiotics using *Penicilium chrysogenum.*	2
IV	To study the induction effect of β-galactosidase enzyme in *E. coli.*	2
V	Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*.	2
VI	Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger.*	2
VII	Microbial production of citric acid by solid state fermentation process.	2
VIII	Microbial production of enzymes by (a) solid state and (b) submerged fermentation.	2
IX	Fermentative production of Ethanol using *Saccharomyces cerevisiae*	2

1	**SUBJECT CODE:** BBT553	**COURSE TITLE: Bioinformatics I (Virtual Lab)**
2	**EXAM DURATION:** 3 HOURS	**SEMESTER:** V
3	**L:T:P::** 0 : 0 : 2 **CREIDTS : 2**	**PREREQUISITES:** Bioinformatics theory course

COURSE OBJECTIVES:

To retrieval of the sequence data
Demonstration of locating the chromosome and retrieval of gene expression data
To provide practical knowledge for retrieval of PubMed data
Practical knowledge of ORF finding, motif information and retrieval of Gene information

COURSE OUTCOMES (SIX): Upon completion of this course, the students will be able to:

CO1	Demonstrate the retrieval of sequence data
CO2	Perform experiments related to locating chromosome and gene expression data
CO3	Demonstrate the data retrieval system of PubMed.
CO4	Perform the ORF finding and retrieval of gene information
CO5	Utilize the Protein Data Bank (PDB) database to retrieve and interpret structural data of proteins.
CO6	Use the Prosite database to identify and retrieve motif information associated with protein sequences.

CO-PO MAPPING (1 TO 3 SCALE)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	1	1	1	1	2	1	1	2	1	1	1
CO-2	3	2	2	1	1	1	1	1	2	1	1	1
CO-3	1	2	1	1	1	2	1	1	1	1	1	1
CO-4	1	1	2	1	1	2	1	1	1	1	1	1
CO-5	3	1	1	2	1	1	1	1	1	1	1	1
CO-6	3	1	1	1	1	1	1	1	2	2	2	1

REFERENCE BOOK:

1. Alphey L. DNA sequencing: from experimental methods to bioinformatics. BIOS scientific publishers Ltd; 1997
2. Iftekhar M, Ghalib MR. Bioinformatics Practical Manual
3. Karthikeyan M, Vyas R. Practical chemoinformatics. Springer; 2014 May 6

COURSE DETAILS: BIOINFORMATICS I (VIRTUAL LAB)		
Unit	**Content**	**Contact Hours**
I	Retrieving sequence data from Entrez: Learn how to access and retrieve nucleotide and protein sequences from the Entrez system, a key resource for bioinformatics research.	1
II	Retrieving structural data of a protein using PDB database: Acquire the skills to retrieve and interpret 3D protein structures from the Protein Data Bank (PDB) to understand protein function and interactions.	1
III	Retrieving Motif Information of a Protein Using Prosite: Explore how to identify and analyze protein motifs using the Prosite database, enhancing your understanding of protein function and classification.	1
IV	Locating the chromosome of a Gene : Develop the ability to accurately locate and interpret the chromosomal position of genes, which is crucial for studying genomic organization and gene function.	2
V	Finding ORF of a Given Sequence: Gain expertise in identifying open reading frames (ORFs) within nucleotide sequences, a fundamental step in gene prediction and analysis.	1
VI	Locating the chromosome of a Gene: Learn to identify the chromosomal location of specific genes, which is essential for understanding their role in genetics and genomic organization.	2

B.Tech.

(Biotechnology)

3rd Year

6th Sem

Syllabus

SUBJECT CODE: BBT 601
EXAM DURATION: 3 Hours
L: T: P :: 3 : 0 : 0 **CREDITS:** 3

COURSE TITLE: Bioprocess Engineering II
SEMESTER: VI (EVEN)
PREREQUISITE: Basic Knowledge of Fermentation Biotechnology, Bioprocess Engineering I and Microbiology

Course Objectives:

- To impart knowledge on fundamentals of stoichiometry of reactions used in bioreactor operations.
- To explain the principles of bioreactors and their application to upstream and downstream processing.
- To impart knowledge of different kinetics models applied for Batch, CSTR, PFR and other types of reactors.
- To describe the different downstream processing, product fractionation and polishing techniques.

Course Outcomes (Six):

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

- Perform unit conversions; solve material and energy balance problems in unit operations.
- Analyze the stoichiometry of cell growth and product formation.
- Learn about classification and kinetics of reactions, elementary and non-elementary reactions.
- Kinetic analysis of batch reactor, CSTRS and Plug flow reactor data.
- Recognize the basis for various steps in downstream processing design strategy for purification of a product.
- Learn techniques such as precipitation, membrane separation and chromatographic techniques for the purification of a targeted protein(s) or any other biological material.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	1	1	1							1
CO-2	2	2	2	1	1							
CO-3	2	2	2	2	2							
CO-4	1	1	1	1	2							
CO-5	2	2	1	2	2							
CO-6	2	1	2	2	2							

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	K.V. Narayanan and B. Lakshmikuttyamma, Stoichiometry & Process Calculations, Prentice Hall Publishing, Delhi.	2006
2.	B.I. Bhatt and S. M. Vora, Stoichiometry, 4th Edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi.	2001
3.	M. L. Shuler and F. Kargi, Bioprocess Engineering-Basic Concepts, 2nd Edn., Prentice Hall.	2004

4.	P. M. Doran, Bioprocess Engineering Principles, 2nd Edn, Academic Press.	2005
5.	N. K. Prasad, Downstream Process Technology - A New Horizon in Biotechnology", Prentice Hall of India, New Delhi.	2012
6.	M. R. Ladisch, Bioseparations Engineering: Principles, Practice and Economics, 1st Edn., Wiley Interscience.	2001
7.	J. D. Seader and E.J. Henley, Separation Process Principles, 3rd Edn., Wiley.	2010
8.	Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd.	2008
9.	P. A. Belter, E. L. Cussler, and W.S. Hu, Bioseparation: Downstream Processing for Biotechnology, 2nd Edn., Wiley-Interscience.	1994

Course Details

COURSE DETAILS: BIOPROCESS ENGINEERING II		
Unit	**Content**	**Contact Hours**
I	**Stoichiometry of Bioprocesses: Material and Energy Balance** Introduction to conversion of units, Dimensionless groups applied in bioprocess, graphical differentiation and integration, material balance equation for steady and unsteady state, simplifications for steady-state processes with and without chemical reaction, stoichiometry of cell growth and product formation, degrees of reduction of substrate and biomass, yield coefficients of biomass and product formation, maintenance coefficients, oxygen consumption and heat evolution in aerobic cultures. Energy balance - heat capacity, estimation of heat capacities, general energy balance, Enthalpy calculation, enthalpy change: heat of combustion, heat of reaction for biomass production processes, energy-balance equation for cell culture and fermentation processes.	13
II	Kinetics of homogenous reactions: classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and non-elementary reactions, Kinetic models for non-elementary reactions, temperature dependent term of a rate equation, activation energy and temperature dependency.	10
III	Kinetic analysis of batch reactor data: Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half-life period, irreversible reaction in parallel and series, auto catalytic reactions. Kinetic interpretation of batch reactor data for single reactions, interpretation of variable volume batch reaction data for zero, first, second and third order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation. Design for single reaction: size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system	10

	of given conversion, recycle reactor, Design of multiple reactions in batch, CSTR and PFR.	
IV	**Downstream Processing** Introduction to the various downstream processing steps and their significance in biotechnology, Cell disruption; cell separation, Centrifugation and Filtration: Flocculation, and sedimentation. Extraction: Basic equations of extraction, Aqueous two-phase extraction, batch extraction, staged extraction and differential extraction, Supercritical fluid extraction; Adsorption and Leaching, Precipitation; Membrane-based purification: Reverse osmosis, Dialysis.	8
V	**Product Resolution / Fractionation and Polishing** General chromatography theory and the different chromatographic techniques like adsorption, partition, ion exchange, affinity, gel filtration and HPLC, Dialysis, Crystallization, and Drying. Any Emerging Technologies in downstream processing in biotechnology industries.	8
		49

SUBJECT CODE: BBT 602 **COURSE TITLE:** PLANT BIOTECHNOLOGY
EXAM DURATION:3 HOURS **SEMESTER:** VI (EVEN)
L: T: P :: 3 : 1 : 0 CREDITS: 4 **PREREQUISITE:** Basic knowledge of genetic engineering ,biochemistry and elementary biology

Course Objectives:

- To impart the basic concepts of plant tissue culture.
- To develop understanding about tissue culture techniques and involved culturing strategies.
- To impart knowledge about the importance of tissue culture in crop improvement.

Course Outcomes :

On successful completion of the course, the student will be able to:

- Understand the principle and basic requirements for plant tissue culture.
- Explain the difference between tissue and organ culture and their applicability.
- Understand haploid culture and in vitro selection of mutants.
- Analyse somaclonal variation for improved crop varieties in vitro cultures.
- Identify suitable cryopreservation and reculture technique for the cultured tissue.
- Understand the development of transgenic plants through genetic manipulations.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	1	2	1	2	1	1					1
CO-2	3	2	2	1	3	1	1					1
CO-3	2	1	2	1	3	1	1					1
CO-4	2	2	2	1	3	1	1					1
CO-5	2	1	2	1	3	1	1					
CO-6	2	2	2	1	3	1	1					1

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Hudson T Hartmann: Plant Propagation-Principle and Practices, Pearson Education India; 8 edition.	2015
2.	Principles of Plant Biotechnology- An Introduction of Genetic Engineering in Plants by S.H. Mantell, J.W. Mathews and R.A. Mckee, Blackwell Scientific Publications.	1985
3.	Chopra V L, Sharma R P & Swaminathan M S: Agricultural Biotechnology by Science Pub Inc.	1996
4.	Hamish A, Collin & Sue Edwards: Plant Cell Culture, BIOS Scientific Publishers.	1998
5.	Razdan M K: An Introduction to Plant Tissue Culture, Science Publishers.	2003

6.	Plant Tissue Culture: Theory and Practice by S.S. Bhojwani M.K. Razdan, Elsevier Science.	1996
7.	H.S. Chawla. Plant Biotechnology, Oxford & IBH Publishing 2020Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag.	1998

Course Details

Course Details: PLANT BIOTECHNOLOGY		
Unit	Content	Contact Hours
I	**Introductory history of plant biotechnology:** Laboratory organization; Principles of Plant Tissue Culture. Concepts of totipotency, explants, inoculums, acclimatization. Nutrition of plant cells; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents. An appraisal of different media, selection of media, Sterilization of the media. Hormones: Auxins, Cytokinins, Gibberellins, Abscisic Acid, Ethylene etc. Explant preparation and Surface sterilization. Basic procedure for Aseptic Tissue transfer.	10
II	**Culture of plant materials-** explants selection and technique of culturing. Organogenesis, Embryogenesis, Somaclonal variation, germiclonal variation. Establishment, growth and maintenance of Callus and cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field. Tissue and organ culture; Cellular differentiation and regulation of morphogenesis; Somatic embryogenesis; Control of organogenesis and embryogenesis; Single cell culture	10
III	Haploid production: Androgenesis; Anther and microspore culture; Gynogenesis; Embryo culture and rescue in agricultural and horticultural corps; Protoplast isolation; Culture– regeneration; Somatic hybrid-cybrids; In vitro selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions; Micropropagation: Application of micropropagation in agriculture and forestry. Meristem culture and virus elimination; Shoot tip culture.	8
IV	Improved crop varieties through somaclonal variation in invitro cultures. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture. Application of plant tissue culture production of secondary metabolites and other industrial products.	8
V	Genetic transformation using Ti plasmid Manipulation of gene expression in plants; Production of marker free transgenic plants. Developing insect-resistance, diseaseresistance, herbicide resistance plants. Genetic manipulation of flower pigmentation, Developing quality of seed storage, Provitamin A, iron proteins in rice, modification of food plant taste and appearance, yield increase in plants.	8
		44

SUBJECT CODE: BBT 603
EXAM DURATION:3 HOURS
L: T: P :: 3 : 1 : 0 CREDITS: 4

COURSE TITLE: BIOINFORMATICS II
SEMESTER: VI (EVEN)
PREREQUISITE: Elementary knowledge of bioinformatics I , molecular biology and computer

Course Objectives:

- To provide knowledge to analyze various computational methods involved in protein modeling, RNA structure prediction and drug designing.
- To teach various concepts of machine learning, Artificial Neural Networks, document clustering.

Course Outcomes:

On completion of this course, the students will be able to

- Understand the various tools and techniques related to insilico modeling of biomolecules along with methods of drug designing, protein docking
- Analyze problems related to collection and analysis of biological data
- Develop steady and time dependent solutions along with their limitations
- Apply Machine learning techniques for decision making
- Learning information retrieval using NLP
- Understand molecular dynamics and simulation techniques

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	2	2	3							1
CO-2	2	2	3	3	3							1
CO-3	2	2	2	3	3							1
CO-4	2	2	2	3	3							
CO-5	2	2	3	3	3							
CO-6	2	2	2	3	3							1

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.	1998
2.	D.W.Mount; Bioinformatics- Sequence and genome analysis; Cold Spring HarbourLabpress.	2004
3.	Hand Book Of Bioengineering- Skalak R &ShuChien, McGrawHill.	1986
4.	Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.	2006

5.	Purifing Protein for Proteomics, Richard J. Sinpson, I.K. International Pvt. Ltd.	2004
6.	Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co.	1997

Course Details

Course Details: BIOINFORMATICS II		
Unit	Content	Contact Hours
I	Inference problems and techniques for molecular biology. Overview of key inference problems in biology: Homology identification, Genomic sequence annotation (Genes and ORFs identification), Protein structure prediction (Secondary and Tertiary structure prediction), Protein function prediction, Biological network identification, Next generation sequencing, Microarray data analysis	10
II	Basics of RNA Structure prediction and its limitations, Features of RNA Secondary Structure, RNA structure prediction methods: Based on selfcomplementary regions in RNA sequence, Minimum free energy methods, Suboptimal structure prediction by MFOLD, Prediction based on finding most probable structure and Sequence co-variance method. Application of RNA structure modeling	10
III	Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms, Simulated Annealing, Support vector machines; The relation between statistics and machine learning; Evaluation of prediction methods: Parametric and Nonparametric tests, cross-validation and empirical significance testing (empirical cycle), Clustering (Hierarchical and Kmean).	8
IV	Basic concept of Force field in molecular modeling (Potential energy calculation); Overview of key computational simulation techniques: Introduction to simulation, Computer simulation techniques, Types of computer simulation (Continuous, Discrete-event and Hybrid simulation), Differential equation solvers, Parameter estimation, and Sensitivity analysis.	10
V	Overview of key techniques for the management of large document collections and the biological literature: Document clustering, Information retrieval system; Natural Language Processing: Introduction, Major areas of NLP, Natural language information extraction; Insilico Drug Designing: Major steps in Drug Designing, Ligand and Structure based drug designing, Protein-ligand docking, QSAR Modeling, Pharmacodynamics (Efficacy & Potency) &Pharmacokinetics (ADME), Lipinski's rule of five, Pharmacogenomics.	6
		42

SUBJECT CODE: BBT061
EXAM DURATION: 3 Hours
L: T: P :: 3 : 0 : 0 **CREDITS**: 3
COURSE TITLE: Animal Biotechnology
SEMESTER: VI (EVEN)
PREREQUISITE: Basic Knowledge of Genetic Engineering and Immunology

Course Objectives:

- To introduce in vitro culture techniques of animal cells and tissues
- To learn different types of culture systems and reactors used for culturing of animal cells
- To elaborate various applications of animal tissue cultures with specific reference to transgenic animal production

Course Outcomes (Six):

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

- Understand basics of animal tissue culture and its importance
- Learn about the different types of animal cell culture media, their maintenance and cultivation of cell lines.
- Understand techniques to establish animal cell cultures invitro as well as different types of reactors and their working
- Learn the strategies involved in developing clones in lab
- Understand the methods of transgene delivery and production of transgenic animals
- Understand the process of stem cell differentiation and their applications with case studies

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	2	2	1	1	1				1
CO-2	2	2	2	2	2	1	1	1				2
CO-3	2	2	2	2	2	1	2	1				
CO-4	3	3	2	2	1	1	1	2				
CO-5	3	3	2	1	3	1	1	2				1
CO-6	3	3	2	1	3	1	1	2				1

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell	2000
2.	G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO	1991
3.	I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International	2003
4.	I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International	1997

5.	Animal cell culture: Ian Freshney	2015

Course Details

COURSE DETAILS: ANIMAL BIOTECHNOLOGY		
Unit	Content	Contact Hours
I	Basic cell culture techniques, Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.	8
II	Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture etc.; Behaviour of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants	8
III	Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins	8
IV	Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multi-surface propagators; Multi-array disks, spirals and tubes; Roller culture; Micro carriers; Perfused monolayer cultures; Membrane perfusion; Hollow fibre perfusion; Matrix perfusion; Microencapsulation; Growth monitoring	8
V	Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; Cell lineages and developmental control genes in drosophila and mice; Differentiation of germ layers; Cellular polarity; Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of proto oncogenes	8
		40

SUBJECT CODE: BBT 062
COURSE TITLE: Biomarker & Diagnostics
EXAM DURATION: 3 Hours
SEMESTER: VI (EVEN)
L: T: P :: 3 : 0 : 0 **CREDITS:** 3
PREREQUISITE: Basic Knowledge of Molecular Biology, Immunology and Analytical Techniques

Course Objectives:

- To introduce basics of molecular diagnostics, its scope and applications
- To learn various pathways of cell signaling, eukaryotic cell control system and their components
- To learn different molecular mechanisms of generation of metabolic disorders
- To elaborate various applications of biomarkers in disease diagnostics
- To understand advanced molecular techniques: FISH, CGH, flow cytometry, genome mapping methodology

Course Outcomes (Six):

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

- Understand the history and basics of Molecular Diagnostics.
- Understand importance of biomarkers in molecular diagnostics
- Understand molecular oncology with specific emphasis on cancer and its relevant cause
- Learn principles and applications of some of advanced molecular diagnostic techniques
- Learn about the different types of molecular markers, their role in diagnostics.
- Understand the basics of chromosome related disorders, techniques like FISH, cytometry and others used in diagnostics.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	1	1	1	1				3
CO-2	2	2	1	2	2	1	1					1
CO-3	2	2	2	1	2	1						1
CO-4	2	2	2	2	2	1						2
CO-5	2	1	2	2	2	1						1
CO-6	2	1	1	1	1	1						

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Molecular biology of the cell. Bruce Alberts, 6th Edition	2014
2.	Principles of Tissue Engineering. Robert Lanza. Elsevier Publications	2000
3.	Introduction to Tissue Engineering, Applications and Challenges. Ravi Birla. Wiley Publications	2014
4.	Molecular Cell Biology: Darnell J, Lodish H and Baltimore D	1990
5.	Cell and Molecular Biology: De Robertis EDP and De Robertis EMF	1980
6.	An Introduction to Human Molecular Genetics by Pasternak et al., John Wiley & Sons	2005
7.	Human Chromosomes by Miller & Tharman, Springer Publishing Company	2001
8.	Molecular Biology of the Cell by Alberts et al., Garland Press	2008

9.	Genes IX, by Lewin B, Pearson India	2007
10.	Cell and Molecular Biology by De Robertis and De Robertis, Lipincott & Wilkins	2007
11.	Genome III by TA Brown, Garland Press	2006
12.	Elements of Medical Genetics by Turnpenny and Ellard, Churchill Livingstone	1995
13.	Animal Cell Culture: Ian Freshney	2015

COURSE DETAILS: BIOMARKER & DIAGNOSTICS		
Unit	Content	Contact Hours
I	Introduction to Molecular Diagnostics: History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario, Cellular Complexity: Cell components, Cell Differentiation, Cellular communication – endocrine signaling, paracrine signaling and autocrine signaling, contact dependent and synaptic communications, Intracellular networks – transport pathways, signaling pathways and metabolic networks. Eukaryotic Cell Control System and their Components, Intracellular cell cycle control system, Extracellular Cell Cycle Control System, Regulation of Cell Growth and Apoptosis, Genetic and epigenetic factors that regulate these pathways, their abnormalities that alter the pathways and cellular functions.	**12**
II	Molecular Oncology Mitochondrial disorders: Cancer – Benign and Malignant neoplasms, multifactorial disposition, Cancer pathogenesis, positive and negative mediators of neoplastic development, Proto-oncogenes, Oncogenes and Tumor suppressors. Allele loss and loss of Heterozygosity. Mitochondrial inheritance, Mitochondrial myopathy, lactic acidosis, MELAS, LHONs, identity testing	**8**
III	Biomarkers in disease diagnostics: FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumor & cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders	**6**
IV	Chromosomes, Human disorders, and Cytogenetic analysis: Structure, types and organization; Chromosome organization, Euchromatin and heterochromatin and Histone modifications. Chromosome banding and nomenclature; Nomenclature and functional significances of chromosome bands. GC and AT rich isochores. Structural and Numerical aberrations and its consequences. X-chromosome dosage compensation and inactivation mechanism. Sex determination and Y chromosome; function, and diseases. Uniparentaldisomy, Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques and clinical diagnostics.	**10**
V	Genomic instability, Chromosome mapping & Genome plasticity: Common fragile sites and methods of induction, Heritable fragile sites and FXS. Genomic Instability, mechanism and diseases. Trinucleotide Repeats; Mechanism of expansion and triplet repeats and related disorders. Genetic linkage maps, Relation to the probability of recombination, Pedigree analysis with genetic markers and overview of human genome project	**10**
		46

SUBJECT CODE: BBT 063
COURSE TITLE: Food Biotechnology
EXAM DURATION: 3 Hours
SEMESTER: VI (EVEN)
L: T: P :: 3 : 0 : 0 **CREDITS:** 3
PREREQUISITE: Basic Knowledge of Fermentation

Biotechnology and Microbiology

Course Objectives:

- To introduce significance of microbes in food and food industry
- To learn basic principles of the equipment involved in the commercially important food processing methods and unit operations
- To learn different techniques of food preservation
- To impart knowledge about indicators of food safety and HACCP system

Course Outcomes (Six):

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

- Understand importance of microbes and their products in food industry.
- Acquire knowledge of types of foods and their production methodologies.
- Learn the techniques of alcohol and brewery industry and solve the challenges of similar and associated industries.
- Learn processing and preservation technologies for milk and dairy products.
- Learn about the different Food preservation and packaging techniques.
- Learn the Hazard Analysis Critical Control Point System (HACCP system) and Predictive Microbiology/Microbial Modelling.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	2	3	3	1						1
CO-2	2	2	2	2	2							1
CO-3	2	2	2	2	3							
CO-4	2	2	2	2	3							
CO-5	2	1	1	2	3							
CO-6	1	2	2	2	3	1	3	2				

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Frazier, W.S. and Weshoff, D.C., 2017. Food Microbiology, 5th Edn., McGraw Hill Book Co., New York.	2017
2.	Mann & Trusswell, 2007. Essentials of Human Nutrition.3rd Edition. Oxford University Press	2007
3.	Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi	1987
4.	Lindsay, 1988. Applied Science Biotechnology. Challenges for the Flavor and Food Industry. Willis Elsevier	1988
5.	Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology	1989

Course Details

COURSE DETAILS: FOOD BIOTECHNOLOGY		
Unit	**Content**	**Contact Hours**
I	History of Microorganisms in food: Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic parameters of foods that affect microbial growth. Basic principles of the equipment involved in the commercially important food processing methods and unit operations.	8
II	Microorganisms in food: spoilage of fresh meats and poultry, processed meats, seafood's, fruits and vegetables. Fermented food products, Medical foods, Probiotics and health benefits of fermented milk and foods products. Dehydrated Foods, Enteral Nutrient Solutions (Medical Foods), Single-Cell Protein. Starter cultures, Production process of cheeses, beer, wine and distilled spirits. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.	10
III	Determining Microorganisms and/or their Products in Foods: Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms .Enumeration and Detection of Food-borne Organisms .Bioassay and related Methods. Common Food borne diseases. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products.	8
IV	Food Preservation: Food preservation by various methods especially Irradiation, Characteristics of radiations in food preservation, principles underlying the destruction of microorganisms by Irradiation. Application of radiations in food (processing for irradiation). Radappertization, Radicidation, and Radurization of Foods. Effect of Irradiation on Food quality and storage ability. Miscellaneous Food Preservation Methods: High- Pressure Processing, Pulsed Electric Fields, Aseptic Packaging, Manothermosonication (Thermo-ultrasonication).	8
V	Indicators of Food Safety and Quality: Indicators of Food microbial quality, product quality and food safety. Fecal Indicator Organisms, Predictive Microbiology/Microbial Modeling. The Hazard Analysis Critical Control Point System (HACCP System), Microbiological Criteria. Food borne intoxicants and mycotoxins.	6
		40

SUBJECT CODE: BBT 064 **COURSE TITLE:** Entrepreneurship in Biotechnology
EXAM DURATION: 3 Hours **SEMESTER:** VI (EVEN)
L: T: P :: 3 : 0 : 0 **CREDITS:** 3 **PREREQUISITE:** Elementary Knowledge of Biotechnology and Managerial Economics

Course Objectives:

- To introduce entrepreneurship opportunities in biotechnology
- To learn concepts of entrepreneurs, business development strategies, market
- To understand role of government schemes in development of Bio-entrepreneurship
- To discuss emerging biotechnology based industries related to drug development, transgenics, environmental biotechnology
- To understand ethics and IPR in biotech industries

Course Outcomes (Six):

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

- Understand the importance of Bio-entrepreneurship and its scope.
- Learn about important factors affecting biotech business.
- Understand the important aspects of establishing bio-industries.
- Learn about different policies by the Government. They will also come to learn about different schemes for setting up biotech industries.
- Learn fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
- Pave the way for the students to catch up Bio-entrepreneurship as a career option

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	1	2	1	1	2	2	3	1
CO-2	1	1	1	1	1	2	1	2	3	3	3	
CO-3	1	1	1	1	1	1	1	2	3	3	3	
CO-4	1	1	1	1	1	1	1	1	2	2	2	
CO-5	1		1		1	1	1		2	2	2	
CO-6			1	1	1			2	2	2	3	

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Biotechnology Entrepreneurship 1st Edition. Starting, Managing, and Leading Biotech Companies. Craig Shimasaki. Academic Press.	2014
2.	Introduction to Biotech Entrepreneurship: From Idea to Business: A European Perspective. Matei**,** Florentina**,** Zirra, Daniela (Eds.). Springer nature publication.	2019

3.	Biotechnology Entrepreneurship from Science to Solution Start-Up, Company Formation and Organization, Team, Intellectual Property, Financing, Part 1st Edition. Michael L. Salgaller. Logos Press.	2010
4.	How to Start a Biotech Company. Sourish Saha et.al., Independently published.	2019

Course Details

COURSE DETAILS: ENTREPRENEURSHIP IN BIOTECHNOLOGY		
Unit	**Content**	**Contact Hours**
I	Entrepreneur - Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Development of Entrepreneurship steps in entrepreneurial process, Biotech Entrepreneurship in India, Identification of Business Opportunities, Qualities, skills and attributes that successful biotech entrepreneurs possess. Case studies of successful and unsuccessful bio-entrepreneurs	8
II	Business development in biotechnology - Factors affecting biotech business: (finance, infrastructure, equipment, manpower , resources , project location, end product, quality issues, etc.) Basic principles and practices of management - Definition, concepts and application; Organization types, coordination, control and decision making in management	8
III	Core concept of Market: Identification and evaluation of market potential of various bioentrepreneur sectors. Marketing, Marketing research-concept and techniques, Considerations in establishment of biotechnological start-up - Different models of biotechnological start-ups .The budget for a biotechnological start-up company. Seed capital raising for a biotechnological startup company	8
IV	Role of government and schemes, financial institutions in fostering Bio-entrepreneurship, Skills in bio-entrepreneurship-Personality and attitude, Organizational behavior, Leadership, Principles of effective communication Body language, public speaking, presentations, business proposal writing.	8
V	Biotechnology: emerging industries with examples from Transgenic, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module. Ethics and IPR in biotech-Industries - Fundamentals of ethics in business, Ethical dilemmas in biotech industry, IPR- Introduction, Forms of IPR.	8
		40

SUBJECT CODE: BBT 651 **COURSE TITLE:** Bioprocess Engineering II Lab

EXAM DURATION: 2 Hours **SEMESTER:** VI (EVEN)

L: T: P :: 0 : 0 : 2 **CREDITS:** 1 **PREREQUISITE:** Bioprocess Engineering theory course

Course Objectives:

- To impart knowledge about the basic fundamental principles of bioprocess engineering by performing different experiments.
- To make them correlate theory and practical process by experimentation.

Course Outcomes (Six):

On successful completion of the course, the student will be able to

- Learn process of cellular disruption and cell components separation
- Learn estimation and separation of proteins using different techniques.
- Understand the process of manufacturing and processing of recombinant proteins.
- Understand the basics of different chromatographic techniques and their applications in manufacturing industries.
- Learn the process of isolation and extraction of phytochemicals
- Learn product polishing techniques.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	2	1	3				1		1	1
CO-2	2	2	3	1	2						1	
CO-3	1	1	2	2	2							
CO-4	3	2	2	2	2							1
CO-5	2	2	2	2	1							
CO-6	2	2	2	2	1						1	

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Scopes, R. K. Protein Purification: Principles and Practice, 3rd Edn, Springer.	2013
2.	Andreas, H., Walker, J. M., Wilson, K., Clokie, S. (Eds.). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, United Kingdom: Cambridge University Press.	2018
3.	Belter, P. A., Cussler, E. L., and Hu, W.S. Bioseparation: Downstream Processing for Biotechnology, 2nd Edn., Wiley-Interscience.	1994

4.	Abelson, J. N. Simon, M. I. and Deutscher, M. P. Methods in Enzymology: Guide to Protein Purification, Volume 182, Academic Press.	1990
5.	Published research articles related to the experiments	

Course Details

S. No	List of Experiments
1	Estimation and separation of proteins using different techniques.
2	Bacterial cell disruption using different methods like physical, chemical and enzymatic methods.
3	Downstream processing of a recombinant protein over expressed in bacterial system.
4	Separation of a recombinant protein in bacterial cell lysate using Ammonium sulphate precipitation.
5	High resolution purification of the recombinant protein by affinity chromatography.
6	Downstream processing of lysozyme from egg white using ion exchange chromatography.
7	Downstream processing of lysozyme from egg white using ion exchange chromatography.
8	Downstream processing of caffeine from tea dust.
9	Experiments involving crystallization of the downstream processed material.
10	Product polishing by lyophilisation and drying.

SUBJECT CODE: BBT 652 **COURSE TITLE:** Plant Biotechnology Lab
EXAM DURATION: 2 Hours **SEMESTER:** VI (EVEN)
L: T: P :: 0 : 0 : 2 **CREDITS:** 1 **PREREQUISITE:** Plant Biotechnology theory course

Course Objectives:

- To provide knowledge to apply fundamental principles of plant tissue culture.
- To teach concepts behind culturing techniques from different explants.
- To inculcate the hands on practice attitude in students to perform explants selection, media preparation, sterilization and callus culture initiation.

Course Outcomes (Six):

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

- Operate and handle the plant biotechnology lab equipment.
- Perform tissue culture media preparation, sterilization and explants selection.
- Understand in vitro cultures through axillary bud induction
- Analyze plant secondary metabolites from selected medicinal
- Learn DNA/RNA extraction and estimation
- Perform extraction of plant proteins along with estimation.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	1	2	2	3	1	2		1		1	2
CO-2	2	2	1	1	3	1	1		1		1	2
CO-3	2	1	3	1	2	1	1		1		1	1
CO-4	2	2	2	1	1	1	1		1		1	1
CO-5	2	1	3	2	2	2	2		1		1	1
CO-6	2	2	3	2	1	1	1		1		1	1

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Plant Biotechnology: Practical Manual by C.C. Giri, ArchanaGiri I. K. International Publications.	2007
2.	A Practical Manual For Plant Biotechnology by Tejovathi G, CBS Publishers and Distributors.	1996
3.	Plant Biotechnology: Laboratory Manual For Plant Biotechnology by H.S. Chawla, Oxford and IBH Publishing	2004

Course Details

S. No	List of Experiments
1.	Preparation of Stocks solution for plant tissue culture media.
2.	Preparation of MS/B5 medium (semi-solid) and sterilization.

3.	Explant selection, preparation and surface sterilization.
4.	To learn culturing, sub culturing and maintenance using selected explants.
5.	Initiation of in vitro cultures through axillary bud induction.
6.	Initiation of callus cultures from different explants.
7.	Preparation of artificial seed/synthetic seed for conservation of germplasm.
8.	Extraction of DNA/RNA from plants and its estimation.
9.	Isolation and characterization of plant secondary metabolites from selected medicinal plants.
10.	Extraction of proteins from plants and its estimation.

SUBJECT CODE: BBT 653 **COURSE TITLE:** Bioinformatics II Lab
EXAM DURATION: 2 Hours **SEMESTER:** VI (EVEN)
L: T: P :: 0 : 0 : 2 **CREDITS:** 1 **PREREQUISITE:** Bioinformatics II theory course

Course Objectives:

- To introduce the fundamental principles of bioinformatics
- To make them correlate theory and practical processes through experimentation.

Course Outcomes (Six):

After successful completion of this course, the students will be able to:

- Understand the basic software and tools used in structure prediction of biomolecules
- Conduct experimental procedure for Ramachandran plot and its analysis
- Construct and analyse of restriction maps, QSAR model and homology model
- Identify and structurally modify a natural product, to design a compound with the desired properties and to assess its therapeutic effects, theoretically.
- Enhance their practical knowledge and thus their employability
- Construction of primer for PCR.

CO-PO Mapping (1 to 3 scale)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	2	2	3				2		1	1
CO-2	2	2	2	1	3				1		2	1
CO-3	2	2	2	2	2				1		1	1
CO-4	2	2	2	2	3				1		2	1
CO-5	2	2	3	3	2				1		1	1
CO-6	2	2	3	3	2				1		1	1

Reference Book:

S. No.	Name Of Authors/Books/Publishers	Year of Publication/ Reprint
1	Alphey L. DNA sequencing: from experimental methods to bioinformatics. BIOS scientific publishers Ltd; 1997.	1997
2	Iftekhar M, Ghalib MR. Bioinformatics Practical Manual	2015
3	Karthikeyan M, Vyas R. Practical chemoinformatics. Springer; 2014 May 6	2014
4	Brown FK. Chemoinformatics: what is it and how does it impact drug discovery. Annual reports in medicinal chemistry. 1998 Jan 1;33:375-84	1998

Course Details

S. No	List of Experiments
1	Identification of Distantly related homologous sequences of a given query protein sequence using PSI-BLAST
2	Construct Phylogenetic tree of five evolutionary related protein/nucleotide sequences
3	Prediction of secondary structure of RNA using any web server.
4	Construction and analysis of Ramachandran Plot using any suitable web server
5	Align two homologous protein structure and calculation the RMSD for the superposition result
6	Comparative assessment of best available tools for genome annotation
7	Construction of restriction maps for various vectors used in genetic engineering using tool "NEB cutter".
8	Primer Design: Construct primers for the given DNA sequence using any suitable web based tool
9	Generate 2D QSAR model of a set of legend descriptor data